Vol. 36, No. 2, July 2012 ISSN 0378-813 X

PKV RESEARCH JOURNAL

DR. PANJABRAO DESHMUKH KRISHI VIDYAPEETH

(AGRICULTURAL UNIVERSITY)

AKOLA (Maharashtra) INDIA

DR. PANJABRAO DESHMUKH KRISHI VIDYAPEETH, AKOLA

RESEARCH JOURNAL

1. PKV Research Journal is published twice a year in January and July by Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola.
2. The contribution of paper is open only to active members and subscribers.
3. Annual membership of Journal subscription (with effect from 1-1-2006)
   i) Active member Rs. 200/- per annum
   ii) Students Rs. 100/- per annum
   iii) Libraries/Institutes Rs. 200/- per annum
   iv) Other subscribers Rs. 500/- per annum (for overseas)
   v) Life members/Donors Rs. 1000/- (Rs. 3000/- for overseas)
   vi) Patrons Rs. 5000/-
   vii) Sustaining Associates Rs. 10,000/-
4. A limited space will be provided for the advertisement pertaining to various branches of Agriculture and Veterinary Science.
5. **Correspondence :** All correspondence regarding subscription and business matter may please be addressed to the Secretary, PKV Research Journal, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Krishi Nagar, Akola - 444 104 Maharashtra State (India).

This publication is included in the abstracting and indexing coverage of Biosciences Information Service of Biological Abstracts and Field Crop Abstracts.

CONTENTS

Vol. 36 **No. 2** **July, 2012**

Short Note

PKV Res. J. Vol. 36 (2), July 2012

Evaluation of Different Grain Sorghum Genotypes for Stability and Genotypes x Environment Interaction

Bahaa A. Zarea

ABSTRACT

Twenty grain sorghum genotypes were evaluated under eight different environments (two nitrogen fertilizer levels, i.e 50 and 100 kg N fad^{-1} (fad=4200 m^2) at two locations, i.e. Sohag and Assiut Agricultural Research Stations, in two successive growing seasons, 2008 and 2009). The combined analysis of variance over all environments indicated significant differences between all studied genotypes respecting grain yield and the agronomic traits. The response of genotypes to environments varied greatly and significantly, all genotypes exhibited better performance under high level of nitrogen fertilization. The range of the studied traits ranged from 69.6-74.9 days for flowering date, 113.6-138.7 cm for plant height, 7.1-9.1 for number of green leaves plant^{-1}, 19.8-24.0 g for 1000-27.9-59.8 g plant^{-1} for grain yield plant^{-1}. Highly significant genotype x environment interaction was found for all studied characters. A large portion of this interaction was accounted for by the linear regression on the environmental means. The magnitude of non-linear components was considerably small. Stability parameters across all environments indicated that all hybrids exhibited significant linear response to environmental conditions. Five genotypes, i.e., BTX-629, BTX-630, ICSB-88003, ICSB-20 and ICSB-155 showed stability in grain yield and other traits since they had high means and exhibited high regression coefficient (approximately one).

Grain sorghum (*Sorghum bicolor* (L.) Moench) is the best adapted Cereals to adverse conditions of water, Salinity and low soil fertility. Evaluation of genotypes under different environmental conditions and genetic stability are important in plant breeding program. Adaptability and stability performance of cultivars over locations and years are important for national policy in crop production, therefore, a grain producer is interested primarily in growing a cultivar with high yield and stability performance at a proper location.

Rao (1970) evaluated six sorghum genotypes at 18 locations over a two years period in India and revealed that genotype x location and genotype x location × year interactions were highly significant, while genotype × year interaction was not significant. Cowie (1973) reported that nitrogen supply had major effects on grain yield. Rao (1972) and Kambal and Mahmoud (1978) concluded that the interaction of genotypes with locations was more numerous than that of genotypes x years indicating that the genetic superiority of specific genotypes over a large number of locations can help in earlier release of a new hybrids or varieties resulting in saving time and efforts. Desai *et al.*, (1983) studied G x E interaction in sorghum hybrid breeding and concluded that the high yielding ability of hybrids was primarily due to better management. Saeed *et al.*, (1984) reported that genotypes showed larger interaction with locations within a year than that with years irrespective of maturity. They revealed that testing genotypes at more locations should be done rather than testing genotypes in more years. Moreover, increasing number of replications per test more than two, environments in a year more than eight, and years of testing more than two, was not effective in increasing efficiency in genotypes evaluation, especially for early and medium maturing genotypes. Eweis *et al.*, (1992) indicated that yield and yield components of Dorado variety were significantly increased by increasing nitrogen fertilizer rates from 60 up to 100 kg N faddan^{-1}. Bashir *et al.*, (1994) found that the average of grain yield was significantly increased by 1.8 (ard fad^{-1}) when raising nitrogen rate from 80 to 100 kg fad^{-1}.

Eweis (1998) studied the yield stability of a number of sorghum varieties across 14 different environments at Middle and Upper Egypt. He found that genotype x environment (GxE) interaction was highly significant and played an important role in determining yield stability. Ali (2000) reported that mean square due to the linear interaction of crosses x environments was highly significant for panicle weight and grain yield plant^{-1}. In this regards, Mourad et al (2000) found that panicle weight, grain yield panicle^{-1}, 1000-grain weight, green yield, total biomass and grain yield significantly increased by increasing nitrogen fertilizer rates from 80 to 100 kg fad^{-1}. Mostafa, (2001) studied performance and stability of some grain sorghum genotypes (varieties and hybrids) over years. He found that mean squares due to years, genotypes and years x genotypes were significant in case of number of days to 50 per cent flowering, plant height

Assistant Research, Field Crop Research Institute (FCRI), Sorghum Research Department, Egypt

and grain yield. Moreover, the significancy of pooled deviation for grain yield indicated that the genotypes differed considerably with respect to their stability. Data showed that the variety E 35-1 had a (bi) value (1.75) and an average grain yield higher than the grand mean and it seemed to be the most desirable and stable genotype. Kheiralla, *et al.*, (2004) reported that the pooled deviation mean squares were significant for Spike length and 1000-kernel weight indicating that the non-linear component of genotypes x environment interaction was operating.

The main objectives of this study were to evaluate mean performance of twenty grain sorghum genotypes under two dosages of nitrogen across two years and two locations and to identify grain yield stability of these genotypes over tested environments.

MATERIAL AND METHODS

Twenty grain sorghum genotypes (*Sorghum bicolor* (L.) Moench) of diverse origin (Table 1) were evaluated during 2008 and 2009 growing seasons under two dosages of nitrogen fertilizer (50 and 100 kg N fad^{-1}) at two locations, i.e. Sohag and Assiut Agricultural Research Stations (eight environments). Split plot design with three replications was used in this investigation; the main plots consisted of two dosages of nitrogen. The twenty grain sorghum genotypes were randomly assigned to the sub plots. Each genotype was sown in one row 6.0 m. long and 60 cm. apart. Planting were done in hills spaced 15 cm apart within row and seedling were thinned to two plants $hill^{-1}$. Planting dates were June 22nd and 23rd and June 19th and 20th at Sohag and Assiut in 2008 and 2009 growing seasons, respectively.

Data were recorded on days to 50 per cent flowering, plant height (cm.), number of green leaves $plant^{-1}$, 1000-grain weight (g) and grain yield $plant^{-1}$. The grain moisture was adjusted to 14 per cent moisture. All other agronomic practices were done as recommended for grain sorghum.

Data for two years, two locations and two fertilizer rates were considered as eight environments (EV_1 through EV_8). The analysis of variance for each environment was performed according to Steel and Torrie, 1980. Critical Differences (CD) were used for comparing means. Test of homogeneity of the error mean squares across all environments was not significant indicating that selection of these environments was not biased. Hence, the combined analysis was performed in this study. It is worth noting that the environments used provided a wide range of environments. The five studied traits were statistically analyzed and combined. Stability analysis for these traits across all environments was performed according to the following model of Eberhart and Russel (1966):

$$Y_{ij} = U_i + \beta_i I_j + \sigma_{ij}$$

Where:

Y_{ij} = variety mean of the i^{th} variety at the j^{th} environment (location).

U_i = mean of the i^{th} variety over all environments.

σ_i = regression coefficient that measures the response of the i^{th} variety to varying environments.

βj = environmental index obtained as the mean of all varieties at the environment j^{th} minus the grand mean.

σ_{ij} = deviation from the regression of the i^{th} variety at the j^{th} environment.

The stable variety is one that has three characteristics as follows:

1 - Regression coefficient significantly different from zero (b_i=0) and not significantly different from unity (b_i = 1).

Table 1. Name and origin of the twenty grain sorghum genotypes.

Name of genotypes		Origin	Name of genotypes		Origin
1.	ICSB-81	ICRISAT	11.	ICSB-88010	ICRISAT
2.	ICSB-79	ICRISAT	12.	ICSB-1816	ICRISAT
3.	ICSB-10288	ICRISAT	13.	ICSB-89002	ICRISAT
4.	BTX-629	ICRISAT	14.	ICSB-1848	ICRISAT
5.	BTX-630	Texas- USA	15.	ICSB-102	ICRISAT
6.	BN-96	USA	16.	ICSB-93	ICRISAT
7.	ICSB-88005	ICRISAT	17.	ICSB-20	ICRISAT
8.	ICSB-3047	Texas- USA	18.	ICSB-95	ICRISAT
9.	ICSB-91003	ICRISAT	19.	ICSB-1836	ICRISAT
10.	ICSB-88003	ICRISAT	20.	ICSB-155	ICRISAT

2 - Minimum value of the deviation of regression, $S^2d_i = 0$.

3 - High performance with a reasonable range of environmental variation.

RESULTS AND DISCUSSION

Data for separate trial were statistically analyzed as usual. Test of homogeneity of the error mean squares across all environments was done as described in Steel and Torri (1982). It was not significant for all studied traits indicating that selecting of these environments was not biased and hence the combined analysis was followed up in this investigation.

The combined analysis of variance (Table 2) revealed that all environments differed significantly regarding all studied traits. Also, for all studied traits, the twenty tested sorghum varieties significantly differed at different environments and when the data were combined over all environments. The interaction of genotypes by environments was significant for all studied traits indicating that each genotype responded differently under each environment.

Data in Tables 3 indicate that the average days to 50 per cent flowering, plant height, number of green leaves plant^{-1}, 1000-grain weight and grain yield plant^{-1} for the 20 sorghum varieties differed greatly and significantly from one environment to another. Based on the combined data, it ranged from 69.6 – 73.9 days for flowering date, 113.6 – 138.7 cm for plant height, 7.1 – 9.1 for number of green leaves plant^{-1}, 19.8 – 24.0 g for 1000-grain weight and 27.9 – 54.6 g for grain yield. Coefficient of variation (C.V. %) were below 10 per cent for all experiments. Rao, (1970), Saeed, *et al.,* (1984) and Kheiralla *et al.,* (1997) observed that the difference in mean performance of a particular set of genotypes (varieties) was due mainly to the use of that new improved varieties and the differences among environments can be mainly attributed to the farmer factor as well as the variation in soil fertility and varied cultural procedures practiced by the farmers. The environmental index for all traits was calculated as the difference between the environment mean and the mean over-all environments. For the five studied characters, the indices covered a wide range and displayed a good distribution within this range. Therefore, the assumption for stability analysis is fulfilled.

The 20 sorghum varieties differed significantly with respect to all studied characters across all environments (Table 2). On the basis of across all environments mean, data in Table 3 showed that the three sorghum genotypes BTX-629, ICSB-155, ICSB-20 were earlier in flowering date as compared to other varieties. For plant height, the three varieties ICSB-3047, ICSB-20 and BTX-629 were the shortest plants (113.6, 123.3 and 123.8 cm), respectively. The high values for number of green leaves plant^{-1} were obtianed for the three sorghum varieties, ICSB-88003, ICSB-88005, ICSB-95 (9.1, 8.6 and 8.6 leaves plant^{-1}), respectively. For 1000-grain weight, the three varieties ICSB-3047, ICSB-102 and ICSB-88002 had the highest values (23.9, 23.9 and 23.8 g), respectievly. The highest grain yield plant^{-1} was obtained by the three sorghum varieties ICSB-88003, ICSB-88010 and ICSB-81 (59.8, 54.6 and 49.8 g plant^{-1}), respectively.

The analysis of variance presented in Table 4 revealed that highly significant mean squares due to genotypes, environments and genotypes × environments interaction for all studied traits indicated that genotype varied considerably across different environments. Furthermore, environment + (genotype × environment) interaction was partitioned into environment (liner), genotype × environment interaction (sum of squares due to regression, bi) and pooled deviation mean squares, S^2d_i

Moreover, most of the G x E interactions was a linear function, which was highly significant for all studied traits. For that reason, the regression coefficient (bi) and deviation from regression (S^2di) pooled over the eight environments were calculated for each genotype. Significant genotype × environment mean squares for the days to 50 per cent flowering, plant height, number of green leaves and grain yield plant^{-1} indicated that genotypes were genetically differed in their response to different environments when tested against pooled deviation. Moreover, the highly significant pooled deviation for days to 50 per cent flowering and 1000 grain weight indicated that the non linear component of genotype × environment interaction was operating. These findings are in agreement with those obtained by Eweis (1998), Ali (2000) and Mostafa, (2001). Meanwhile, it was clear from Table 4 that the interaction of variety x environment for the five studied characters was highly significant. Such significant interactions encourage sorghum breeders to develop high yielding and more uniform varieties under varied environmental conditions. High yield potential and

Table 2. Analysis of variance of separate environments and combined for grain yield and other agronomic traits

Source	d. f.	Flowering date	Plant height	No green leaves	1000-grain weight	Grain yield plant^{-1}
Combined over 8 environments						
Environments (Env)	7	466.176**	7314.047**	68.001**	323.324**	1769.378**
Rep (Env)	16	1.573	38.235	0.241	0.575	8.549
Genotypes (G)	19	33.531**	1318.432**	7.141**	39.464**	1841.249**
Een x G	133	8.533**	53.012**	0.817**	3.405**	10.779**
Pooled error	304	1.401	25.434	0.474	0.490	5.922
C.V.		1.65	3.98	8.75	3.13	5.781
Env-1 (YR=1 LOC=1 NF=1)						
REP	2	2.150	65.000	0.017	0.126	12.491
GENO	19	13.260**	176.842**	1.628**	4.332**	271.270**
Error	38	0.904	17.632	0.736	0.699	11.569
C.V.		1.40	3.04	9.39		6.74
Env-2 (YR=1 LOC=1 NF=2)						
REP	2	0.417	3.407	0.119	0.138	5.941
GENO	19	8.417**	205.726**	1.677**	5.321**	276.625**
Error	38	1.1545	12.613	0.366	0.511	6.768
C.V.		1.47	2.96	8.37	3.37	6.35
Env-3 (YR=1 LOC=2 NF=1)						
REP	2	2.150	13.138	0.895	0.883	12.149
GENO	19	7.302**	185.370**	1.676**	3.273**	187.368**
Error	38	1.009	20.156	0.424	0.537	3.509
C.V.		1.41	3.34	8.50	3.15	4.41
Env-4 (YR=1 LOC=2 NF=2)						
REP	2	3.217	152.807	0.482	1.239	3.947
GENO	19	9.413**	342.928**	2.423**	5.236**	308.771**
Error	38	1.761	40.039	0.405	0.400	5.940
C.V.		1.78	5.73	9.24	3.06	6.67
Env-5 (YR=2 LOC=1 NF=1)						
REP	2	0.650	30.417	0.017	0.180	12.953
GENO	19	5.834**	211.404**	0.508	15.219**	181.632**
Error	38	1.018	26.469	0.561	0.606	4.931
C.V.		1.46		7.89	3.10	4.58
Env-6 (YR=2 LOC=1 NF=2)						
REP	2	2.017	13.950	0.121	0.710	7.531
GENO	19	16.227**	163.027**	1.421	0.769	188.242**
Error	38	1.754	18.511	17.799	0.368	3.184
C.V.		1.79	3.51	8.72	2.99	4.65
Env-7 (YR=2 LOC=2 NF=1)						
REP	2	1.217	19.117	0.178	0.879	9.750
GENO	19	10.705**	178.157**	1.869**	10.631**	266.427**
Error	38	0.866	12.783	0.548	0.442	8.733
C.V.		1.32	2.75	8.86	2.99	6.70
Env-8 (YR=2 LOC=2 NF=2)						
REP	2	2.317	8.867	0.076	0.448	3.634
GENO	19	22.101	25.876	1.674**	9.518**	236.368**
Error	38	2.579	55.147	0.275	0.365	2.743
C.V.		2.13	6.38	8.13	3.06	4.69

*, ** significant and highly significant at 0.05 and 0.01 probability levels, respectively.

Table 3. Mean performance of twenty grain sorghum varieties evaluated under two nitrogen fertilizer rates at two locations in two successive years, 2008 and 2009 growing seasons (Eight environments, EV_1 through EV_8).

Genotypes	Number of days to 50% flowering									Plant height (cm)								
	EV_1	EV_2	EV_3	EV_4	EV_5	EV_6	EV_7	EV_8	Mean	EV_1	EV_2	EV_3	EV_4	EV_5	EV_6	EV_7	EV_8	Mean
ICSB-81	74.0	73.0	77.0	71.7	76.7	71.0	78.7	77.0	74.9	120.0	146.7	100.0	129.6	117.3	146.7	104.0	130.0	124.3
ICSB-79	71.0	65.7	72.3	70.0	77.3	67.0	79.3	69.7	71.5	123.0	143.3	106.0	146.0	133.0	160.0	121.0	128.3	132.6
ICSB-10288	73.0	69.0	75.7	71.0	74.3	67.0	75.3	69.3	71.8	120.4	140.0	106.1	134.8	122.7	145.0	114.0	128.3	126.4
ICSB-3047	70.7	67.0	72.0	68.7	77.0	69.0	78.7	70.3	71.7	107.0	128.3	96.5	119.1	107.7	130.0	99.0	121.3	113.6
BTX-630	74.3	68.0	75.7	71.7	73.3	70.3	75.3	70.0	72.3	111.8	128.3	100.8	127.6	116.0	136.7	108.0	122.0	118.9
BN-96	73.7	65.0	75.0	71.0	79.0	68.0	81.0	69.0	72.7	116.3	135.0	110.0	131.0	119.7	135.0	116.0	128.3	123.9
ICSB-88005	74.3	69.0	77.0	73.0	72.3	70.7	76.0	71.7	73.0	132.0	143.3	129.7	144.4	132.0	145.0	131.7	140.0	137.3
BTX-629	69.0	64.3	72.0	68.0	73.7	67.0	74.7	68.0	69.6	120.5	136.7	109.9	129.4	118.0	135.0	113.0	128.3	123.8
ICSB-91003	71.7	69.0	72.3	71.0	73.0	67.0	73.3	71.3	71.1	116.2	133.3	104.7	136.9	124.7	145.0	118.0	124.7	125.4
ICSB-1836	72.0	68.0	73.7	69.7	74.3	70.0	76.7	71.0	71.9	109.8	125.0	100.9	125.3	114.3	130.0	110.3	118.3	116.7
ICSB-88010	73.7	70.3	74.7	71.7	71.7	68.7	72.7	70.3	71.7	131.7	148.3	126.7	136.9	124.7	145.0	118.0	141.7	134.1
ICSB-1816	73.3	65.0	76.3	71.7	70.3	69.7	72.7	69.7	71.1	106.2	128.3	100.3	125.6	114.7	130.0	111.0	119.7	117.0
ICSB-89002	72.7	68.0	75.3	73.7	74.0	70.7	75.3	72.3	72.8	117.2	133.3	106.9	132.4	120.7	140.0	114.0	128.3	124.1
ICSB-1848	72.7	66.0	75.7	73.0	75.3	68.7	79.3	70.0	72.6	112.7	128.3	101.5	130.1	118.3	138.3	111.3	119.7	120.0
ICSB-102	72.7	69.0	73.0	69.7	73.7	68.3	73.3	71.7	71.4	128.3	143.3	127.9	139.7	128.0	140.0	127.7	136.7	134.0
ICSB-93	75.0	68.0	76.0	72.0	72.0	70.3	73.0	70.0	72.0	128.5	150.0	120.8	147.7	135.0	155.0	128.3	144.0	138.7
ICSB-20	73.3	66.0	74.3	70.0	71.0	69.0	72.0	69.0	70.6	118.3	136.7	110.6	128.0	116.7	135.0	111.0	130.0	123.3
ICSB-95	76.7	68.7	78.0	73.0	75.7	70.7	77.3	71.3	73.9	117.4	145.0	105.9	142.0	129.3	151.7	121.3	131.3	130.5
ICSB-88003	73.0	69.0	74.0	69.3	74.7	68.0	74.7	71.0	71.7	132.0	143.3	128.4	140.6	128.7	140.0	129.3	138.7	135.1
ICSB-155	71.7	66.0	74.3	72.3	71.0	68.0	72.3	68.7	70.5	129.9	143.3	115.3	142.1	129.7	150.0	122.7	136.7	133.7
Means	72.9	67.7	74.7	71.1	74.0	69.0	75.6	70.6	71.9	120.0	138.0	110.4	134.5	122.6	141.7	116.5	129.8	126.7
CD. 0.05	1.7	1.5	2.1	1.6	2.1	1.7	2.6	1.5	1.94	6.14	8.04	6.31	7.29	7.26	8.23	7.65	5.72	7.14

Table 3. Continued . . . .

Genotypes	Number of green leaves plant^{-1}									1000-grain weight (g)								
	EV_1	EV_2	EV_3	EV_4	EV_5	EV_6	EV_7	EV_8	Mean	EV_1	EV_2	EV_3	EV_4	EV_5	EV_6	EV_7	EV_8	Mean
ICSB-81	8.3	9.0	5.7	8.5	7.3	10.3	6.8	8.1	8.0	22.1	27.7	21.9	24.6	21.4	26.8	21.2	23.8	23.7
ICSB-79	7.7	8.0	6.4	8.4	6.6	9.7	6.7	7.1	7.6	21.1	26.8	20.4	23.9	22.6	28.6	20.6	24.3	23.5
ICSB-10288	7.4	8.3	5.5	7.9	6.6	9.7	5.8	7.5	7.3	21.2	27.2	20.0	22.7	22.8	29.3	22.7	25.7	24.0
ICSB-3047	6.3	8.0	6.0	6.5	7.2	9.3	5.4	7.4	7.1	22.7	28.4	23.5	25.9	20.5	25.6	21.2	23.3	23.9
BTX-630	6.3	9.0	6.4	7.4	7.6	9.3	5.3	7.8	7.5	22.2	27.1	21.0	23.8	20.0	24.4	18.9	21.5	22.4
BN-96	6.4	8.7	5.3	6.6	7.7	10.0	5.3	7.5	7.3	19.4	25.6	18.9	22.0	18.5	24.3	18.0	20.9	20.9
ICSB-88005	8.0	9.7	7.9	8.3	8.5	9.7	7.1	9.3	8.6	22.2	25.8	20.9	23.2	20.0	23.2	18.8	20.9	21.9
BTX-629	6.6	8.7	6.9	7.0	7.6	9.3	6.1	7.9	7.6	21.9	25.8	21.4	23.5	18.8	22.2	18.4	20.2	21.5
ICSB-91003	7.4	9.7	7.3	7.5	8.2	8.7	6.6	8.4	8.1	21.3	24.5	22.1	23.3	18.1	20.8	18.8	19.8	21.1
ICSB-1836	6.9	9.7	7.7	7.6	8.0	9.3	6.9	9.1	8.3	21.3	26.6	21.5	23.9	19.8	24.7	20.0	22.3	22.5
ICSB-88010	8.1	9.0	7.9	8.4	8.4	9.3	7.2	8.6	8.4	19.7	24.6	18.2	21.1	17.7	22.1	16.4	19.0	19.9
ICSB-1816	6.1	9.7	6.1	6.3	7.3	9.0	5.2	8.5	7.4	18.8	25.0	18.4	21.7	16.9	22.5	16.3	19.1	19.8
ICSB-89002	6.9	9.3	7.8	7.6	7.9	9.0	6.9	8.5	8.1	19.4	23.3	21.0	22.5	19.9	24.0	20.7	22.3	21.6
ICSB-1848	6.3	10.0	7.3	6.8	7.5	9.0	6.0	9.2	8.0	19.9	25.5	20.7	22.9	19.3	24.7	20.0	22.3	21.9
ICSB-102	7.4	10.0	7.6	7.9	8.3	9.3	6.8	8.9	8.4	22.1	26.4	21.3	23.7	23.0	27.4	22.2	24.7	23.9
ICSB-93	7.2	8.0	5.9	7.3	8.3	9.7	6.2	7.0	7.5	20.8	26.7	20.2	23.2	19.6	25.1	19.0	21.8	22.0
ICSB-20	7.2	8.3	6.9	7.6	7.5	9.3	6.9	8.7	7.9	21.6	26.4	20.9	23.5	20.8	25.4	20.1	22.6	22.7
ICSB-95	7.7	9.7	7.6	8.4	8.7	9.7	7.3	9.2	8.6	20.5	26.5	18.9	22.3	21.3	27.3	19.7	23.2	22.5
ICSB-88003	8.7	10.3	8.2	9.0	9.3	10.0	7.6	9.6	9.1	22.4	25.7	21.8	23.6	23.2	26.7	22.6	24.5	23.8
ICSB-155	7.8	9.7	7.2	8.1	8.5	10.0	6.8	9.0	8.5	24.1	27.3	20.2	23.5	21.4	26.8	19.8	23.0	23.2
Means	7.2	9.1	6.9	7.7	7.8	9.5	6.4	8.4	8.0	21.2	26.1	20.7	23.2	20.3	25.1	19.8	22.3	22.3
CD. 0.05	1.3	1.3	1.0	1.2	1.0	1.4	1.0	1.1	0.8	1.0	1.4	1.1	1.1	1.0	1.2	0.9	1.1	1.2

Table 3. Continued . . . .

Genotypes	grain yield plant^{-1} (g)								
	EV_1	EV_2	EV_3	EV_4	EV_5	EV_6	EV_7	EV_8	Mean
ICSB-81	49.2	60.0	44.3	49.7	45.3	55.3	40.8	54.0	49.8
ICSB-79	44.6	56.5	37.9	46.6	43.3	54.8	36.8	48.0	46.1
ICSB-10288	29.0	39.2	23.8	33.4	30.2	40.8	24.7	32.2	31.7
ICSB-3047	25.8	35.9	22.5	34.7	27.5	38.2	25.0	31.2	30.1
BTX-630	36.0	45.0	30.6	36.0	33.9	42.4	28.8	38.3	36.4
BN-96	25.5	35.4	21.9	31.7	26.5	36.9	22.8	30.4	28.9
ICSB-88005	47.8	55.1	45.6	48.6	43.8	53.4	44.2	50.1	48.6
BTX-629	27.3	32.6	23.6	28.8	24.4	33.9	24.5	27.7	27.9
ICSB-91003	46.8	53.3	44.2	47.2	40.5	50.0	42.9	48.5	46.7
ICSB-1836	50.9	58.8	46.6	46.2	41.0	51.9	41.1	52.3	48.6
ICSB-88010	54.7	60.8	51.4	54.8	49.5	59.6	50.5	55.9	54.6
ICSB-1816	43.3	54.2	37.7	44.1	40.6	50.7	35.3	47.1	44.1
ICSB-89002	35.0	47.3	29.0	38.2	34.0	46.0	28.2	39.2	37.1
ICSB-1848	42.6	56.1	35.4	43.6	40.0	52.6	33.2	46.6	43.8
ICSB-102	48.0	59.3	46.0	48.1	43.8	54.0	42.8	52.7	49.3
ICSB-93	40.4	51.8	34.0	41.5	38.5	49.4	32.3	43.5	41.4
ICSB-20	35.2	43.9	29.5	36.3	34.6	43.3	31.6	36.9	36.4
ICSB-95	42.1	53.3	36.7	44.1	40.0	50.7	34.8	46.4	43.5
ICSB-88003	59.2	66.5	57.5	59.0	56.4	63.4	54.9	61.8	59.8
ICSB-155	36.3	44.9	33.2	36.4	34.3	42.3	31.3	38.6	37.2
Means	41.0	50.5	36.6	42.5	38.4	48.5	35.3	44.1	42.1
CD. 0.05	4.2	5.4	3.9	3.0	2.9	3.5	2.7	4.7	3.9

average stability are due to most attributes involved in determining the wide adaptation of a new variety or hybrid (Eberhart and Russell, 1966).

Estimates of various stability parameters of the 20 grain sorghum varieties with respect to number of days to 50 per cent flowering, plant height, number of green leaves, 1000-grain weight and grain yield plant^{-1} are presented in Table 5. The stability parameters in this table are: 1. the average ($\bar{x}$) for different characters, 2.the regression coefficient (b_i) of the performance on environmental indices, and 3.the squared deviation (S^2d_i) from the regression. According to the definition of Eberhart and Russell (1966), a stable preferred variety would have approximately: 1. $b_i = 1$, 2. $S^2d_i = 0$ and 3. High mean performance. However, Johnson *et al.,* (1955), Paroda et al (1971) and Lin (1986) considered the squared deviation from regression as a measure of stability, while the regression was regarded as a measure of response of a particular variety to environmental indices.

For days to 50 per cent flowering, all sorghum genotypes, except "ICSB-88010" were stable since it exhibited insignificant deviation from regression (S^2d_i) and b_i values equal approximately one. However, out of the twenty sorghum varieties, ten exhibited b_i values more than one ($b_i > 1$).

As for plant height, the stability parameters (Table 5) indicated that all genotypes accept suitable mean value of this trait. Eleven of them were considered to be more adapted to favourable environments since their regression coefficient values were more than unity ($b_i > 1$). On the other hand, the three sorghum genotypes, ICSB-81, ICSB-79 and ICSB-88010 were considered unstable since they had significant values for deviation from regression (S^2d_i)

The mean values of number of green leaves plant^{-1} varied from 7.2 – 9.1 leaves plant^{-1}. The b_i values for eleven sorghum varieties were above unity ($b_i > 1$), indicating that the non-linear portion of regression was low and the linear regression play an important role in the stability of these varieties under a wide range of environments. On the other hand, five varieties, i.e. ICSB-81, ICSB-79, ICSB-10288, ICSB-1848 and ICSB-93 were considered to be unstable, since they exhibited significant deviation from regression (S^2d_i).

Concerning of 1000 grain weight, the mean values ranged from 19.8 – 23.9 g. It is worth noting that the mean values of most studied varieties tended to be high toward the upper limit of the mean range. Eleven sorghum varieties were considered to be stable since their mean values of the regression coefficient equal

Table 4. Stability analysis of variance for grain yield and other agronomic traits of 20 sorghum varieties evaluated under eight different environmental conditions.

S.O.V.	df	Days to 50% flowering	Plant height	Number of leaves plant^{-1}	1000-grain weight	Grain yield plant^{-1}
Total	159	31.67**	523.89**	4.531**	21.798**	306.94**
Genotypes	19	33.54**	1318.43**	7.141**	39.464**	1841.25**
Env + (Geno x Env)	140	8.41**	138.65**	1.387**	6.467**	32.90**
Env (Linear)	1	1055.20**	1055.19**	157.781**	754.423**	4128.55**
Geno x Env (linear)	19	0.63	905.89**	0.445**	1.447**	10.83**
Pooled deviation	120	0.91**	9.53	0.233	1.0289**	2.27
ICSB-81	6	0.44	21.39*	0.722**	0.045	1.76
ICSB-79	6	0.76	34.52**	0.720**	1.792**	1.03
ICSB-10288	6	1.18	1.85	0.489**	4.123**	3.93
ICSB-3047	6	0.93	7.69	0.097	1.109**	7.75**
BTX-630	6	1.04	2.21	0.076	0.631**	0.57
BN-96	6	0.22	2.15	0.191	0.009	3.64
ICSB-88005	6	0.41	3.76	0.049	0.865**	1.01
BTX-629	6	0.16	5.36	0.069	2.011**	1.54
ICSB-91003	6	0.36	16.08	0.177	2.939**	3.08
ICSB-1836	6	0.09	3.07	0.205	0.273	10.42**
ICSB-88010	6	5.53**	34.2**	0.026	0.508**	1.37
ICSB-1816	6	0.16	6.72	0.255	0.416*	0.53
ICSB-89002	6	0.17	1.34	0.159	0.812**	0.96
ICSB-1848	6	0.51	8.26	0.555**	0.343*	0.66
ICSB-102	6	0.44	7.31	0.122	1.092**	3.03
ICSB-93	6	1.57	2.35	0.509**	0.016	0.67
ICSB-20	6	0.37	9.42	0.114	0.009	1.77
ICSB-95	6	1.16	13.07	0.041	1.599**	0.30
ICSB-88003	6	0.78	6.94	0.067	0.791**	0.99
ICSB-155	6	1.89	2.98	0.010	1.195**	0.36
Pooled error	320	0.47	8.69	0.154	0.165	2.02

1 - ** & * indicate significant at P = 0.01 and 0.05, respectively.

2 – Mean squares of pooled error were divided by number of replications (6).

more than unity $b_i > 1$). On the other hand, values of the deviation from regression (S^2d_i) were significant for 15 sorghum varieties. However, the five genotypes, ICSB-81, BN-96, ICSB-1836, ICSB-93 and ICSB-20 were considered to be stable since they had insignificant deviation from regression (S^2d_i) and also had high mean values as compared to other varieties with b_i values equal approximately one.

Data in Table 5 indicate clearly that values of grain yield plant^{-1} covered a wide range and ranged from 27.9 – 59.8 g plant^{-1}. Fourteen varieties exhibited b_i values equal approximately one; therefore they considered to be stable under a wide range of environments. From these varieties, only two, i.e., ICSB-3047, and ICSB-1836e were unstable since they had significant deviation from regression. On the other hand, all studied varieties except the aforementioned ones were stable since they had insignificant deviation from regression.

Table 5. Stability parameters of grain yield per plant and other agronomic traits for 20 grain sorghum varieties evaluated under eight environments across Egypt.

Genotypes	Days to 50% flowering			Plant height			Number of leaves plant^{-1}			1000-grain weight			Grain yield plant^{-1}		
	$\bar{x}$	b_i	S^2d_i	$\bar{x}$	b_i	S^2d_i	$\bar{x}$	b_i	S^2d_i	$\bar{x}$	b_i	S^2d_i	$\bar{x}$	b_i	S^2d_i
ICSB-81	68.8	0.920	0.44	124.3	1.532	21.39*	8.0	1.111	4.33**	19.8	1.066	0.04	49.8	1.151	1.76
ICSB-79	69.6	0.882	0.76	132.6	1.450	34.52**	7.6	0.726	4.32**	19.9	1.162	1.79**	46.1	1.292	1.03
ICSB-10288	69.9	0.902	1.18	126.4	1.191	1.85	7.4	1.129	2.93**	20.9	1.088	4.12**	31.7	1.075	3.93
ICSB-3047	70.2	0.882	0.93	113.6	1.143	7.69	7.0	1.149	0.58	21.1	1.049	1.11**	30.1	0.946	7.75**
BTX-630	70.6	0.852	1.04	118.9	1.073	2.21	7.4	1.281	0.46	21.5	1.092	0.63**	36.4	1.003	0.58
BN-96	**70.6**	**0.970**	**0.22**	**123.9**	**0.864**	**2.15**	**7.2**	**1.492**	**1.14**	**21.6**	**1.209**	**0.01**	**28.9**	**0.976**	**3.64**
ICSB-88005	70.8	1.042	0.41	137.3	0.569	3.76	8.6	0.857	0.29	21.9	0.875	0.86**	48.6	0.740	1.01
BTX-629	71.3	1.038	0.16	123.8	0.883	5.36	7.5	1.010	0.41	21.9	0.883	2.01**	27.9	0.671	1.53
ICSB-91003	71.5	0.961	0.36	125.4	1.110	16.08	8.0	0.831	1.06	22.0	0.645	2.94**	46.7	0.692	3.08
ICSB-1836	**72.0**	**0.973**	**0.10**	**116.7**	**0.870**	**3.07**	**8.1**	**0.947**	**1.23**	**22.3**	**1.005**	**0.27**	**48.6**	**0.972**	**10.42****
ICSB-88010	72.8	0.835	5.53**	134.1	0.832	34.21**	8.4	0.592	0.16	22.4	1.110	0.51**	54.6	0.730	1.37
ICSB-1816	72.0	1.012	0.16	117.0	0.953	6.72	7.3	1.457	1.53	22.5	1.261	0.42**	44.1	1.170	0.53
ICSB-89002	72.3	0.998	0.17	124.1	1.013	1.34	8.0	0.780	0.95	22.5	0.613	0.81**	37.1	1.282	0.96
ICSB-1848	72.5	1.001	0.51	120.0	1.045	8.26	7.8	1.211	3.33**	22.7	0.977	0.34*	43.8	1.446	0.66
ICSB-102	72.7	1.031	0.44	134.0	0.557	7.31	8.3	0.953	0.73	23.2	0.826	1.09**	49.3	0.989	3.03
ICSB-93	72.8	1.114	1.57	138.7	1.101	2.35	7.4	0.952	3.06**	23.5	1.177	0.02	41.4	1.244	0.67
ICSB-20	**73.5**	**1.161**	**0.37**	**123.3**	**0.911**	**9.42**	**7.8**	**0.774**	**0.68**	**23.7**	**0.976**	**0.01**	**36.4**	**0.904**	**1.77**
ICSB-95	73.6	1.225	1.16	130.5	1.360	13.07	8.5	0.862	0.25	23.8	1.223	1.60**	43.5	1.187	0.30
ICSB-88003	**74.2**	**1.193**	**0.77**	**135.1**	**0.510**	**6.94**	**9.1**	**0.835**	**0.40**	**23.9**	**0.646**	**0.79****	**59.8**	**0.688**	**0.99**
ICSB-155	74.9	1.007	1.89	133.7	1.034	2.98	8.4	1.053	0.06	23.9	1.116	1.19**	37.2	0.840	0.36
Mean	71.8			126.7			7.9			22.3			42.1		

*** and ** indicate significant at 0.05 and 0.01 levels of probability, respectively.**

Generally, the stability parameters showed that three genotypes, *i.e.* BN-96, ICSB-1836 and ICSB-20 were considered to be stable for all the studied traits under all environmental conditions as outlined by Eberhart and Russell 1966. However, the sorghum variety ICSB-88003 was considered better genotype since it produced the highest grain yield per plant and had better performance. Therefore, these genotypes may be recommended as a breeding stock in any future breeding program aiming for producing stable high yielding hybrids for grain yields. These results are in harmony with those obtained by Rao (1972) and Kambal and Mahmoud (1978), Desi, *et al.* (1983), Saeed, *et al.* (1984), Eweis (1998), Ali (2000) and Mostafa, (2001).

LITERATURE CITED

Ali, M.A., 2000. Heterosis, combining ability and stability studies in grain sorghum, Ph.D. Thesis. Fac. Agric. Assiut, Univ., Egypt.

Basher, M.I., E. O. Eweis and E.N. Gendy, 1994. Influence of tillage systems and nitrogen fertilizer rates on productivity and economics of grain sorghum and some soil properties, J. Agric. Sci. Mansoura Univ. 19 (11) : 3607-3617.

Cowei, A. M., 1973. Effect of nitrogen supply on grain yield and protein content in hybrid grain sorghum, Ph. D. Thesis, Department of Agriculture, University of Queensland, St. Lucia. Queensland, Australia.

Desai, K.B., R.H. Patel, S.B.S. Tikka and M.U. Kukadia, 1983. Phenotypic stability of some promising genotypes of grain sorghum, Indian J. Agric. Sci., 53 : 495-497.

Eberhart, S.A. andW.A.Russel,1966. Stability parameters for comparing varieties, Crop Sci.,6:34- 40.

Eweis, E.O. 1998. Combining grain sorghum yield and its stability parameters for cultivar selection across variable environments in Middle and Upper Egypt, Egypt J. Appl. Sci., 13 (7): 129-136.

Eweis, E.O., M. I. Basher, Z.H. Darweesh and S. M.M. Abd-El-Salam, 1992. Effect of plant density and nitrogen fertilizer on growth, yield and chemical composition of grain sorghum, Egypt J. Appl. Sci., 7 (12):700-708.

Ismail, A.A., 1995. The performance and stability of some wheat genotypes under different environments, Assiut J. Agric. Sci., 26: 15-37.

Johnson, H.W.; H.F. Robinson and R.E. Comstock, 1955. Estimates of genetic and environmental variability in soybeans, Agron. J., 47: 314-318.

Kambal, A.E. and M.A. Mahmoud, 1978. Genotype × environments interaction in grain sorghum variety tests in the Sudan general rain-lands, Exprl. Agric. 14: 41-48.

Kheiralla, K.A., M. EL-Morshedy, M.H. Motawea and A.A. Saeed, 2004. Performance and stability of some wheat genotypes under normal and water stress conditions, Assiut J. Agric. Sci., 35 (2): 73-94.

Lin, C.S.; M.R. Binns and L.P. Lefkovitch, 1986. Stability analysis: Where do we stand? Crop Sci. 26: 894-900.

Mostafa, M.S.A., 2001. Performance and stability evaluation of some grain sorghum hybrids and varieties over years, Egypt J. plant Breed, 5: 127-136.

Mourad, A.E.A.A., S. J. Latif and M. R. A. Hovny, 2000. Influence of irrigation numbers and different nitrogen rates on growth and yield of grain sorghum, Egypt J. Appl. Sci., 15 (11) : 192-207.

Paroda, R.S. and J.D. Hayes, 1971. An investigation of genotype-environment interaction for rate of ear emergence in spring barley, Heredity 26: 157-175.

Rao, N.G.P. 1970. Genotype × environmental interaction in grain sorghum, Indian J. Genet. and Plant Breed, 30 : 75-80.

Rao, N.G.P., 1972. Sorghum breeding in India Recent development. P .101-104, In N.G P. Rao and 2.L.R.Hcuse (Eds).Sorghum in the seventies, Oxford and IBH Publishing Co., New Delhi, India.

Saeed, M., C.A. Francis and J.F. Rajewski, 1984. Maturity effects on genotype x environments interaction in grain sorghum, Agron. J., 76 : 55-58.

Steel, R.G.D. and J.H. Torrie, 1969. Principles and procedures of statistics, McGraw-Hill Book Company, New York, Toronto and London.

❖ ❖ ❖

PKV Res. J. Vol. 36 (2), July 2012

Recurrent Selection in Safflower Population Segregating for Genetic Male Sterility

S. S. Lande[1], A. M. Apturkar[2] and S. N. Deshmukh[3]

ABSTRACT

The present study was undertaken to determine extent of yield improvement expected after second cycle of recurrent selection from random mating population of safflower, to estimate genotypic and phenotypic correlations and to select the promising progenies significantly superior over checks AKS-207 and Bhima. Genotypic and phenotypic coefficients of variation were high for seed yield per plant (33.31 and 34.17, respectively). The broad sense heritability estimates were high for days to 50 per cent flowering (0.97), followed by seed yield per plant (0.95), number of seeds per capitulum (0.89), number of capitulas plant^{-1} (0.87), and number of primary branches plant^{-1} (0.85). The expected genetic advance for seed yield plant^{-1} was 45.46 per cent over population mean, 47.02 per cent over check variety AKS-207 and 47.33 per cent over check variety Bhima at 20 per cent selection intensity. The seed yield plant^{-1} was positively correlated with number of primary branches per plant (0.230**), number of capitula plant^{-1} (0.269**), and number of seeds capitulum^{-1} (0.170**). 100 seed weight had shown significant negative correlation with number of seeds capitulum^{-1}.The top 63 progenies significantly superior over checks AKS-207 and Bhima were selected for next recombination cycle in safflower population improvement programme. The third cycle improved population of RMP-I realized 20.3 and 7.15 per cent increase seed yield over locally grown, most popular variety Bhima and recently released safflower variety AKS-207, respectively. Out of 63 progenies, 12 progenies exhibited significant increase for yield contributing characters besides seed yield over check Bhima and AKS-207. These progenies should be utilized for next recombination cycle to improve seed yield and yield contributing characters in future population improvement programme.

The seed yield normally has low heritability and is the result of interactions of number of factors inherent both in plant as well as in the environment in which plant grows. Therefore, selection for such characters based on phenotypic expression is likely to be less efficient. Under such circumstances, the breeder has to take into consideration the relative influence of different yield contributing characters on yield. The information about association among different components of yield is necessary for designing effective plant breeding programme through selection and for simultaneous improvement of yield components. Therefore, such information can be obtained from genotypic and phenotypic correlation coefficients between yield and yield contributing characters.

Recurrent selection is a method of population improvement which is used to increase the frequencies of desirable alleles to maintain high genetic variability and to break undesirable linkages. The improvement of population through recurrent selection after constitution of base population is suggested by Knowls (1958).

The improvement of population through recurrent selection method helps to accumulate desirable genes and facilitates breakage of undesirable linkages and is also effective in increasing the frequency of desirable genes in selected population (Singh, 2005). Therefore, the proposed study aims to explore the possibility of achieving the improvement in yield and yield contributing characters through population improvement in safflower.

MATERIAL AND METHODS

The present study was conducted during *Rabi* season of 2006-07, 2007-08 and 2008-2009 on the field of Oilseeds Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The experimental material was derived from the safflower random mating population-I (RMP-I) segregating for genetic male sterility. The second cycle population was sown in isolation for recombinations in open pollinated condition during *Rabi* 2006-07. Total 350 sterile plants were tagged at the time of flowering and these plants were harvested individually. Out of 350, the 315 progenies were grown for evaluation in modified randomized block design as suggested by Eckebil *et.al.*,(1977) in *Rabi* 2007-08 along with two checks (AKS-207 and Bhima) in two replications. The data were recorded on five randomly

1. Assistant Prof. , 2. PG Student and 3. Senior Res. Sci., College of Agriculture, Dr.PDKV, Akola

selected competitive fertile plants from each progeny for days to 50 per cent flowering, days to maturity, plant height (cm), number of primary branches plant^{-1}, number of capitula plant^{-1}, number of seeds capitulum^{-1}, 100 seed weight (g), oil content (%) and seed yield plant^{-1} (g). The third cycle improved population of RMP-I was evaluated with two checks during *Rabi* 2008-09. In present study, the top 63 progenies were selected on the basis of high seed yield plant^{-1} over checks AKS-207 and Bhima. The remnant seed of these 63 selected progenies were composited to constitute 3rd cycle population. The 3rd cycle population was sown with two checks AKS-207 and Bhima in five replications in *Rabi* 2008-09 to realize the genetic gain.

RESULTS AND DISCUSSION

Progeny components of variances

The significant and large genetic variation among progenies is prerequisite of recurrent selection programme. In the present study, the variability parameters like, genotypic variance, phenotypic variance, genotypic coefficients of variation (G.C.V.), phenotypic coefficient of variation (P.C.V.) and heritability estimates in broad sense (h2 b.s.) were estimated for all the nine characters and results obtained have been presented in Table 1.

Estimates of genotypic coefficients of variation were high for grain yield (33.31%), number of capitula plant^{-1} (29.93), number of primary branches plant^{-1} (27.82) and number of seeds capitulum^{-1} (21.19). The genotypic coefficients of variation were moderately high for plant height (11.33), 100 seed weight (8.06) and days to 50 per cent flowering (7.47). The estimates of phenotypic coefficients of variation were high for number of capitula (47.00) plant^{-1} (32.00), number of primary branches plant^{-1} (30.10) and number of seeds capitulum^{-1} (22.43). The phenotypic coefficient of variation values were moderately high for plant height (12.60) and 100 seed weight (10.64) whereas, the magnitudes of phenotypic coefficient of variation were comparatively low for days to 50 per cent flowering (7.60), oil content (4.42) and days to maturity (2.77).

Heritability estimates

Estimates of heritability in the selected safflower progenies segregating for genetic male sterility are useful in determining the method of selection to improve population for specific traits. Genetic study of quantitative traits in its predictive role, expressing the reliability of the phenotypic value as guide to breeding value.

The heritability values ranged from 0.41 for oil content to 0.97 for days to flowering. The estimates of heritability on progeny mean basis was high for days to 50 per cent flowering (0.97), followed by seed yield (0.95), number of seeds capitulum^{-1} (0.89) and number of capitula plant^{-1} (0.87). Heritability value was moderately high for number of primary branches plant^{-1} (0.85) and plant height (0.80), while it was low for 100 seed weight (0.57) and oil content (0.41). In present study, the minimum differences were noted between the GCV and PCV values with high heritability estimates for number of seeds capitulum^{-1}, plant height and days to 50 per cent flowering clearly indicates little share of environmental component of variance suggestive of negligible influence of environment on the expression of these characters. Hence, selection for seed yield, plant height and 50 per cent flowering could prove effective and improvement may be possible through recurrent selection programme. High estimates of components of variances and heritability have also been reported in safflower for several yield contributing and quality traits by Reddy (2002) and Mahajan (2007).

Genotypic and phenotypic correlations

The recurrent selection are mainly designed and conducted primarily for improvement of seed yield. However, it means that other yield contributing traits are also equally important. The selection of yield contributing characters should be correlated with seed yield (Gardner, 1978). However, if selection is practiced for high seed yield alone, undesirable correlated response may occur in other traits as pointed out by Doggett (1972). The genotypic and phenotypic correlations between seed yield and yield contributing characters obtained in the present study have been presented in Table 2.

Days to 50 per cent flowering exhibited significant positive genotypic and phenotypic correlations with days to maturity and number of seeds capitulum^{-1}. However, it has shown significant negative genotypic and phenotypic correlations with number of primary branches plant^{-1}, number of capitula plant^{-1}, 100 seed weight and oil content.

The genotypic and phenotypic correlations for plant height showed significant positive correlation with number of primary branches plant^{-1} and oil content. The number of primary branches plant^{-1} showed significant

Table 1. Estimates of progeny components of variance and heritability (b.s) for seed yield and its contributing characters in safflower

Progeny components	Days to 50% flowering	Days to maturity	Plant height (cm) branches	No. of primary plant^{-1}	No. of capitula plant^{-1}	No. of seeds capitulum^{-1}	100 seed weight (g)	Oil content (%)	Seed yield plant^{-1} (g)
$\hat{}\sigma^2$ g(prog)	51.60	9.92	75.36	8.62	46.41	57.20	0.20	0.74	116.71
$\hat{}\sigma^2$ P(prog).	53.18	13.06	93.23	10.09	53.08	64.08	0.35	1.76	122.80
S.E. (m) ±	1.77	2.50	5.97	1.71	3.65	3.70	0.55	1.43	3.49
G.C.V	7.47	2.41	11.33	27.82	29.93	21.19	8.06	2.86	33.31
P.C.V.	7.60	2.77	12.60	30.10	32.00	22.43	10.64	4.42	34.17
h^2 (b.s.)	0.97	0.75	0.80	0.85	0.87	0.89	0.57	0.41	0.95

Table. 2. Genotypic (G) and phenotypic (P) correlations between seed yield and it's contributing characters in safflower

Characters		Days to 50 % flowering	Days to maturity	Plant height (cm)	No. of primary branches plant^{-1}	No. of capitula plant^{-1}	No. of seeds capitulum^{-1}	100 seed weight (g)	Oil content (%)	Seed yield plant^{-1} (g)
Days to 50 % flowering	G	1	0 .249**	0.056	-0.191**	-0.243**	0.162**	-0.311**	-0.342**	0.056
	P	1	0.249**	0.056	-0.169**	-0.224**	0.154**	-0.243**	-0.218**	0.054
Days to maturity	G		1	0.001	-0.400**	0.074	0.077	-0.036	-0.091	0.076
	P		1	0.031	-0.012	0.065	0.067	-0.024	- 0.037	0.063
Plant height (cm)	G			1	0.225**	0.049	-0.030	-0.100*	0.100*	-0.009
	P			1	0.204**	0.048	-0.030	-0.055	0.113*	0.007
No. of primary branches	G				1	0.599**	-0.019	0.036	0.126*	0.230**
plant^{-1}	P				1	0.553**	-0.017	0.047	0.070	0.220**
No. of capitula plant^{-1}	G					1	0.042	0.162**	0.071	0.269**
	P					1	0.036	0.155**	0.033	0.254**
No. of seeds capitulum^{-1}	G						1	-0.324**	0.136*	0.170**
	P						1	-0.254**	0.086	0.159**
100 seed weight (g)	G							1	-0.321**	0.072
	P							1	-0.187**	0.054
Oil content (%)	G								1	-0.062
	P								1	-0.033
Seed yield plant^{-1} (g)	G									1
	P									1

The correlation coefficients were tested at n-2 degrees of freedom at 5% and 1% level of significance.

Table 3 : Evaluation of improved population to realize genetic gain in safflower.

S.N.	Treatments	Third cycle population (2008-09)		Second cycle population (2006-07)	
		Seed yield (kg ha^{-1})	Per cent increase	Seed yield (kg ha^{-1})	Per cent decrease
1.	Improved population	1347	-	1280	
2.	AKS-207	1119	20.7	1338	-
3.	Bhima	1257	7.15	1389	-
	SE (diff.) ±	139.29	-	60.7	-
	C.D. (5%)	276.64	-	170.7	-

Table 4. Promising progenies for seed yield $plant^{-1}$ and yield 'contributing characters superior over AKS-207 and Bhima

S.N.	Progeny number	Seed yield $plant^{-1}$ (g)	Number of primary branches $plant^{-1}$	No. of capitula $plant^{-1}$	No. of seeds $capitulum^{-1}$	Plant height (cm)
1	PI -102	92.80	22.99	47.66	46.03	90.20
2	PI -293	73.75	16.50	38.83	42.00	95.81
3	PI -255	69.78	16.49	39.33	54.33	88.27
4	PI -294	62.33	16.83	42..49	42.00	87.29
5	PI-121	55.71	16.83	47.00	39.83	89.83
6	PI -110	52.76	19.50	36..64	38.80	87.83
7	PI- 171	52.00	18.20	37.83	39.49	94.66
8	PI -265	51.70	18.50	37.16	50.00	90.22
9	PI -127	47.36	17.20	36.99	47.66	93.10
10	PI -182	45.58	19.42	36.76	44.00	88.33
11	PI -112	43.88	16.16	36.99	46.83	84.22
12	PI -79	43.09	18.83	38.00	39.83	97.16
13	AKS-207	31.35	11.97	28.64	31.90	75.78
	Bhima	31.15	12.66	27.93	32.05	74.84
	S.E.(M)	2.46	1.21	2.58	2.62	4.22
	CD 5 %	6.86	3.37	7.18	7.29	11.75

positive genotypic and phenotypic correlations with number of capitula $plant^{-1}$ and seed yield $plant^{-1}$. However, it has shown significant positive genotypic correlations with oil content.

Number of capitula $plant^{-1}$ was found to have significant positive genotypic and phenotypic correlations with 100 seed weight and seed yield $plant^{-1}$. The number of seeds per capitulum showed significant positive genotypic correlations with seed yield $plant^{-1}$ and oil content. In present study in safflower random mating population segregating for genetic male sterility, the seed yield $plant^{-1}$ had positive and significant genotypic and phenotypic correlations with number of primary branches $plant^{-1}$ (0.230**), number of capitula $plant^{-1}$ (0.269, 0.254**) & number of seeds $capitulum^{-1}$ (0.170**, 0.159**).

Reddy (2002) and Nandhkhile *et. al.,* (2008) reported significant positive correlation between seed yield and yield contributing characters.

Evaluation of improved population to realize genetic gain:

In safflower improvement programme, making use of population improvement approach through recurrent selection is expected to achieve the desired results because the strategies envisage the possibility of breaking undesirable linkages and accumulation of desirable alleles in the population as a result of intermating and recombination. The data (Table 3) revealed that improved population exhibited 20.3 and 7.15 per cent increased seed yield over recently released safflower variety AKS-207 and locally grown, most popular variety Bhima, respectively as compared to 2nd cycle population.

Reddy *et. al.*, (2008) evaluated three cycles of recurrent selection for seed yield in genetically broad-based population of safflower segregating for genetic male sterility for development of safflower varieties with broad genetic base.

Promising progenies on the basis of seed yield plant^{-1} coupled with yield contributing characters

In the present study, 63 out of 315 progenies recorded significant increase in seed yield over checks Bhima and AKS-207. Out of 63 progenies, 12 progenies exhibited significant increase for yield contributing traits besides seed yield over check Bhima and AKS-207 and presented in Table 4.

The progeny pl-102 recorded significantly increase seed yield (92.80) with yield contributing characters like number of primary branches plant^{-1} (22.99), number of capitula plant^{-1} (47.66), number of seeds capitulum^{-1} (46.03) and plant height (90.20) followed by the progeny PI-293 recorded increase seed yield (73.75) with yield contributing characters like number of primary branches plant^{-1} (16.50), number of capitula plant^{-1} (38.83), number of seeds capitulum^{-1} (42.00) and plant height (95.81) besides seed yield (73.75) over both the checks. Similarly, the progeny PI-121 recorded significant increase for number of primary branch plant^{-1} (16.83), number of capitula plant^{-1} (47.00), number of seeds capitulum^{-1} (39.83) and plant height (89.83) besides seed yield (73.75) over both the checks. Twelve progenies also recorded significant increase for seed yield and yield contributing characters over both checks.

Larger populations of these 12 progenies should be exploited in future population improvement programme as they showed significant superior performance for seed yield and yield contributing traits over both checks. These progenies will provide opportunity for yield improvement in safflower breeding programme through population improvement.

LITERATURE CITED

Doggett, H., 1972. Recurrent selection in sorghum population, Heredity 28 : 9-29.

Eckebil, T.P., W. H. Ross, C.O. Gardner and J.W. Marranville, 1977. Heritability estimates, genetic correlations and predicated gains from S_1 progeny tests in three grain sorghum random mating populations, Crop Sci., 17 : 374-377.

Gardner, C.O., 1978. Population improvement in maize. In Maize breeding and genetics, Edn. D.B. Walden. John Wiley and Sons., New York : 207-228.

Knowls, P.F., 1958. Safflower, Adv. Agron., 10 : 289-323.

Mahajan, P.V., 2007. Evaluation of progenies selected from random mated population of safflower using genetic male sterile lines, M.Sc.Thesis (Unpub). Dr. PDKV, Akola.

Nandkhile S.G., S.S. Lande and S.N. Deshmukh, 2008. Correlation Studies for Yield Contributing Characters in Safflower, PKV Res. J., 32 (2):200-202.

Reddy, N.S.H., 2002. Studies on recurrent selection in a safflower population segregating for genetic male sterility, M.Sc. Thesis (Unpub.), Dr. PDKV, Akola.

Reddy,N.S.H. ,V.P.Naole, V.S. Goyal, P.V. Patil, Vandana B. Kalamkar, N.H.Sabale,J.J.Maheshwari and P.B.Ghorpade, 2008. Evaluation of three cycles of recurrent selection for improvement of seed yield in safflower using genetic male sterility, 7th International Safflower Conference WAGGA Australlia. Safflower Unexploited Potential and World Adaptability Abstract Book : 61-61

Singh, B.D., 2005.Population improvement. In Plant Breeding : Principles and Methods.Kalyani Publishers, New Delhi,7th Ed. : 367-395.

❖ ❖ ❖

Combining Ability Studies in Rabi Sorghum

D. T. Deshmukh[1], S. A. Takalkar[2], R. B. Ghorade[3] and P. R. Hasnale[4]

ABSTRACT

In the present studies the *Rabi* sorghum genotypes were assessed for combing ability effects and heterosis for yield and yield contributing characters. The result revealed the importance of female parent, AKms -71 A and male parent AKR – 354 as a good general combiner for number of grains per panicle and grain yield plant^{-1} (g) and can be used in *Rabi* sorghum improvement programme. Moreover, the two crosses namely, AKms – 71 A x AKrb – 502 and ms 104 A x AKR – 354 recorded significant specific combing ability effect in conjugation with highest magnitude of standard heterosis over check, PKV Kranti for the characters, number of grains panicle^{-1} and grain yield plant^{-1} (g). Hence these crosses can be advocated for exploitation of heterosis.

Rabi sorghum cultivation is getting great impetus because of its good grain quality and fodder quality. In Maharashtra, it is being cultivated on an area of 28.7 lakh hectares with an annual production of 21.1 lakh tonnes. In Vidarbha region of Maharashtra state, it is being cultivated on a area of 39 thousand hectares with an annual production of 30.5 thousand tonnes (Anonymous, 2009). The low productivity of *Rabi* sorghum as compared to *Kharif* sorghum in Maharashtra state (735 kg ha^{-1}) and Vidarbha region (782 kg ha^{-1}) evokes the scope to increase the crop productivity.

The crop breeding programme plays the vital role in increasing the crop productivity. The crop improvement work in Maharashtra state leads to development of new genotypes such as Phule Yesoda,Phule Chitra, Phule Mauli, Parbhani Joyti, Parbhani Moti and PKV Kranti. The genotypes have higher yield potential and possessed good quality grains as that of well adopted genotypes Maldandi (M-35 – 1). However, in case of *Rabi* sorghum, a significant increase in productivity as much as happened in *Kharif* sorghum could not be achieved. Therefore, there is a need to strengthen a strong and diverse parental line development programme along with its utilization in hybrid development. On that basis, new diverse parental lines have been chosen and tested in the said experiment. In breeding programme the selection of parents is very crucial factor and selection of parents on the basis of mean performance may or may not be proved useful. Indeed, there are several biometrical techniques which can be used for selection of parents. Among them combing ability analysis (Kempthorne, 1957) appeared to be useful tool for screening large number of lines with rapidity and has practical utility in breeding programme aimed at crop improvement.

MATERIAL AND METHODS

The experimental material comprised of forty genotypes which includes four cms lines viz., ms-104A, Akms-75-1A, Akms-80A, Akms-71A and seven restorers viz. RS-585, AKR 354, Akrb-387.2, Akrb-400, Akrb-501, Akrb-502 and Akrb-503 and 28 hybrids along with check PKV- Kranti. It was grown in randomized block design with three replications at Sorghum Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, during 2009-10. The observations were recorded on five randomly selected plants per plot for the characters such as plant height (cm), panicle length (cm), number of leaves plant^{-1}, number of primaries per panicle, number of grains per panicle, 1000 grains weight (g), grain yield plant^{-1} (g) and fodder yield plant^{-1} (g) and for the characters days to 50 per cent flowering and days to maturity observations were recorded on plot basis. Data were analyzed using line x tester analysis as per methodology suggested by Kempthorne (1957).

RESULTS AND DISCUSSION

The analysis of variance for combining ability (Table 1) indicated the significant mean sum of squares for all the characters studied except panicle length (cm). The variance component of crosses was portioned in to different components representing the main effects of females (lines), males (restorers) and their interactions. These components had shown significant variations for most of the characters studied. The male component had shown significant variations for character number of leaves per plant whereas, female component had shown significant variations for days to maturity, plant height and number of leaves per plant. The component female vs male had shown significant variations for all the characters except plant height.

1. Sorghum Breeder, 2 & 4. PG Students and 3. Senior Res. Sci., Sorghum Research Unit, Dr. PDKV., Akola.

Table 1: Analysis of variance for combining ability for various characters

Sources of variation	d.f.	Mean Sum of Squares									
		Days to 50% flowering (days)	**Days to maturity (days)**	**Plant height at harvest (cm)**	**Panicle length (cm)**	**No. of leaves $plant^{-1}$**	**No. of primaries $panicle^{-1}$**	**No. of grains $panicle^{-1}$**	**1000 grain weight (g)**	**Grain yield $plant^{-1}$ (g)**	**Fodder yield $plant^{-1}$ (g)**
Replications	2	102.15**	65.79**	4741.88**	5.97*	0.74	47.84	8872.89	2.32	4.70	244.65
Crosses	27	35.50**	34.48**	1037.58*	2.26	5.19**	84.19**	154728.17**	55.47**	312.57**	787.86**
Females (lines)	3	63.71	96.71*	2680.84*	0.50	13.48**	126.85	114865.06	14.97	271.39	153.71
Males (restorers)	6	55.22	26.77	922.35	0.22	9.03*	57.33	200877.72	77.22	353.24	1437.20
Females vs Males	18	24.23*	26.68**	802.12	3.23*	2.53**	86.04**	145988.84**	54.97**	306.15**	677.10**
Error	54	11.43	7.92	591.25	1.83	0.54	20.14	10847.40	2.67	22.23	159.45

Table 2: Estimates of General Combining ability effects of parents for various characters

Parents	Days to 50% flowering (days)	Days to maturity (days)	Plant height at harvest (cm)	Panicle length (cm)	No. of leaves $plant^{-1}$	No. of primaries $panicle^{-1}$	No. of grains $panicle^{-1}$	1000 grain weight (g)	Grain yield $plant^{-1}$ (g)	Fodder yield $plant^{-1}$ (g)
Females(Lines)										
ms 104 A	0.571	-1.39	-0.16	0.01	0.03	0.32	2.05	-0.92	-1.00	-3.94
Akms 75-1 A	-1.66	-0.01	7.06	-0.04	0.45*	-1.73	-40.04	-0.32	-1.94	0.48
Akms 80 A	-1.09	-1.63	-15.88*	-0.16	-1.13 **	-1.94	-64.91*	0.18	-2.37	1.48
Akms 71 A	2.19*	3.03**	8.98	0.20	0.65**	3.35*	102.90**	1.06*	5.32**	1.98
SE (gi) ±	1.0216	0.9849	7.7853	0.4186	0.2175	1.2864	29.7108	0.4918	1.2983	3.684
CD 5%	2.0481	1.9746	15.6086	0.8392	0.436	2.5791	59.5662	0.9861	2.6029	7.3859
CD 1%	2.7276	2.6297	20.7866	1.1176	0.5806	3.4346	79.3269	1.3132	3.4664	9.8361
Males (Restorers)										
RS-585	0.66	1.16	-6.63	0.12	-0.69*	1.69	-27.90	-4.61**	-6.23**	0.91
AKR-354	-0.83	-0.16	20.81*	-0.11	-0.48	3.16	259.76**	-0.57	8.78**	15.00**
Akrb-387.2	-2.66	-2.50	-9.00	0.07	-1.21**	-2.67	-10.73	2.24**	1.78	-11.85*
Akrb-400	-1.33	-1.58	-10.10	-0.02	0.06	-2.67	-126.58**	-0.71	-5.44**	-8.15
Akrb-501	-1.33	0.91	9.02	-0.01	1.18**	1.14	-66.82	-0.68	-3.17	0.91
Akrb-502	2.16	1.25	-4.87	0.17	0.20	-0.37	60.96	1.28	4.19*	-10.23*
Akrb-503	3.33*	0.91	1.77	-0.22	0.93**	-0.27	-88.67*	3.05**	0.09	13.42**
SE (gj) ±	1.3514	1.3029	10.299	0.5538	0.2877	1.7017	39.3037	0.6506	1.7175	4.8734
CD 5%	2.7094	2.6121	20.6482	1.1102	0.5768	3.4118	78.7987	1.3044	3.4433	9.7706
CD 1%	3.6082	3.4787	27.4981	1.4785	0.7681	4.5436	104.9397	1.7372	4.5857	13.0119

Table 3: Estimates of Specific combining ability effects of crosses for various characters

S.N.	Hybrids	Days to 50% flowering (days)	Days to maturity (days)	Plant height at harvest (cm)	Panicle length (cm)	No. of leaves $plant^{-1}$	No. of primaries $panicle^{-1}$	No. of grains $panicle^{-1}$	1000 grain weight (g)	Grain yield $plant^{-1}$ (g)	Fodder yield plant (g)
		1	2	3	4	5	6	7	8	9	10
1	ms-104 A x RS-585	4.76	3.31	13.82	-1.49	1.65**	-1.00	-6.55	-0.22	-0.49	-2.70
2	ms-104 A x AKR-354	-1.07	0.31	-14.88	2.27*	0.76	3.46	333.58**	2.92*	13.08**	5.05
3	ms-104 A x AKrb-387.2	-1.90	-0.69	-19.33	1.08	0.10	-0.50	-71.31	-6.09**	-8.96*	14.80
4	ms-104 A x Akrb-400	-0.90	-1.27	-5.57	0.18	-0.65	4.02	-2.60	3.49**	3.76	7.14
5	ms-104 A x Akrb-501	-3.23	-3.10	2.62	-0.29	-1.03	-3.92	-103.83	-6.72**	-9.69**	-2.52
6	ms-104 A x Akrb-502	-0.40	-2.10	29.59	0.05	-1.25*	-2.34	-183.48*	4.02**	-2.97	3.33
7	ms-104 A x Akrb-503	2.76	1.56	-6.25	0.18	0.41	0.29	34.21	3.60**	5.27	-25.10*
8	Akms-75-1A x RS-585	-2.33	3.59	-10.13	1.62	-0.50	9.65**	200.87*	3.01*	10.49**	-9.18
9	Akms-75-1A x AKR-354	2.83	1.26	21.55	0.52	-0.18	-6.35	-241.72**	3.03*	-5.32	-19.97*
10	Akms-75-1A x Akrb-387.2	0.66	0.26	-7.03	-1.05	0.74	-1.58	-80.02	4.27**	1.82	2.68
11	Akms-75-1A x Akrb-400	1.33	2.67	-8.66	-0.68	-0.53	-2.91	86.36	-2.46	0.52	-6.71
12	Akms-75-1A x Akrb-501	1.66	1.17	-4.86	-1.17	0.08	2.46	145.12	-2.89	1.70	6.95
13	Akms-75-1A x Akrb-502	-1.16	-4.82	1.76	-0.15	0.53	-2.55	-202.72*	-6.24**	-14.17**	4.72
14	Akms-75-1A x Akrb-503	-3.00	-4.15	7.38	0.91	-1.13	1.28	92.11	1.28	4.94	21.50*
15	Akms-80A x RS-585	-3.57	-4.78	3.68	0.48	0.35	1.19	86.07	-2.60	0.24	-10.82
16	Akms-80A x AKR-354	-3.07	-3.45	12.50	0.31	-0.39	-0.60	-196.12*	-4.33**	-11.61**	19.96*
17	Akms-80A x Akrb-387.2	0.09	1.54	18.25	0.20	0.27	1.82	169.31*	5.08**	11.54**	-6.45
18	Akms-80A x Akrb-400	-1.23	0.63	-4.58	-1.49	0.12	1.22	37.96	0.43	2.0	-6.72
19	Akms-80A x Akrb-501	0.76	1.13	-7.11	1.01	-0.26	3.21	33.86	3.48**	5.13	0.28
20	Akms-80A x Akrb-502	3.26	2.46	-27.01	0.36	0.45	-6.47	-156.79	1.15	-5.01	-13.70
21	Akms-80A x Akrb-503	3.76	2.46	4.26	-1.89	-0.54	-0.37	25.71	-3.21	-2.33	17.44
22	Akms-71A x RS-585	1.14	-2.11	-7.38	-1.61	-1.50*	-9.83**	-280.40**	-0.17	-10.24**	22.70*
23	Akms-71A x AKR-354	1.31	1.88	-19.16	-1.11	-0.18	3.49	104.26	0.07	3.86	-5.05
24	Akms-71A x Akrb-387.2	1.14	-3.11	8.11	-0.23	-1.11	0.26	-17.96	-3.26	-4.41	-11.03
25	Akms-71A x Akrb-400	0.81	-2.03	18.81	0.99	1.06	-2.33	-121.71	-2.46	-6.32	6.28
26	Akms-71A x Akrb-501	0.81	0.79	9.35	0.44	1.21*	-1.75	-75.15	5.44**	2.85	-4.71
27	Akms-71A x Akrb-502	-1.69	5.46*	-4.34	-0.26	1.26*	11.36**	543.00**	1.06	22.15**	5.64
28	Akms-71A x Akrb-503	-3.52	0.13	-5.39	0.79	0.26	-1.20	-152.03	-1.67	-7.88*	-13.84
	SE (ij) ±	2.7028	2.6058	20.5981	1.1075	0.5754	3.4035	78.6073	1.3013	3.4350	9.7469
	CD 5%	5.4188	5.2243	41.2964	2.2204	1.1535	6.8236	157.5974	2.6089	6.8867	19.5412
	CD 1%	7.2165	6.9574	54.9962	2.9570	1.5362	9.0872	209.8794	3.4743	9.1713	26.0239

Table 4: Estimates of standard heterosis (%) over check (PKV-Kranti) for various characters

S.N.	Hybrids	Days to 50% flowering (days) 1	Days to maturity (days) 2	Plant height at harvest (cm) 3	Panicle length (cm) 4	No. of leaves plant^{-1} 5	No. of primaries panicle^{-1} 6	No. of grains panicle^{-1} 7	1000 grain weight (g) 8	Grain yield plant^{-1} (g) 9	Fodder yield plant (g) 10
1	ms-104 A x RS-585	-4.74	-1.08	1.22	6.94	12.19	-3.36	-15.45**	-20.85**	-32.89**	-15.37
2	ms-104 A x AKR-354	-13.43**	-4.62*	-2.56	15.80*	4.02	7.35	30.94**	-6.38	22.81**	9.47
3	ms-104 A x AKrb-387.2	-16.60**	-7.35**	-13.67	21.59**	-13.04	-10.35	-18.97**	-18.24**	-33.78**	-9.97
4	ms-104 A x Akrb-400	-13.82**	-7.07**	-9.24	15.80*	-6.46	-2.16	-22.45**	-0.76	-23.07**	-14.48
5	ms-104 A x Akrb-501	-16.60**	-6.53**	3.26	13.08*	-0.53	-9.63	-25.52**	-0.29	-44.85**	-15.16
6	ms-104 A x Akrb-502	-9.08**	-3.80	10.62	16.21*	0.20	-9.50	-21.96**	5.93	-17.40*	-21.19
7	ms-104 A x Akrb-503	-3.94	-2.72	-4.12	14.64*	-1.00	-4.57	-16.93**	9.49**	-9.33	-26.63*
8	Akms-75-1A x RS-585	-15.80**	0.27	-6.44	24.66**	-8.90	12.18	-3.23	-10.70**	-13.32	-17.70
9	Akms-75-1A x AKR-354	-11.45**	0.34	17.43	16.96**	-2.43	-14.09*	-14.68*	-0.02	-14.88*	-13.95
10	Akms-75-1A x Akrb-387.2	-16.19**	-5.44*	-4.72	8.85	-0.20	-16.01*	-22.73**	-0.01	-14.59*	-18.73
11	Akms-75-1A x Akrb-400	-13.82**	-2.72	-7.35	10.42	0.00	-18.43**	-18.99**	-14.89**	-31.23**	-25.20*
12	Akms-75-1A x Akrb-501	-13.43**	-1.90	3.14	7.70	21.09**	-1.80	-10.23	-15.95**	-24.49**	0.65
13	Akms-75-1A x Akrb-502	-12.64**	-6.53**	1.19	14.64*	14.63*	-13.60*	-26.50**	-19.56**	-41.07**	-14.57
14	Akms-75-1A x Akrb-503	-13.43**	-6.26**	5.43	18.52**	15.48*	-6.50	-15.76**	4.95	-11.82	31.44**
15	Akms-80A x RS-585	-16.60**	-7.89**	-10.62	17.37**	-17.92*	-3.48	-18.48**	-24.18**	-34.17**	-18.43
16	Akms-80A x AKR-354	-17.78**	-7.89**	2.77	15.05*	-24.39**	-4.08	-13.15*	-18.11**	-28.00**	32.63**
17	Akms-80A x Akrb-387.2	-16.19**	-5.72*	-3.66	15.40*	-25.24**	-10.22	-9.34	14.16**	3.50	-27.99*
18	Akms-80A x Akrb-400	-16.19**	-5.72*	-15.99	10.77	-11.34	-11.31	-24.41**	-5.88	-29.11**	-24.07*
19	Akms-80A x Akrb-501	-13.82**	-3.26	-8.39	19.68**	-2.43	-0.83	-20.29**	2.18	-18.64**	-5.79
20	Akms-80A x Akrb-502	-6.71*	-1.90	-22.49*	16.96**	-0.20	-0.46	-24.94**	0.83	-24.06**	-34.39**
21	Akms-80A x Akrb-503	-4.74	-2.17	-6.50	1.50	-0.47	-9.86	-22.51**	0.49	-26.85**	27.96*
22	Akms-71A x RS-585	-7.11*	-1.90	-4.30	13.08*	-18.65**	-13.84*	-28.24**	-15.45**	-39.57**	20.28
23	Akms-71A x AKR-354	-8.69**	0.27	-0.33	8.85	0.00	12.90*	21.44**	-4.16	17.16*	4.73
24	Akms-71A x Akrb-387.2	-11.06**	0.34	3.08	15.05*	-20.36**	-8.31	-7.57	-5.53	-12.58	-32.62**
25	Akms-71A x Akrb-400	-9.87**	-4.08	6.10	21.59**	21.95**	-8.18	-23.80**	-8.54*	-30.41**	-8.70
26	Akms-71A x Akrb-501	-9.87**	0.27	10.53	18.52**	37.43**	-0.23	-15.95**	9.73**	-8.08	-10.91
27	Akms-71A x Akrb-502	-8.69**	0.34	-0.73	15.40*	13.78	20.73**	39.18**	3.37	43.88**	-11.81
28	Akms-71A x Akrb-503	-9.48**	-0.26	0.45	19.28**	22.80**	-1.80	-23.24**	0.8175	-22.64**	-7.06
	SE (D) ±	2.7018	2.6051	20.5979	1.1045	0.5715	3.4029	78.6073	1.2987	3.4341	9.74
	CD 5%	5.3739	5.1815	40.9692	2.1969	1.1368	6.7684	156.3500	2.5831	6.8305	19.3863
	CD 1%	7.1274	6.8723	54.3372	2.9137	1.5077	8.9769	207.3662	3.4260	9.0592	25.7120

The general combining ability effects (Table 2) revealed that female parent Akms-71A had significant and desirable gca effects for days to 50 per cent flowering, days to maturity, number of leaves plant^{-1}, primaries per panicle, grains per panicle, 1000-grains weight and grain yield plant^{-1}. The male parent AKR-354 and AKrb – 502 showed significant and desirable gca effects for grain yield plant^{-1}. The former male parent also showed significant and desirable gca effects for plant height, number of grains per panicle and fodder yield per plant. These lines can be identified as potential parents for harvesting these traits in hybrids. Similar findings were also recorded by Jagdeshwar and Shinde (1992) and Gaikwad *et. al.*, (2002) in their combining ability studies.

The specific combining ability effects (Table 3) revealed that the crosses namely, ms-104 A x AKR – 354, AKms –75–1 A x RS – 585, AKms- 18 A x Akrb – 387.2 and Akms-71A x Akrb-502 showed significant and desirable sca effects for grain yield plant^{-1} and number of grains per panicle. Similar inferences were recorded by Gaikwad *et. al.*, (2002)) and Patil *et. al.*, (2005) in their combining ability studies.

The magnitude of standard heterosis (Table 4) revealed that the crosses namely, Akms-71A x Akbr-502 , Ms – 104 A x AKR – 354, Akms-71A x AKR – 354 and exhibited highest standard heterosis over check, PKV kranti for grain yield per plant (43.88%, 22.81%, and 17.16, respectively) and number of grains per panicle (39.18%, 30.94%, and 21.44 %, respectively). The cross Akms-71A x Akbr-502 also showed significant heterosis for panicle length (15.40%) and number of primaries per panicle (15.40%). Thawari *et. al.*, (2000), Prabhakar (2001) and Chaudhary *et. al.*, (2006) also recorded significant positive heterosis in desirable direction for number of grains panicle^{-1} and grain yield plant^{-1}.

The combining ability studies revealed the importance of selection of female parent namely AKms – 71 A and male parent AKR-354 as good combiner for number of grains per panicle and grain yield. The crosses AKms-71 A x AKrb-502 and ms-104 x AKR-354 recorded significant specific combining ability effect in conjugation with higher magnitude of standard heterosis for the characters number of grains per panicle (39.81% and 30.94%) and grain yield plant^{-1} (43.88% and 22.81%) indicating the presence of dominance interaction component for this character in the aforesaid crosses. The result of present study primarily revealed the significance of female parent AKms – 71 A and male parent AKR 354 as a potential parent for crop improvement programme on the basis of general combining ability. Secondly the crosses AKms – 71 –A x AKrb-502 and ms-104 x AKR-354 showed significant specific combining ability effect and higher magnitude of standard heterosis over best check variety PKV Kranti for grain yield and yield contributing characters. These crosses may prove useful for exploitation of heterosis. Hence the large scale evaluation of these hybrids in multilocation trials may prove useful for exploitation of potential new *Rabi* hybrids.

LITERATURE CITED

Anonymous, 2009. Economic survey of Maharashtra 2009-10. (www.mahadesh.maharashtra.gov.in)

Chaudhary, S.B.; J.V. Patil, B.B. Thombare and V.M. Kulkarni, 2006. Exploitation of useful heterosis in rabi sorghum, Ann. Plant Physiol, 20(2):254-257.

Gaikwad, N.J., Thete, R.Y., D.G. Kanawade , J.V. Patil and N.S. Kute, 2002. Selection of parents based on combining ability in sorghum (*Sorghum bicolor* (L.) Moench), Indian J. Agri. Res., 36(2) : 141-144.

Jagadeshwar, K. and V.K. Shinde, 1992. Combining ability in rabi sorghum (*Sorghum bicolor* (L.) Moench). Indian J. Genet., 52(1):22-25.

Kempthorne, O., 1957. An introduction to genetic statistics, John Willey and Sons. New York : 468-470.

Patil, J. V., S. B. Chaudhary, B. B. Thombre, M. S. Shinde and V.G. Kachole, 2005. Studies on combining ability of newly developed restress in *Rabi* sorghum (*Sorghum bicolor* (L.) Moench), J. Maharashtra Agric. Univ., 30(2) : 227-229.

Prabhakar, 2001. Heterosis in *Rabi* sorghum (*Sorghum bicolor* (L.) Moench), Indian J. Genet., 61(4): 364-365.

Thawari, S.B.; S.B. Atale and R.S. Wadhokar, 2000. Heterosis studies in newly stabilized B lines of sorghum (*Sorghum bicolor* (L.) Moench), J. Soils and Crops, 10(1) : 75-77.

❖ ❖ ❖

Genetic Variability Studies in Urdbean

M. P. Meshram[1], N. G. Sonone[2] and A. N. Patil[3]

ABSTRACT

Genetic variability, correlation and path coefficient in 27 promising lines of urdbean were studied to find out important traits contributing towards grain yield. Genetic variability study revealed that the characters *viz*., plant height, number of pods plant^{-1}, pod weight plant^{-1} and grain yield plant^{-1} exhibited high genotypic variance and heritability coupled with genetic advance indicating the presence of high additive gene effects suggesting its utility for direct selection. The correlation coefficient of grain yield was highly positive and significant with number of branches plant^{-1}, number of pods plant^{-1}, pod weight plant^{-1} at genotypic as well as phenotypic level. Path analysis revealed that pod weight plant^{-1}, followed by number of pods plant^{-1}, length of pod , number of branches plant^{-1} and number of seeds pod^{-1} exhibited high direct effect in desirable direction.

Legumes represent the third largest family of higher plants and comprise more than 650 genera and 18,500 species. Mungbean and Urdbean are two important legumes in Phaseloid clade within Papillionidae and occupy pivotal position in Indian Agriculture. The productivity of pulses is very low as compared to cereals, which have been selected for high grain yield under high input conditions, while the selection pressure in case of pulses have been focused on the adaptation to both biotic and abiotic stresses.

Selection of genotypes based on yield as such is difficult to the integrated structure of plant in which most of the characters are inherited and being governed by the large number of cumulative, duplicate and additive genes. Urdbean breeding strategy for the improvement involves generating genetic material, selection of superior genotypes from the variable genetic material to develop superior varieties. This necessitates a thorough knowledge on the nature of relationship prevalent between yield contributory characters and grain yield and the extent of genetic variability. Therefore, the present investigation aims to assess the variability together with the relative contribution of different yield attributes to grain yield and their interrelationship by estimating correlation, path analysis and coefficient of variability with heritability and genetic advance so as to select superior genotypes.

MATERIAL AND METHODS

The material for this study consisted of 27 promising urdbean genotypes collected from IIPR, Kanpur and Pulses Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The field experiment was conducted in Randomized block design with three replications at Pulses Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.) during *Kharif* 2010. Each plot consisted of four rows of 4m length with a spacing of 30 cm between rows and 10 cm between plants. One border row was planted at both the side to reduce the border effect. The recommended package of practices of crop production and protection were followed for satisfactory crop growth.

Observations on days to 50 per cent flowering, days to maturity were recorded on plot basis while other yield determining attributes like plant height, no. of branches plant^{-1}, no. of pods plant$^{-1,}$ pod weight plant^{-1}, length of pod, no. of seeds pod^{-1} , 100 seed weight and seed yield plant^{-1} were recorded on randomly selected five competitive plants from each genotype in each replication.

Genetic variability parameters were calculated as proposed by Johnson *et al* (1955) and Dewey and Lu (1959), Correlation coefficients by Singh and Choudhari (1977) and Path analysis was done according to the procedure suggested by Dewey and Lu (1959).

RESULTS AND DISCUSSION

Analysis of different genetic parameters are presented in Table1. Grain yield plant^{-1} ranged from 3.40 to 13.40 g with a mean value of 8.16 g. It had a high coefficient of variation at both the genotypic and phenotypic level. The high magnitude of genotypic coefficient of variation (GCV) revealed the presence of high genetic variability in the population. The phenotypic coefficient of variation was in general higher than the genotypic coefficient of variation. This may be due to the insertion of error variance in to phenotypic

1. Assistant Prof., 2. Research Associate, 3. Senior Res. Sci., Pulses Research Unit, Dr. PDKV, Akola

Table 1: Genetic parameters for 10 different characters in urdbean

Characters	Mean	Minimum	Maximum	GCV	PCV	H_2 (%)	Genetic advance
Days to 50% flowering	36.57	34.00	46.67	5.95	9.47	39.47	7.70
Days to maturity	69.00	60.67	79.00	6.53	7.92	67.99	11.09
Plant Height (cm)	53.11	29.33	103.67	35.44	36.34	95.13	71.21
Branches plant^{-1}	4.74	3.33	7.00	18.18	26.25	47.95	25.93
No. of pods plant^{-1}	36.01	16.67	55.00	32.61	37.63	75.10	58.21
Pod weight plant^{-1} (g)	11.69	4.67	18.87	33.35	40.93	66.39	55.97
Length of pod (cm)	5.38	4.80	5.68	2.32	5.96	15.16	1.86
No. of seeds pod^{-1}	6.20	5.33	7.00	3.67	11.92	9.48	2.33
100 seed weight (g)	4.17	3.13	6.77	18.11	18.61	94.69	36.31
Seed yield plant^{-1} (g)	8.16	3.40	13.40	31.91	40.41	62.34	51.90

variation. The GCV was ranged from 2.32 for length of pod to 35.44 for plant height which showed the existence of sufficient diversity among the genotypes selected for the present investigation.

Heritability values were high for all the characters except number of seed pod^{-1} and length of pod. Since, broad sense heritability includes both additive and epistatic effect, it will be reliable only when high heritability coupled with high genetic advance. Plant height followed by number of pods plant^{-1}, grain yield plant^{-1}, pod weight, 100 seed weight and branches plant^{-1} showed high heritability coupled with high genetic advance, which indicates the presence of high additive gene effects (Panse, 1957) suggesting direct selection for these traits would be fruitful. Similar findings of high heritability coupled with high genetic advance were reported by Chauhan *et al*. (2005), Gowda *et al*. (1997), Kasundra *et al*., (1995) and Lakshmaiah *et al*., (1989). High heritability coupled with moderate genetic advance was observed for days to 50 per cent flowering and days to maturity, suggesting the presence of additive and non additive gene action for traits mentioned above. The characters *viz*., plant height, number of pods plant^{-1}, pod weight and grain yield plant^{-1} exhibited high genotypic variance and high heritability coupled with high genetic advance which in turn would be useful for selection for improvement of the crop.

Phenotypic and genotypic correlation coefficients between yield and its components were computed and are summarized in Table 2. The genotypic correlation coefficients were higher in magnitude than the corresponding phenotypic correlation coefficients for most of the characters pair The correlation coefficient of grain yield plant^{-1} was highly positive and significant with number of branches plant^{1}, number of pods plant^{1}, pod weight plant^{1} and length of pod at genotypic level and branches plant^{1}, number of pods plant^{1}, pod weight plant^{1} at phenotypic level , indicating possibility of improving these characters simultaneously. Lad *et al* (2011) also reported positive and significant correlation between number of pods plant^{1}, pod length, number of branches plant^{1}. Similar results were also reported by Amanullah and Mirhatam (2000), Sanjeev *et al,* (2001), Srividhya *et al* (2005) , Makeen *et al,* (2009) for number of pods, Sandhu *et al.,* (1980) for number of pods and pod length, Chauhan *et al,* (2007) for number of pods and number of branches plant^{1}, Natarajan and Rathinasamy (2000) for number of branches plant^{1} however, number of seeds pod^{-1} recorded positive but non significant association with grain yield plant^{-1} conforming the earlier findings of Lad *et al,* (2011) and Sanjeev *et al* , (2001). The association between grain yield with days to 50 per cent flowering and days to maturity was significant but negative at genotypic level. Lad *et al*, 2011 reported negative but non significant correlation between these characters. Plant height and 100 seed weight showed non significant and negative association with grain yield plant^{-1} at both genotypic and phenotypic level.

Association of various characters with the trait of major interest like yield is the consequence of their direct and indirect effect. A clear picture emerged when correlation coefficients were partitioned into direct and indirect effects by path analysis (Table 3). Results of path analysis revealed that pod weight plant^{-1}had maximum direct effect on grain yield followed by days to 50 per cent flowering. However days to 50 per cent flowering showed significant but negative correlation

Table 2. Genotypic (above diagonal) and phenotypic (below diagonal) correlation of 10 characters in urdbean

Characters	Days to 50% flowering	Days to maturity	Plant height (cm)	Branches plant^{-1}	Pods plant^{-1}	Pod weight plant^{-1}	Length of pod (cm)	Seeds pod^{-1}	100 seed weight (g)	Correlation with grain yield plant^{-1}
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	1	1.005**	0.949**	-0.454*	-0.644**	-0.618**	-0.341	-0.665**	-0.099	-0.677**
2	0.500**	1	0.646**	-0.389*	-0.396*	-0.497**	-0.289	-0.226	0.035	-0.523**
3	0.599**	0.522**	1	-0.304	-0.347	-0.147	0.227	-0.187	0.122	-0.178
4	-0.138	-0.151	-0.197	1	0.515**	0.579**	0.299	-0.580	0.124	0.608**
5	-0.301	-0.291	-0.313	0.429*	1	0.822**	0.574**	0.384*	-0.233	0.818**
6	-0.252	-0.324	-0.138	0.425*	0.753**	1	0.799**	0.051	-0.057	0.995**
7	0.039	-0.057	0.064	0.143	0.291	0.325	1	-1.345**	0.114	0.839**
8	-0.045	-0.057	-0.081	-0.011	0.268	0.158	0.377	1	0.470*	0.091
9	-0.062	0.019	0.120	0.092	-0.165	-0.019	0.053	0.140	1	-0.083
10	-0.243	-0.315	-0.158	0.413*	0.742**	0.974**	0.355	0.149	-0.028	1

*, ** significant at 5 and 1 per cent level, respectively

Table 3. Direct and indirect path effects of different characters towards grain yield in urdbean

Characters	Days to 50% flowering	Days to maturity	Plant height (cm)	Branches $plant^{-1}$	Pods $plant^{-1}$	Pod weight $plant^{-1}$	Length of pod (cm)	Seeds pod^{-1}	100 seed weight (g)	Correlation with grain yield $plant^{-1}$
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	0.1532	-0.1211	-0.1055	0.0198	-0.0565	-0.5874	-0.0097	0.0345	-0.0050	-0.677**
2	0.1543	-0.1205	-0.0718	0.0170	-0.0348	-0.4721	-0.0082	0.0117	0.0017	-0.523**
3	0.1457	-0.0779	-0.1111	0.0133	-0.0304	-0.1394	0.0064	0.0097	0.0062	-0.178
4	-0.0697	0.0469	0.0337	-0.0438	0.0452	0.5502	0.0085	0.0301	0.0063	0.608**
5	-0.0989	0.0477	0.0386	-0.0225	0.0877	0.7811	0.0163	-0.0199	-0.0119	0.818**
6	-0.9494	0.0599	0.0163	-0.0254	0.0722	0.9498	0.0222	-0.0026	-0.0029	0.995**
7	-0.0523	0.0348	-0.0252	-0.0131	0.0503	0.7399	0.0285	0.0699	0.0058	0.839**
8	-0.1020	0.0272	0.0207	0.0254	0.0337	0.0486	-0.0383	0.05201	0.0239	0.091
9	-0.0152	-0.0042	-0.0135	-0.0054	-0.0204	-0.0544	0.0032	-0.0244	0.0509	-0.083

*, ** significant at 5 and 1 per cent level, respectively

Residual effect=0.1282

with grain yield plant^{-1} may be due to the indirect effect of all other characters except number of branches plant^{-1} and number of seeds pod^{-1}. Direct effect of number of pods plant^{-1} and length of pod on grain yield was small but great indirect effect via pod weight plant^{-1} resulted in their highly significant correlation with grain yield plant^{-1}. These results were in agreement with the earlier findings of Sandhu *et al*., (1980) and Lad *et al*., (2011) for 50 per cent flowering and pod length, Issacs *et al*., (2000) for number of pods plant^{-1} and pod length, Kingshlin and Vanniarajan (2000) for days to 50 per cent flowering and number of pods plant^{-1} Chauhan *et al*., (2007) Srividhya *et al*. (2005), Mahmood-ul-Hassan *et al*.(2003) for number of pods plant^{-1}

The trait days to maturity had maximum negative direct effect followed by plant height and number of branches plant^{-1}, days to maturity and plant height also showed negative association with grain yield plant^{-1}, however number of branches plant^{-1} had positive and significant association with grain yield due to presence of higher positive indirect effect through pod weight. 100 seed weight had positive direct effect on grain yield plant^{-1}; however negative indirect effect via all the characters except length of pod had converted the correlation coefficient into negative. All the above facts indicate clearly and emphatically that pod weight plant^{-1} should be given maximum importance with close consideration for number of pods, length of pod, number of branches plant^{-1} and number of seed pod^{-1} during the selection procedure aimed at improvement of urdbean crop.

Present investigation clearly reveals direct selection of the traits *viz.*, pod weight plant^{-1}, number of pods plant^{-1}, pod length, number of branches plant^{-1} and plant height would be more effective to enhance the breeding efficiency for seed yield in urdbean.

LITERATURE CITED

Amanullah and Mirhatam, 2000. Performance and distinguishing characters of promising blackgram. Sahad J. Agric. , 16(5):467-476.

Chauhan, D.A., B.G. Solanki and R.M. Kshirsagar, 2005. Genetic variability and D^2 analysis in blackgram (*Vigna mungo* L. Hepper) Crop Prot. Prod.,1(2): 55-57

Chauhan, M. P., A. C. Mishra and Ashok Kumar Singh, 2007. Correlation and path analysis in Urdbean, Legume Res. – An International J., 30 (3) : 115-118.

Dewey, D.R. and Lu, K.H., 1959. A correlation and path analysis of components of crested wheat grass seed production, Agron. J., 51: 515-518.

Gowda , M. B., Prakash J. C .and J. Shanthalu 1997. Genetic variability in black gram (*Vigna mungo* (L.) Hepper) Crop Res., 13(2) : 369-372

Issacs, S.M., S. Jebaraj and S.K. Ganesh, 2000. Estimates of genetic variability and heritability in black gram, Res. on Crop. (1):37-39.

Johnson, H. W., H. F. Robinson, and R.E. Comstock, 1955. Estimates of genetic and environmental variability in soybean, Agron. J., 47 : 314-318.

Kasundra, J.K., K.V. Pethani and K.B. Katharia , 1995. Studies on genetic variability, correlation and path analysis in Urdbean, Indian J.Pulses Res. 8(2):113-118.

Kingshlin, M. and C. Vanniarajan, 2000. Association of yield attributes and component analysis among the quantitative characters of rice fallow urdbean genotypes, Crop Res. 19(1):102-105

Lad D.B., P. B. Punde and P. K. Jagtap 2011. Character association and path analysis in Black gram (*Vigna mungo* (L.) Hepper), J.Agric. Res. Tech., 36(1) : 46-49.

Mahmood-ul-Hassan, Muhammad Zubair and Saifullah Ajmal, 2003. Correlation and path coefficient analysis in some promising lines of mashbean (*Vigna mungo*), Pak. J. Biol. Sci., 6(4) : 370-372

Natarajan, C. and R. Rathinasamy, 2000. Genetic variability, correlation and path analysis in black gram, Madras Agric. J., 88(4-6): 218-222.

Panse, V.G., 1957, The application of genetics to plant breeding. Indian J. Genet., 40 : 282-302

Sandhu, T.S., Bhullar, B.S., Cheema H.S. and Brar, J.S. 1980, Path coefficient analysis in urdbean, Indian J. of Agric. Res., 14(1):35-41.

Sanjeev, G., S. R. Gupta, H.K. Dikshit and R.A. Singh, 2001. Variability and its characterization in Indian collection of black gram (*Vigna mungo* (L.) Hepper) Pl. Genet. Resources News Lett.127:20-24.

Srividhya, A., M.R. Sekhar and G.L.K. Reddy, 2005. Correlation and path analysis in F2 generation of urdbean Legume Research, 28 (4) : 297-299

Singh, R.K. and B.D. Chaudhary, 1977. Biometrical methods in quantitative genetic analysis, Kalyani Pub., New Delhi.

❖ ❖ ❖

PKV Res. J. Vol. 36 (2), July 2012

Drip Fertigation Effect on Yield, Water Use Efficiency and Economics of Bt Cotton in Semi-arid Region

Jagvir Singh[1], Shilpa Babar[2], Rachana Deshmukh[3], P. R. Bharambe[4] and R. B. Singandhupe[5]

ABSTRACT

A field experiment was conducted at C.I.C.R., Nagpur during *Kharif* season of 2007, 2008 and 2009 to maximise the yield of Bt cotton with irrigations and N K fertilizers through drip. The results revealed that irrigation at 0.8 ETc had a significant effect on number of bolls and seed cotton yield as compared to drip and surface irrigation at 0.6 ETc. The increase in number of bolls per m^2 and yield in the former irrigation level was 19 and 16 per cent, respectively over later irrigation. The water use efficiency (WUE) was found to be highest at 0.8 ETc (3.45 kg ha^{-1} mm) as compared to 1.0 ETc (3.13 kg ha^{-1} mm) which saved 20 per cent water. The mean highest seed cotton yield (2287 kg ha^{-1}) as well as WUE (3.19 kg ha^{-1} mm) was recorded with 100 per cent NK through drip followed by 100 per cent NPK fertilizer (2044 kg ha^{-1}) as soil application.

Irrigation water is a critical scarce resource in rainfed area of Maharashtra particularly semi-arid region. Maharashtra state is endowed with suitable medium black soils for the production of cotton but unfortunately the potential of cotton production was not duly recognised with the production challenges in this state of India. Drip fertigation with soluble nutrients is an option wherever water availability limits conventional irrigation which reduces the risk of yield reduction. At the same time, adoption of effective irrigation technique economises water and fertiliser at substantial amount and enhances input use efficiency (Mintesinot *et.al.*,2004;Taisheng *et.al.*, 2006). Out of total cotton area in the country (10.17m ha), about one-third area (3.97m ha) is in Maharashtra alone and the farmers of this area have been cultivating cotton under rainfed condition for longer period and harvesting very low yield of 296 kg lint ha^{-1} as against the national average yield of 488 kg lint ha^{-1} (Anonymous 2010). The area of cotton under drip in Maharashtra is less than 0.07lakh ha (Magar and Nandgude, 2005). Under adverse circumstances of limited and erratic distribution of rainfall in hot and semi-arid region of the country where cotton is the main crop, the yield is drastically reduced due to inadequate soil moisture in root zone. Due to limited sources of water for irrigation to cotton in rainfed region, drip system may be a better strategy to save water and increase fertilizer use efficiency. Considering these major constraints of low productivity, field studies were undertaken, involving irrigation and fertilizer through drip to improve fertiliser and water use efficiency to achieve the maximum yield of Bt cotton in semi-arid tropical regions.

MATERIAL AND METHODS

The field experiment on drip fertigation in Bt cotton was conducted at C.I.C.R. Farm, Nagpur during 2007-08 to 2009-2010. The treatments consisted of four irrigation schedules viz. I_1- 0.6 ETc, I_2- 0.8 ETc, I_3- 1.0 ETc through drip and I_4- surface irrigation at 0.6 ETc (IW/CPE) in three splits manually and four fertigation levels (Table 1). These treatment combinations were tested in split plot design with three replications by keeping irrigation regimes in main- plots and fertilizers in sub- plots (Table 1).

Table 1. NPK fertilizers through drip and soil application in sub- plots

Fertilizers	Methods	Fertilizer in splits
F_1- 75% , F_2- 100% and F_3- 125% NK	by drip	6 splits
F_4- 100% NPK	as soil	3 splits

In F_1, F_2 and F_3, P was applied as basal in soil, 100 per cent NPK fertiliser was 120:27:53 kg ha^{-1} and the discharge rate of dripper was 2.9 litres ha^{-1} measured at frequent intervals to attain desired uniformity coefficient.

The crop water demand (ETc) was calculated as

$$ETc = Epan \times Kp \times Kc \qquad (1)$$

Where Epan: Pan evaporation (mm); Kp: pan-

1, & 5. Principal Scientists, 2 & 3. Senior Research Fellows and 4. Ex Head, Crop Production Division, Central Institute for Cotton Research, Nagpur

coefficient (0.75); Kc: crop coefficient which varies for different growth stages of crop, as per FAO 56 (Allen *et. al.*, 1998). For cotton it was 0.45, 0.75, 1.15 and 0.70 for initial (0- 25 days), active growth period (26-70 days), boll development (71- 120 days) and maturity stage, respectively. For different levels of ETc, before irrigation the soil moisture content (0-30 cm soil depth) was estimated gravimetrically. The soil of experimental site was medium deep black (Vertisols) with clayey in texture, low organic carbon (3.8 g kg^{-1}), moderately alkaline in reaction (pH 8.2), low in available N (110 kg ha^{-1}) and P (8.1 kg ha^{-1}) and rich in K (526 kg ha^{-1}). The water retention at -33 kPa (field capacity) was 31. Seed cotton yield of 3 pickings and number of bolls per m^2 was recorded. Water use efficiency in kg seed cotton yield per unit of water used was estimated.

Table 2. Details of agronomic .and crop data

Variables	2007	2008	2009
Cotton variety	NCS 145 Bt	NCS 145 Bt	NCS 145 Bt
Planting date	23 June	19 June	6 July
Spacing (R-R X P-P)	90cm x 60cm	90cm x 60cm	90cm x 60cm
First irrigation	7 July	1 July	21 July
Last irrigation	15 October	25 October	30 October
No. of irrigations	31	36	34
First harvesting date	5 Nov.	15 Nov.	15 Nov.
LGP	165 days	170 days	166 days
CPE during season	723	793	769
Total rainfall in season	934 mm	569 mm	707 mm
Erratic rainfall distribution	600 mm in July	59% defficient	25% defficient

R-R: row to row, P-P : plant to plant,
LGP: length of growing period

RESULTS AND DISCUSSION

Irrigation water

The water used during the crop growth period is given in Table 3. The effective rainfall which was computed based on storage capacity of soil (up to 60 cm depth) was found to be 607, 405 and 563 mm in 2007, 2008 and 2009, respectively. Mean of consumptive water used by Bt cotton of three years indicated that the saving of water in drip irrigation was 10.3, 7.7 and 3.8 per cent in 0.6, 0.8 and 1.0 ETc irrigation schedule, respectively; over surface irrigation 0.6 ETc (I_4) in which the total water use was 728 mm. The irrigations provided through surface method was 40 per cent less than 100 per cent crop evaporative demand as this crop is moisture stress tolerant and hence, the saving of water in drip irrigation system was marginal in all drip irrigation levels (Stone and Nofziger, 1993).

Table 3. Amount of water applied through drip and total consumptive water

Irrigation regimes	Irrigation water through drip (mm)			Total consumptive water (mm)		
	2007	2008	2009	2007	2008	2009
I_1- 0.6 ETc	128	152	105	735	557	668
I_2- 0.8ETc	141	160	140	748	565	703
I_3- 1.0 ETc	174	178	175	781	583	738
I_4- 0.6 ETc (IW/CPE)	190	223	202	791	628	765

Yield attributes

Irrigation and fertigation had a significant effect on the number of opened bolls m^{-2} except in the year 2008 where fertigation levels were non-significant (Table 4). Significantly higher number of opened bolls m^{-2} was recorded at 0.8 ETc (I_2) as compared to 0.6 ETc ($I_{1,}$ I_4) irrigation regimes in all the three years which may be due to sufficient moisture in cotton root zone as required by plant. Significant increase in number of bolls was recorded with 100 per cent fertilizer (F_2) over to 75 per cent fertiliser (F_1) in 2007 and 2009. Pooled data of three years indicated that treatment F_2 (100% NK) through drip registered significant increase in number of bolls m^{-2} by 22.8, 29.8 and 21.1per cent in 2007, 2009 and mean data, respectively, over F_1.

Seed cotton yield

Irrigation regimes

Seed cotton yield was significantly influenced due to irrigation treatment I_2 when it compared to I_4 and yield increase was 21 and 18 per cent in first and third year, respectively (Table 4). Sampathkumar *et. al.*, (2006) reported similar results that under drip method water delivered only at root zone ensured maximum yield than surface irrigation. The yields obtained in treatment I_2 was statistically at par with I_3. Though cotton does not require heavy irrigation but it respond to timely irrigations on ET basis (Taisheng *et. al.*, 2006). Pooled yield of three years indicated similar effect of irrigations through drip as compared to surface irrigation (Veerputhrin *et. al.*, 2002).

Water use efficiency

Maximum water use efficiency (WUE) was observed at I_2 irrigation treatment as compared to other

Table 4. Effect of irrigation and fertilizer levels on bolls, yield and WUE of Bt cotton

Treatments	Total harvested bolls m^{-2}				Seed cotton yield (Kg ha^{-1})				Water use efficiency ($kg\ ha^{-1}mm$)			
	2007	2008	2009	Pooled	2007	2008	2009	Pooled	2007	2008	2009	Pooled
Irrigation regimes												
I_1-0.6 Etc	59. 5	58. 5	56.6	58.2	1991	1971	1937	1966	2.71	3.54	2.90	3.05
I_2- 0.8Etc	73.4	70.0	70.2	71.2	2412	2211	2295	2306	3.22	3.91	3.26	3.45
I_3-1.0 Etc	70.0	64.4	64.8	66.4	2300	2084	2122	2168	2.95	3.58	2.88	3.13
I_4-0.6 ETc (IW/CPE)	62.5	58.8	58.5	59.9	2119	1957	1942	2006	2.68	3.12	2.54	2.78
SEm ±	2.26	1.74	1.84	1.22	136.3	94.5	108.6	45.6	0.14	0.18	0.12	0.14
CD at 5% Fertilizer level	5.52	4.27	4.51	2.98	330.0	231.1	265.7	111.5	0.36	0.48	0.30	0.35
F_1-75% NK	59.4	58.6	53.1	57.0	2016	1907	1901	1941	2.69	3.27	2.65	2.87
F_2-100% NK	72.9	66.3	67.9	69.1	2330	2267	2263	2287	2.91	3.88	3.15	3.19
F_3-125%NK	70.2	65.8	66.9	67.6	2101	2129	2173	2134	2.75	3.65	3.03	3.14
F_4-100%NPK	62.9	61.9	61.6	62.1	2108	2074	1950	2044	2.76	3.56	2.72	3.07
SEm ±	1.50	2.92	2.15	1.49	106.3	108.9	91.0	47.7	0.16	0.19	0.18	0.19
CD at 5%	3.10	NS	4.44	3.08	219.5	224.9	187.8	98.4	NS	0.51	0.49	NS

Table 5. Drip fertigation effect on economics of Bt cotton (mean of 3 years)

Treatments	Pooled yield (kg ha^{-1})	*Gross income (Rs ha^{-1})	Cost of cultivation (Rs ha^{-1})	Net income (Rs ha^{-1})	B:C ratio
Irrigation regimes					
I_1- 0.6 ETc	1966	55048	26500	28548	1.08
I_2- 0.8ETc	2306	64568	27100	37468	1.35
I_3-1.0 ETc	2168	60704	27700	33004	1.19
I_4-0.6 ETc (IW/CPE)	2006	56168	26800	29368	1.10
Fertilizer levels					
F_1-75 % NK	1941	54348	26650	27698	1.04
F_2- 100% NK	2287	64036	27150	36886	1.36
F_3-125% NK	2134	59752	27550	32202	1.17
F_4-100% NPK	2044	57232	25450	31782	1.25

* Considering price 28.00 Rs. kg^1 seed cotton (average price of 3 years)

irrigation schedules in all the years and pooled mean (Table 4). When WUE was assessed between the years, maximum WUE was recorded in 2008 as compared to 2007 and 2009 at all irrigation schedule, might be due to less loss of rain water during crop season of 2008. Significantly higher WUE was recorded at I_2 as compared to surface irrigation (I_4). It is thus, inferred that additional amount of irrigation water lower than 0.8ETc and beyond this level had no extra benefit as the increase in WUE was not proportionate with increase or decrease in water applied to this crop. Similar trend were also observed in pooled analysis of three years data on WUE.

Fertilizers

Seed cotton yield

Among the different fertilizer levels, seed cotton yield significantly increased with treatment F_2 as compared to F_1 treatment through drip. Similar trend was also observed in mean seed cotton yield obtained with 100 per cent fertigation (F_2). The results are in agreement

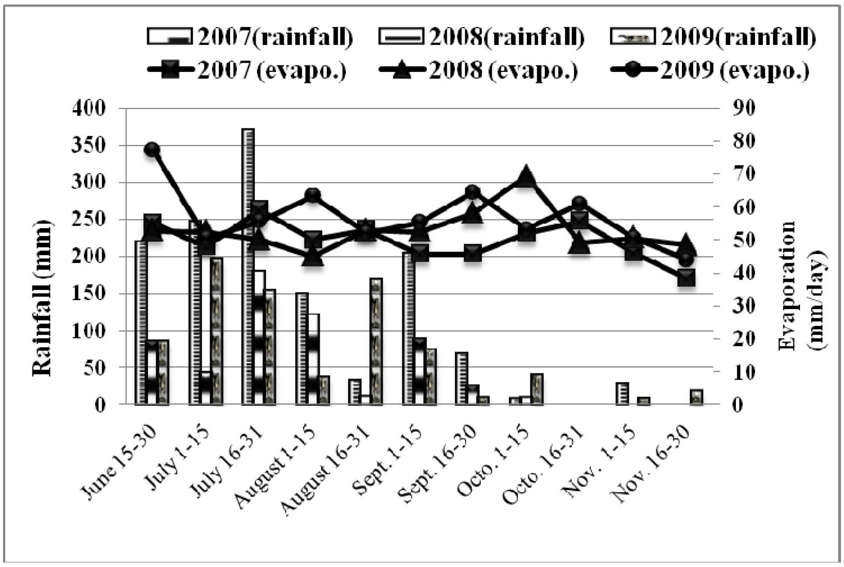


Fig. 1. Weather records during crop season at research, Farm, Nagpur

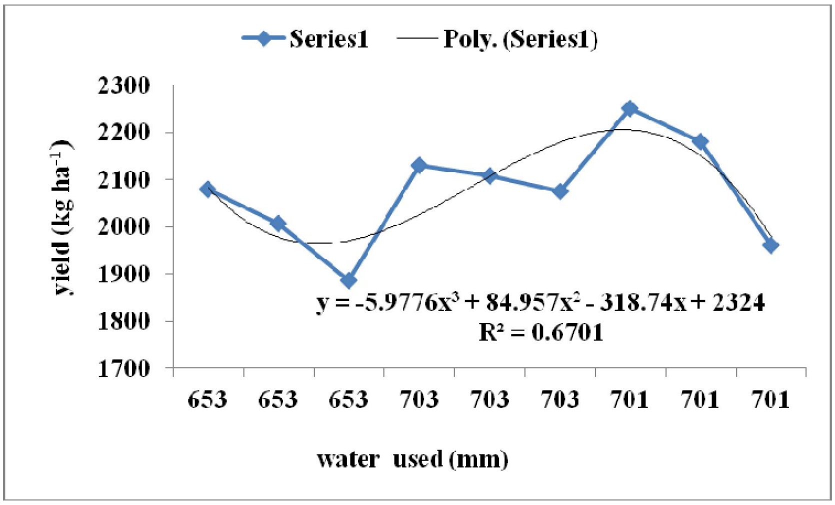


Fig. 2. Response of water on seed cotton yield (pooled data)

with Veerputhrin *et. al.*, 2002 and Kamilov *et. al.*, 2003. Interaction effect of irrigation and fertilizers was not significant.

Water use efficiency

Highest WUE was recorded in treatment F_2 followed by F_3 in 2008 and 2009. Pooled data also showed similar trend like the trend of different years as I_2 treatment resulted highest WUE followed by I_4. Several workers (Veerputhrin *et. al.*, 2002, Stefanie *et.al.*, 2004 and Hirwe and Jadhav, 2011) have reported significant increase in water use efficiency and fertilizer use efficiency under drip system.

Seed cotton yield response to water use

The response function was computed between total water use as a independent variable (x) and crop yield (Y) as a dependent variable by considering the pooled data (replication wise). The yield response was computed up to third degree polynomial ($Y= a+bx+cx^2+dx^3$) as the R^2 value was quite low in second degree polynomial function. The relationship and coefficient presented in equation 2 reveals that with application of each amount of water beyond 653 mm has progressive increase of seed cotton yield up to 703 mm water (Figure 2). Thereafter, the seed cotton yield has showed decreasing trend. The response to applied water was explained by 67 % in case of third degree polynomial, and 13 % in second degree polynomial regression.

$Y = -5.977x^3 + 84.95x^2 - 318.7x + 2324$, R^2 0.67   -(2)

Economics of Bt cotton production

Pooled data of three years on economics analysis of drip irrigation and fertigation (Table 5) indicated that drip irrigation at I_2 enhanced net income (Rs. 37468 ha^{-1}) and B:C ratio (1.38) as compared to irrigation at I_3, where the net income was Rs. 33004 ha^{-1} with B:C ratio 1.19. Fertilizer treatment F_2 had highest net income (Rs. 36886 ha^{-1}) as compared to F_4 as soil application. Hence, 100 per cent NK fertilizer applied through drip and P applied as basal for Bt cotton was found optimum and economical for semi-arid cotton regions of India.

CONCLUSION

Among different irrigation and fertilizer schedules followed in hybrid cotton Bt for assessing the suitability in semi-arid region, 100% fertilizer (120:37:53 kg NPK ha^{-1}) as NK through drip and P fertilizer as soil application at 0.8 ETc was found optimum and economically suitable for achieving potential yield of Bt cotton, as it has been evidenced due to higher number of bolls and water use efficiency.

ACKNOWLEDGEMENTS

The authors would like to thank the Director, Central Institute for Cotton Research, Nagpur, for all the assistance provided to carry out this investigation. The authors also extend their gratitude to the Technology Mission on Cotton, ICAR, New Delhi for financial support to this study.

LITERATURE CITED

Allen, R.G., L.S. Pereira, D. Raes and M. Smith, 1998. Crop evapotranspiration: Guidelines for computing crop water requirements. FAO, Irrigation and Drainage 56, Rome, Italy, 300.

Anonymous, 2010. Statistics at a glance, Directorate of Economics and Statistics, Ministry of Agriculture Govt. of India.

Hirwe, N.A. and A.S. Jadhav, 2011. Effect of different irrigation methods on yield and water use efficiency of summer cotton, PKV Res. J. 35(1):132-133.

Kamilov,B., N. Ibragimov, Y. Esanbikov and S. Evett, 2003. Drip irrigation cotton: irrigation scheduling study by use of soil moisture neutron probe, International J. Water and Irrig., 23 (1): 38-41.

Magar, S.S. and S.B. Nandgude, 2005. Micro-irrigation status and holistic strategy for evergreen revolution, J. Water Manage., 13 (2): 106-111.

Mintesinot, B., H. Verplancke, E. Van Ranst and H. Mitiku, 2004. Examining traditional irrigation methods, irrigation scheduling and alternate furrows irrigation on vertisols in northern Ethiopia, Agric. Water Manage., 64:17–27.

Sampathkumar,T., S. Krishnaswamy, V.Veerbadran and K. Shyamsundar, 2006. Effect of drip, surface irrigation method on yield and yield attributing characters in smmer cotton, Res. on Crops. 7(1): 120-122.

Stefanie Von W., Sietan Chieng and Hans Schreier, 2004. A comparison between low-cost drip irrigation, conventional drip irrigation and hand watering in Nepal, Agric. Water Manage., 64:143-160.

Stone, J.F. and D.L. Nofziger, 1993. Water use and yields of cotton grown under wide spaced furrow irrigation, Agric. Water Manage. 24: 27–28.

Taisheng, Du., Shaozhong Kanga, Jianhua Zhang, Li. D. Fusheng and Hu. Xiaotao, 2006. Yield and physiological responses of cotton to partial root-zone irrigation in the oasis field of north-west China, Agric. Water Manage., 84: 41–52.

Veerputhrin, R., O.S. Karadsamy and S.D. Suredrasingh, 2002. Effect of drip irrigation and fertigation on growth, yield of hybrid cotton, J. Agric. Resource Manage.,1: 88-97.

❖ ❖ ❖

PKV Res. J. Vol. 36 (2), July 2012

Characterization of Soils under Right Bank Canal Command Area of Pench Irrigation Project in Nagpur District of Maharashtra

A. J. Patangray[1], Ommala Kuchanwar[2] and Padmaja H. Kausadikar[3]

ABSTRACT

In order to characterize the soils of right bank canal command area of Pench irrigation project in Nagpur district particularly in Parsheoni Tahasil, the present study was undertakenand for that survey was done in May,2011. Soils of this area are clay loam to clayey with more than 35 per cent clay. Bulk density of these soils varied from 1.28 to 1.53 Mg m^{-3}. The saturated hydraulic conductivity (HC) of these soils ranged from 0.81 to 2.71 cm hr^{-1}. Soil reaction was low to moderately alkaline (pH 7.43 to 8.53). These soils are non saline as indicated by the electrical conductivity which ranged from 0.119 to 0.552 dS m^{-1} at 25^{o} C, but more accumulation of salts was observed in surface layer of these soils. Organic carbon content (2.7 to 6.2 g kg^{-1}) was low to moderate. The calcium carbonate content of these soils was low to moderate ranged from 1.5 to 6.13 per cent.

The Pench Irrigation Project is one of such projects situated on Pench river covering its command area in the part of Nagpur district through Its Left Bank and Right Bank Canals. The Pench Right Bank Canal provides irrigation to the areas falling between Kanhan river North and Nag river in south. The irrigation was started since 1992 from Right Bank Canal. Hence, it was felt pertinent to characterize the soils of these areas.

MATERIAL AND METHODS

Geographically, Right Bank Cannal of Pench Irrigation Projects is located between 79^{o} 0' to 79^{o} 15' E longitudes and 21^{o} 15' to 21^{o} 30' N latitudes covering an area of about 7485.35 ha in Parsheoni Tahasil of Nagpur district, Maharashtra. The elevation of area ranges from 250 to 350 m. Geology of the area mainly consist of Deccan Trap Basalt and soils are developed from basaltic alluvium. Climate of the study area is subtropical dry, sub humid with an anual rainfall of 1145 mm.

Fifty surface soil samples were collected with free survey with the help of GPS where there is a differentiation in soils and were analysed for mechanical composition following international pipette method (Piper, 1966). The saturated hydraulic conductivity was determined by the constant head method (Richards, 1954) using a permeameter.

The bulk density of the soil were determined by cload coating method (Blake, 1965). The fine earth fractions (< 2 mm) were analysed for pH and EC. Cation exchange capacity (CEC) and exchangeable cations according to methods outlined by Jackson (1973), Calcium carbonate is determined by (0) and soil organic carbon by (0).

RESULTS AND DISCUSSION

The clay content in the studied soils varied from 35.73 to 61.70 per cent (Table 1). Pal and Deshpande (1987) also reported high content of clay and smectitic mineralogy in these soils. The silt content ranged from 25.17 to 38.42 per cent and the sand content ranged from 10.12 to 30.12 per cent. Regarding clay, silt and sand the similar result was observed by Meena *et al.*, (2011).

The variation in soil separates in the samples may be due to soil developed on different physiographic units and its parent material (Murthy *et al.* 1982).

Bulk density of these soils ranged from 1.28 to 1.53 Mg m^{-3} (Table 1). Bulk density is influenced by soil texture, organic matter content and cultivation practices and high bulk density indicates compactness of soil (Biswas and Mukherjee., 1987). Comparative low values of bulk density in the study area soils can be ascribed to high clay content and dominated by smectite clay mineral which is expanding type of clay mineral. The result agree with those reported by Bharambe *et al.* (1999). The saturated hydraulic conductivity (HC) of these soils ranged from 0.81 to 2.71 cm hr^{-1} (Table 1). Similar result was given by Magar (1990). Hydraulic conductivity of soil is influenced due to maturing alternation by tillage, alternate wilting and drying, cracking and other logical processes.

The pH of the soils varied from 7.43 to 8.53, indicating their neutral to moderately alkaline soil reaction (Table 2). Similar result was given by Meena *et al.* (2011). Higher pH may be due to the calcareous nature of the soil (Kant and Chauhan., 2005).

1. PG Student, 2. Associate Professor and 3. Assistant Prof., College of Agriculture, Nagpur

Table 1. Physical properties of soils:

Sample No.	Bulk Density	Particle size analysis (%)			Texture	Hydraulic Conductivity(cm hr^{-1})
		Sand	Silt	Clay		
1	1.41	12.23	34.12	53.65	Clay	1.35
2	1.46	10.12	31.45	58.43	Clay	0.98
3	1.51	12.81	28.13	59.06	Clay	0.93
4	1.52	14.2	26.57	59.23	Clay	0.98
5	1.46	13.25	29.11	57.64	Clay	1.11
6	1.42	14.81	29.34	55.85	Clay	1.13
7	1.4	13.27	36.38	50.35	Clay	1.56
8	1.48	11.85	31.12	57.03	Clay	1.12
9	1.41	13.12	36.82	50.06	Clay	1.27
10	1.38	17.12	37.51	45.37	Clay	2.17
11	1.38	17.34	35.78	46.88	Clay	1.96
12	1.35	16.21	38.42	45.37	Clay	2.13
13	1.41	11.27	36.72	52.01	Clay	1.2
14	1.39	15.21	34.17	50.62	Clay	1.21
15	1.46	14.17	29.34	56.49	Clay	1.15
16	1.43	10.81	34.58	54.61	Clay	0.98
17	1.51	13.12	28.25	58.63	Clay	0.98
18	1.43	17.21	32.07	50.72	Clay	1.35
19	1.37	18.27	31.81	49.92	Clay	1.42
20	1.45	14.71	31.12	54.17	Clay	1.18
21	1.48	16.12	27.11	56.77	Clay	1.11
22	1.5	11.34	30.12	58.54	Clay	0.98
23	1.47	12.81	31.81	55.38	Clay	1.1
24	1.44	17.14	26.11	56.75	Clay	0.91
25	1.53	10.58	27.72	61.7	Clay	0.85
26	1.51	11.82	30.17	58.01	clay	0.97
27	1.35	25.75	31.34	42.91	clay	1.52
28	1.29	28.25	33.72	38.03	Clay loam	2.31
29	1.42	27.21	25.17	47.62	clay	1.13
30	1.38	25.28	39.75	34.97	Clay loam	2.71
31	1.41	25.97	27.81	46.22	clay	1.54
32	1.4	25.62	31.17	43.21	clay	1.42
33	1.42	27.36	26.75	45.89	clay	1.29
34	1.39	27.14	31.25	41.61	clay	1.68
35	1.28	31.56	32.71	35.73	Clay loam	2.57
36	1.41	30.12	28.12	41.76	clay	1.65
37	1.43	24.27	26.13	49.6	clay	1.22
38	1.46	21.12	27.37	51.51	clay	0.95
39	1.42	21.65	28.33	50.02	clay	1.14
40	1.42	18.21	32.48	49.31	clay	1.21
41	1.41	28.96	25.71	45.33	clay	1.26
42	1.43	18.23	27.38	54.39	clay	0.81
43	1.43	14.31	31.12	54.57	clay	0.85
44	1.4	14.71	34.51	50.78	clay	1.12
45	1.4	20.93	27.91	51.16	clay	0.98
46	1.45	15.83	28.24	55.93	clay	0.83
47	1.37	16.47	35.42	48.11	clay	1.23
48	1.4	14.3	27.54	58.16	clay	0.81
49	1.33	14.57	32.13	53.3	clay	0.91
50	1.41	16.41	28.17	55.42	clay	0.87

Table. 2 Chemical properties of soils:

Sample No.	pH	EC(dS m^{-1})	S.O.C.(g kg $^{-1}$)	$CaCO_3$(%)
1	8.36	0.151	3.90	4.65
2	8.39	0.197	3.50	4.75
3	8.53	0.178	2.70	5.34
4	8.41	0.160	3.80	4.13
5	8.46	0.125	4.60	4.58
6	7.85	0.214	5.60	2.62
7	7.78	0.177	4.10	2.87
8	8.50	0.201	4.80	5.42
9	7.96	0.119	4.10	2.75
10	7.90	0.147	5.10	2.88
11	7.78	0.196	4.80	2.65
12	7.82	0.220	4.30	2.32
13	8.45	0.230	4.10	4.25
14	8.23	0.160	4.10	4.11
15	7.85	0.160	4.50	2.13
16	7.43	0.196	4.10	2.50
17	7.71	0.168	6.20	1.63
18	7.78	0.185	4.30	2.62
19	8.20	0.165	3.80	4.23
20	8.47	0.261	3.70	4.36
21	8.02	0.219	4.30	4.11
22	8.01	0.552	3.60	4.13
23	7.99	0.142	5.80	3.63
24	8.25	0.312	4.80	4.13
25	8.27	0.227	4.60	4.28
26	8.21	0.151	4.2	4.26
27	8.58	0.179	2.8	6.13
28	8.31	0.161	3.9	4.13
29	8.40	0.144	3.1	5.73
30	8.34	0.319	3.7	4.58
31	8.00	0.229	5.8	3.90
32	7.83	0.286	5.1	3.50
33	7.83	0.228	4.6	2.88
34	7.87	0.375	3.1	5.80
35	7.76	0.181	5.3	1.50
36	8.16	0.185	3.5	3.65
37	8.20	0.192	3.3	4.48
38	8.34	0.162	3.8	6.13
39	8.24	0.154	3.8	4.38
40	8.20	0.294	3.5	4.63
41	7.39	0.223	4.2	4.98
42	8.48	0.373	3.8	6.12
43	8.12	0.186	3.9	4.82
44	8.20	0.158	3.1	5.10
45	7.90	0.160	3.2	3.95
46	8.35	0.281	3.6	4.56
47	8.12	0.162	3.3	4.71
48	8.30	0.377	3.5	4.13
49	7.65	0.281	3.8	3.56
50	8.16	0.226	4.9	4.78

Table 3. Exchangeable properties of soils:

Sample No.	Exchangeable Cations				Sum	C.E.C.
	Ca^{++}	Mg^{++}	Na^{+}	K^{+}		
	(cmol (p+) kg^{-1})					
1	28.60	13.2	1.8	1.1	44.70	49.12
2	30.20	12.2	2.1	0.9	45.40	48.82
3	32.30	13.2	1.7	0.8	48.00	52.40
4	34.20	14.1	2.2	0.8	51.30	56.81
5	35.20	13.2	2.1	0.9	51.40	54.56
6	31.12	15.2	2.1	1.1	49.52	53.13
7	28.82	12.1	1.6	1.1	43.62	47.78
8	32.60	12.3	2.2	0.9	48.00	52.06
9	31.56	14.2	1.8	0.7	48.26	52.29
10	24.90	12.3	1.0	0.8	39.00	41.45
11	28.30	11.2	1.4	1.2	42.10	45.66
12	28.60	13.2	1.8	0.8	44.40	47.08
13	32.50	11.2	2.1	0.7	46.50	49.36
14	27.95	12.3	2.1	0.8	43.15	45.33
15	32.20	12.3	1.8	1.1	47.40	51.35
16	32.25	11.4	2.4	1.4	47.45	49.38
17	36.70	14.2	1.8	0.7	53.40	58.49
18	30.10	12.1	2.2	0.8	45.20	48.86
19	27.65	11.2	1.8	0.9	41.55	44.39
20	30.20	12.3	2.1	0.7	45.30	49.45
21	30.50	12.3	1.7	1.1	45.60	49.67
22	33.50	14.3	2.3	0.9	51.00	55.25
23	35.20	12.5	2.1	0.8	50.60	53.21
24	32.70	13.4	2.2	0.8	49.10	53.78
25	32.40	12.6	2.3	0.9	48.20	52.05
26	30.20	14.3	1.8	1.1	47.40	51.30
27	22.30	12.3	1.8	1.4	37.80	40.38
28	24.50	11.3	1.2	0.7	37.70	39.85
29	28.00	12.2	1.9	0.8	42.90	45.11
30	22.00	8.3	0.9	0.7	31.90	33.76
31	24.00	9.3	1.4	0.9	35.60	37.83
32	25.10	11.2	1.6	1.4	39.30	41.68
33	26.70	12.8	1.6	1.4	42.50	44.74
34	22.80	11.3	1.1	0.9	36.10	39.76
35	22.20	12.3	1.2	1.1	36.80	40.17
36	24.20	12.2	1.5	1.4	39.30	42.90
37	27.00	12.3	2.1	1.4	42.80	46.27
38	29.20	12.3	2.1	0.8	44.40	46.93
39	30.12	15.2	2.2	0.8	48.32	52.92
40	29.27	13.6	1.8	0.4	45.07	48.25
41	26.00	11.2	1.9	1.1	40.20	44.27
42	28.60	12.3	2.3	1.2	44.40	49.01
43	31.46	15.3	2.4	1.5	50.66	55.37
44	31.00	14.3	2.2	1.8	49.30	52.73
45	30.97	16.3	2.3	1.2	50.77	54.01
46	29.20	15.2	1.6	1.4	47.40	51.63
47	28.88	12.3	1.7	0.9	43.78	47.79
48	33.12	14.3	2.1	0.9	50.42	55.29
49	31.61	15.2	2.1	1.1	50.01	54.60
50	28.30	12.3	2.1	1.4	44.10	48.73

The electrical conductivity values ranged from 0.119 to 0.552 dS m^{-1} at 25°C (Table 2) which is well within the acceptable limit of EC range designated for normal soils (Richards, 1954) indicating that these soils are non saline. The similar results were given by Tripathi *et al*. (2004). The organic carbon content of the soils varied from 2.7 to 6.2 g kg^{-1} (Table 2). The similar findings were given by Bharambe *et al.* (1999) and Dahifale *et al.* (2009). The calcium carbonate content ranged from 1.5 to 6.13 per cent (Table 2). The soils of this area are non calcarious to slightly calcarious. The degree of development of sodicity, exchangeable sodium percentages (ESP>5) is more in soils of MH (microhigh) as evidenced by the higher amount of pedogenic $CaCO_3$ (Vaidya and Pal., 2002).

Among the exchangeable cations, calcium was dominant, followed by magnesium, sodium and potassium in all the soil samples. The exchangeable calcium and magnesium contents of soils varied from 22.0 to 36.7 and 8.3 to 16.3 cmol (p+) kg^{-1}, respectively.

The exchangeable sodium and potassium in these soils ranged from 0.9 to 2.4 and 0.4 to 1.8 cmol (p+) kg^{-1} respectively. The similar finding was reported by Kawde *et al.* (2005) and Patil *et al.* (2001).

The cation exchange capacity (CEC) of soils varied from 33.76 to 58.49 cmol (p+) kg^{-1}. The CEC of the soils mainly depends on the amount of clay and organic matter content (Murthy *et al.*, 1982) the similar result was given by Kaushal *et al.* (1986). The values of CEC suggest the dominance of smectite clay mineral in the finer soil fraction. Similar values of CEC and the presence of smectite in black and associated soils were reported by Kaswala and Deshpande (1986) and Balpande *et al.* (1996). Soils of this area are clay loam to clayey (more than 35% clay) and the cation exchange capacity (33.76 to 58.49 cmol (p+) kg^{-1}) indicates the potential of these soils in terms of fertility.

LITERATURE CITED

Balpande, S. S., S. B. Deshpande and D. K. Pal, 1996. Factors and process of Soil degradation in Vertisols of the Purna Valley, Maharashtra, India, Land Degradation and Development, 7: 313-324.

Bharambe, P. R., S. G. Kadam, S. D. Shinde and D. K. Shelke,1999.Characterization of soils of Majalgaon canal command area. Water management center, Marathwada Agriculture University, Parbhani, Maharashtra, J. Indian Soc. Soil Sci., 47: 749-759.

Biswas, T. D. and S. K. Mukherjee, 1987. Textbook of Soil Science, 1st Edn., Tata McGraw Hill Publication Co. Ltd., New Delhi.

Black, C. A., D. D. Evans, J . L. White, L. E. Ensmingel, and F. E. Clark, 1965, Methods of Soil Analysis, part 1, American Soc. Agron. Inc. Agron. Madison Wisconsin, U.S.A : 9: 770.

Dahifale, H. N., A. G. Durgude and A. N. Deshpande, 2009. Nutrient Diagnosis for bronzing of leaves in guava orchards, J. Maharashtra Agric. Univ., 34: 68-76.

Jackson, M. L., 1967. Soil Chemical Analysis, Prentic Hall of India Private Ltd., New Delhi.

Kant Shiva and R. P. S. Chauhan, 2005. Characterization of salt-affected soils of Sharda Sahayak Command area of Faizabad district, J. Soils and Crops. 15: 14-20.

Kaushal, G. S., B. R. Tembhare and S. B. Sinha, 1986. Morphologic and Taxonomy of black soils under Bargi Irrigation Project in Madhya Pradesh. J. Indian Soc. Soil Sci. 34: 329-333

Kawde, A. D., H. N. Ravankar and V. R. Padole, 2005. Characterization of salt affected soil of Kelveli (Dist. Akola) from Purna Valley by saturation extract analysis, J. Soils and Crops, 15: 90-95.

Meena, R. B., S. S. Balpande, V. P. Babhulkar and M. G. Mandle, 2011. Characteristics and classificatio n of water logged soils in Upper Wardha Command Area of Maharashtra, J.of Soils and Crops. 21: 90-94.

Murthy, R. S., L. R. Hirekerur, S. B Deshpande and B. V. Venkata Rao,1982. Benchmark Soils of India morphology, characteristics and classification for resource management. National Bureau of Soil Survey and Land Use Planing (ICAR), Nagpur 374.

Pal, D. K. and S. B Deshpande, 1987. Characteristics and genesis of minerals in some benchmark Vertisols of India, Pedology. 37: 259-275.

Patil, M. N., V. V. Gabhane, and S. T. Dangore, 2001. Characterisation and classification of soils of varkhed watershed in Akola District of Vidarbha Region of Maharashtra, PKV. Res. J. 25: 42-48.

Piper, C.S., 1966. Soil and plant analysis. The University of Adelaide, Adelaide. 368.

Tripathi, P. N., N. P. Gupta and B. S. Dwivedi, 2004. Characterization and classification of soils of Jawaharlal Nehru Krishi Vishwa Vidyalaya farm Jabalpur, M.P., JNKVV Res. J., 38: 22-26.

Vaidya, P. H. and D. K. Pal, 2002. Micro topography as a factor in the degradation of Vertisols in Central India, Land Degradation and Devpt. 13: 429-445.

PKV Res. J. Vol. 36 (2), July 2012

Effect of Spacing and Fertilizer Doses on Growth and Yield Parameters of Sweet Corn

Priti A. Sonkamble[1], R. T. Kausal[2] and Sapna S. Joshi[3]

ABSTRACT

Comprehensive field trials were conducted at Seed Technology Research Unit, Dr. PDKV, Akola during *Kharif* 2008-09, 09-10 and 2010-11 to study the optimum spacing, fertilizer dose for seed production of Sweet Corn. The results revealed that the growth parameters were not influenced by various treatments. The yield and yield contributing characters, like cob length, number of seeds cob^{-1} and seed yield ha^{-1} were influenced significantly. The treatment of spacing 45 x 20 cm with fertilizer dose of 150:75:45 NPK kg ha^{-1} on the ridge planting method were found the best combination for seed yield and quality parameters.

Maize is one of the most widely grown cereals in the world and has great significance as human food, animal feed and raw material for large number of industrial products. Corn is divided into seven groups based on character of kernels. Sweet corn kernels possess a considerable amount of sugar, which absorb water, making cells turgid. On drying these cells collapse making the grains shriveled or wrinkled. Sweet corn is favorable for fresh consumption because of its delicious taste, delicate crust, soft and sugary texture compared to other corn varieties. Sweet corn has been expended widespread in the world. Canned, pure or mixed sweet corn with other foods are popular. At optimum market maturity, sweet corn will contain 5 to 6 per cent sugar, 10-11per cent starch, 3 per cent water soluble polysaccharides and 70 per cent water. Sweet corn also will contain moderate levels of Protein, Vitamin A (yellow varieties) and Potassium.

Sweet corn is medium plant type and provides green ears in 65 to 75 days after sowing. These are harvested earlier by 35 to 45 days compared to normal grain maize. Sweet corn does have some specific environmental and cultural needs that must be met for the plant to produce high, marketable yields. Sweet corns are to be grown must have facility for 5-6 irrigations, any stressful conditions such as moisture stress, deficiency of nutrients i.e nitrogen, phosphorus and potassium or unsuitable plant density can reduce yields and cause small, deformed ears. The information on fertilizer requirement for sweet corn is scanty. Hence there is need to study the effect of different management practices i.e., spacing and fertilizer doses on growth and yield of sweet corn.

MATERIAL AND METHODS

A field experiment was conducted at Seed Technology Research Unit, Dr. PDKV, Akola during the *Kharif* 2008-09, 2009-10 and 2010-11. It was laid out in Factorial Randomized Block Design with three replications. The Sweet Corn Var. Priya was grown by ridge planting method. Four types of spacing i.e S_1-45 x 15 cm, S_2- 45 x 20 cm , S_3- 60 x 15 cm and S_4- 60 x 20 cm were combined with three different fertilizer doses i.e F_1 – 90: 45: 45, F_2 – 120 : 60 : 45 and F_3 – 150 : 75 : 45. Observations were recorded on growth i.e days to 50 per cent flowering and plant height (cm), on yield and yield contributing characters i.e cob length (cm), number of seed cob^{-1} and seed yield as well as on seed quality parameters i.e germination per centage , 1000 seed weight and vigour index of sweet corn.

RESULTS AND DISCUSSION

The pooled data of three years are presented in Table 1 and 2. Days to 50 per cent flowering in sweet corn ranged from 43 to 46 days. Plant height was recorded at maturity and ranged from 188 to 200 cm (Table 1).The observations on days to 50 per cent flowering and plant height were shown non-significant differences among the treatments. The yield components were significantly influenced by different fertilizer levels, length of cob was ranged from 14.3 to 16.4 cm. The highest cob length (16.4 cm) was observed in the F_3S_2 i.e. fertilizer dose

1. Assistant Seed Res. Officer, 2. Seed Research Officer and 3. Agriculture. Asstt., Seed Technology Research Unit, Dr. PDKV, Akola

Table 1 : Effect of spacing and fertilizer treatments on various growth and yield parameters of sweet corn

Treatments	Days to 50 % flowering	Plant height (cm)	Cob length (cm)	No. of seeds cob^{-1}	Seed yield ($q\ ha^{-1}$)
F_1	44.08	197.0	14.9	285.5	41.7
F_2	45.25	194.3	15.7	300.5	42.7
F_3	45.16	193.0	16.2	337.7	46.8
SE (m) ±	0.37	1.18	0.08	0.88	0.13
CD 5%	NS	NS	0.26	2.60	0.39
S_1	44.55	196.5	15.4	304.1	46.9
S_2	44.77	195.8	15.6	310.7	46.3
S_3	45.00	197.1	16.0	297.1	42.1
S_4	45.00	189.6	15.3	319.7	39.6
SE (m) ±	0.42	1.36	0.10	1.02	0.15
CD 5%	NS	4.0	0.30	3.00	0.45
Interaction					
F_1S_1	43.33	199.5	14.3	286.3	45.3
F_1S_2	44.66	199.0	14.8	281.0	44.2
F_1S_3	44.00	200.0	15.5	273.3	39.6
F_1S_4	44.33	189.5	15.1	301.3	37.8
F_2S_1	44.66	197.5	15.9	293.6	46.7
F_2S_2	45.00	195.0	15.6	293.0	43.6
F_2S_3	46.00	197.0	16.3	297.3	41.6
F_2S_4	45.33	188.0	14.9	318.3	38.8
F_3S_1	45.66	192.5	15.9	332.3	48.6
F_3S_2	44.66	193.5	16.4	358.3	51.2
F_3S_3	45.00	194.5	16.3	320.6	45.0
F_3S_4	45.33	191.5	16.0	339.6	42.3
SE (m) ±	0.74	2.36	0.17	1.77	0.26
CD 5%	NS	NS	0.52	5.20	0.78

Table 2 : Effect of different spacing and fertilizer doses on seed yield of sweet corn

Treatment	Seed yield (q ha^{-1})			
	2008-09	2009-10	2010-11	Pooled
F_1S_1	44.27	54.35	37.31	45.3
F_1S_2	42.93	53.61	36.08	44.2
F_1S_3	38.95	51.19	28.66	39.6
F_1S_4	35.48	48.65	29.28	37.8
F_2S_1	46.71	54.74	38.67	46.7
F_2S_2	42.36	51.19	37.35	43.6
F_2S_3	39.91	52.76	32.13	41.6
F_2S_4	36.08	42.53	37.82	38.8
F_3S_1	42.26	58.51	45.03	48.6
F_3S_2	48.03	60.46	45.21	51.2
F_3S_3	38.7	54.13	42.17	45.0
F_3S_4	45.11	44.07	37.73	42.3
SE (m) ±				0.26
CD 5%				0.78

Table 3 : Effect of spacing and fertilizer treatments on seed quality of sweet corn

Treatment	1000 Seed weight(g)	Germination (%)	Vigour index
F_1	120.8	92.5	86.8
F_2	126.1	94.0	87.2
F_3	127.5	95.8	88.4
SE (m) ±	0.13	0.91	0.93
CD 5 %	0.39	2.69	NS
S_1	124.3	96.0	87.9
S_2	124.7	94.8	88.0
S_3	124.8	94.5	87.3
S_4	125.4	90.9	86.5
SE (m) ±	0.15	1.06	1.08
CD 5 %	0.45	3.11	NS
Interactions			
F_1S_1	120.0	95.3	85.9
F_1S_2	121.0	88.2	86.2
F_1S_3	120.6	95.0	87.4
F_1S_4	121.6	90.4	87.7
F_2S_1	125.6	98.0	89.6
F_2S_2	125.3	96.2	88.3
F_2S_3	126.6	92.0	86.4
F_2S_4	127.0	87.3	84.3
F_3S_1	127.3	94.1	88.3
F_3S_2	128.0	98.1	89.6
F_3S_3	127.3	96.0	88.2
F_3S_4	127.6	94.5	87.4
SE (m) ±	0.27	1.83	1.87
CD 5 %	0.79	5.38	NS

Table 4 : Effect of spacing and fertilizer treatments on C : B ratio of sweet corn.

Treatments	Seed Yield q ha^{-1}	GMR	Cost of cult.	NMR	B:C Ratio
F_1S_1	45.3	49830	19565	30265	2.55
F_1S_2	44.2	48620	19455	29165	2.50
F_1S_3	39.6	43560	18895	24665	2.31
F_1S_4	37.8	41580	18715	22865	2.22
F_2S_1	46.7	51370	20455	30915	2.51
F_2S_2	43.6	447960	20145	27815	2.38
F_2S_3	41.6	45760	19845	25915	2.31
F_2S_4	38.8	42680	19565	23115	2.18
F_3S_1	48.6	53460	21470	31990	2.49
F_3S_2	51.2	56320	21730	34590	2.59
F_3S_3	45.0	49500	20400	29100	2.43
F_3S_4	42.3	446530	20130	26400	2.31

150:75:45 and spacing 45 x 20 cm as compared to other treatments. Similar results were also indicated by Stone *et al*. (1998) and Amano and Salazar (1989).

Significant results were observed among all the treatments for the number of seeds cob^{-1} and the treatment F_3S_2 showed highest number of seeds cob^{-1} i.e 358.3. The treatment F_1S_3 which received lowest fertilizer dose of nutrients recorded minimum number of seeds cob^{-1} i.e 273.3. Arunkumar *et al.* (2007) also stated different levels of NPK and reported that cob length and number of seeds cob^{-1} were significantly higher in highest dose of NPK i.e 150:75:46.8 Kg ha^{-1}.

The increase in number of grains cob^{-1} with increased fertilizer application could be attributed to the increased physiological processes in crop plants leading to higher growth and increased photosynthatase to silks. This might be due to better utilization of NPK supply as given by Selvaraju and Iruthayraj (1994), Thakur and Malhotra (1991). The highest seed yield (51.2 q ha^{-1}) was observed in treatment combination F_2S_2 i.e., 45 x 20 cm spacing and 150:75:45 NPK kg ha^{-1} fertilizer applications. Every year the same treatment was found significantly superior for seed yield (Table 2).

Significantly highest germination and 1000 seed weight were found in F_3S_2 i.e 98.1 per cent and 128.0 g, respectively. Vigour Index was not affected by different treatment combinations (Table 3). As regard cost – benefit (Table 4) showed that highest C : B ratio of 1 : 2.59 observed in treatment F_3S_2 and lowest in F_2S_4 i.e. 1 : 2.18 .

Hence, the treatment of spacing 45 x 20 cm with fertilizer dose of 150:75:45 NPK Kg ha^{-1} on the ridge planting method was found the best combination for seed yield and quality parameters as well as for highest cost benefit ratio.

LITERATURE CITED

Amano, L.O. and A. M. Sazalar, 1989. Comparative productivity of corn and sorghum as affected by population density and nitrogen fertilization, Phillipines Agriculturist, 72 : 247-254.

Arunkumar, M.A., S. K. Gali and N.S. Hebsur, 2007. Effect of different levels of NPK on growth and yield parameters of sweet corn, Karnataka J. Agric. Sci. 20(1) : 41-43.

Selvaraju, R. and M. R Iruthayaraj, 1994. Influence of irrigation scheduling, methods of irrigation and nitrogen levels on growth and yield of maize, Madras Agric. J., 81 : 418-420.

Stone, P. J; I. B. Soresen and J. B. Reid , 1998. Effect of plant population and nitrogen fertilizer on yield and quality of super sweet corn, Agro. Soc., New Zealand, 28 : 1-5

Thakur, D. R and V. V. Malhotra, 1991. Response of pop-corn to row spacing and nitrogen, Indian J. Agric. Sci., 61 : 586-587.

❖ ❖ ❖

PKV Res. J. Vol. 36 (2), July 2012

Effect of Farmyard Manure, Phosphorus and Phosphate Solubilizing Bacteria on Growth and Yield of Kabuli Chickpea

V. V. Goud[1], H. B. Kale[2] and A. N. Patil[3]

ABSTARCT

A field experiment was conducted during *Rabi* season 2007-08 to 2009-10 at Pulses Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra to study the effect of farmyard manure (FYM), seed inoculation with phosphate solubilizing bacteria (PSB) and different phosphorus levels on *Kabuli* chickpea. The application of FYM increased the grain yield significantly during the experimentation and increase was to the tune of 6.67per cent, however, net return obtained was not influenced significantly. Seed inoculation with PSB influenced the grain yield significantly over control, however, did not influence the net return significantly. Application of 60 kg P_2O_5 ha^{-1} recorded significantly higher grain yield, growth and yield attributes, gross and net monetary return compared to lower phosphorous level i.e. 30 kg P_2O_5 ha^{-1}.

Chickpea is the premium pulse crop in India and occupies maximum acreage and production but its productivity is low as compared with its potential yield on the experimental stations (Kumar, 1997). Although number of factors are responsible for low productivity, imbalance fertilization is one of them. The *Kabuli* type chickpea is having bolder seed size than the *Desi* type and therefore, it has high nutritional needs for obtaining higher grain yields. Phosphorous is one of the most important nutrients of plant and *Kabuli* chickpea also responds significantly to phosphorus application (Siag, 1995). It is required mainly for root development, nodule formation, seed development and quality improvement. It is being costly, optimum dose needs to be worked out. Applied phosphorous is also subject to fixation in soil reducing its availability (Pandey, 1987). It is necessary to improve its availability in soil. Phosphate solublizing bacteria (PSB) play an important role in making phosphorus available to crop plants as well as enhance the availability of trace elements such as Fe, Zn, etc., and by production of growth promoting substances (Gyneshwar *et. al.*, 2002). FYM is an important source of organic manure which sustains crop productivity, provide good substrate for growth of micro-organism, maintain favourable nutritional balance and soil physical properties. For sustaining productivity and soil health integrates approach seems promising. Data were lacking regarding the integrated use of FYM, PSB and phosphorous application on growth and yield of *Kabuli* chickpea. Therefore, it was felt indispensable to study the response of chickpea to FYM, PSB and phosphorus in respect of yield under irrigated conditions in *Vertisol* of Maharashtra.

MATERIAL AND METHODS

A field experiment was conducted during *Rabi* season 2007-08 to 2009-10 at Pulses Research Unit, Dr. Panjabrao Deshmukh Agricultural University, Akola. The soil was clay loam with pH 8.0l having organic carbon 0.052 per cent, available N 181 kg ha^{-1}, available phosphorous 18.78 kg ha^{-1} and available potassium 310 kg ha^{-1}. The treatment combinations consist of two level of FYM (control and 5t ha^{-1}), three levels of phosphorous (0, 30 and 60 kg P_2O_5/ha) and two levels of PSB (uninoculated and inoculated). In all twelve treatments were tested in a factorial randomized block design with three replications. The chickpea variety PKV Kabuli-2 was used for the study. Seeds were treated with thirum followed by *rhizobium* and subsequently PSB (*Bacillus megaterium*) culture (250 g 10kg^{-1} seed). Phosphorous was applied through single superphosphate (16% P_2O_5) at the time of sowing along with uniform dose of nitrogen (25 kg ha^{-1}) through urea. The chickpea was sown on 3 November 2007, 24 October 2008 and 14 October 2009 and harvested on 18 February 2008, 10 February 2009 and 5 February 2010. The crop was cultivated under irrigated condition with the recommended package of practices. Plant height and yield attributes were recorded at maturity. Economics was calculated by using prevailing market prices of inputs used and outputs.

RESULTS AND DISCUSSION

Effect of FYM

Application of FYM influenced the grain yield significantly over no application; the increase was to the tune of 6.67 per cent. The increase in yield with the

1. Assistant Prof., 2. Assistant Prof. and 3. Senior Res. Sci., Pulses Research Unit, Dr. .P.D.K.V., Akola

application of FYM occurred due to improvement in plant growth and yield attributes. Similar beneficial effects of FYM on growth, yield attributes and grain yield of chickpea have been reported by Lakepale *et. al.*, (2003). This might be probably because FYM addition to soil improved the supply of available nutrients to the plant and brought about favourable soil environment which might have ultimately increased nutrient and water holding capacity of soil for longer period that resulted in better growth, yield attributes and yield of chickpea. The above results are in conformity with the findings of Reddy *et. al.*, (2004) in pigeonpea. Such beneficial effects have also been reported due to the supply of nutrients including phosphorous through FYM to the crop (Kamala and Paliyal, 2002).

Effect of phosphorus

The seed yield of chickpea improved significantly with increase in phosphorus levels (Table 2) due to the improvement in yield attributes like number of pods/plant, seed weight pod^{-1} and 100-grain weight (Table 1). The seed yield plant^{-1} also increased with increase in phosphorus levels. The mean increase in grain yield was 29.10 per cent with 60 kg P_2O_5 ha^{-1} over control. Improvement observed in grain yield was probably because of phosphorus and the rate of symbiotic N_2 fixation and in turn stimulated the growth of plants thereby having beneficial effect on yield attributes giving higher yields. The results are in close conformity with the findings of Meena *et. al.*, (2005).

Effect of PSB

Grain yield was significantly higher (6.73%) with seed inoculation with phosphate solubilizing bacteria over no inoculation (Table 2). The yield attributes improvement clearly corroborated to the yield increase (Table 1). This could be probably ascribed to existence of favourable nutritional environment especially P under the influence of PSB, which had a positive effect on vegetative and reproductive growth and ultimately led to realization of higher yield. The above findings corroborate the results of Mukharjee and Rai (2000).

Economics

Application of FYM @ 5t ha^{-1} and phosphorous @ 60 kg ha^{-1} significantly influenced gross monetary return over their respective control, however, seed inoculation with PSB did not influence gross and net monetary return over control (Table 2). Addition of FYM @ 5t ha^{-1} influenced gross return significantly over control, however, net return was not influenced significantly. Among phosphorus levels, application of

Table 1: Ancillary parameters of chickpea as influenced by different treatments

(Mean of 3 years)

Treatment	Plant height (cm)	Branches plant^{-1}	Grain weight plant^{-1} (g)	Pods plant^{-1}	100 seed weight (g)
FYM					
0 t FYM ha^{-1}	53.1	7.1	22.5	41.1	39.0
5 t FYM ha^{-1}	54.9	7.3	23.8	42.7	39.7
SE (m) ±	0.43	0.01	0.36	0.51	0.02
CD at 5%	1.23	0.03	1.08	1.54	NS
Phosphorus					
0 kg P_2O_5 ha^{-1}	52.6	6.6	20.8	38.0	38.8
30 kg P_2O_5 ha^{-1}	54.1	7.3	23.6	41.8	39.3
60 kg P_2O_5 ha^{-1}	55.3	7.7	25.2	45.9	39.8
SE (m) ±	0.48	0.03	0.40	0.54	0.03
CD at 5%	1.50	0.09	1.17	1.63	1.0
PSB					
Without PSB	53.7	7.1	22.7	41.1	39.2
With PSB	54.3	7.3	23.6	42.7	39.5
SE (m) ±	0.43	0.01	0.36	0.51	0.02
CD at 5%	1.23	0.03	1.08	1.54	NS
Interaction					
CD at 5%	NS	NS	NS	NS	NS
CV%	4.3	5.2	3.2	4.4	2.2

Table 2: Grain yield of chickpea as influenced by various treatments

Treatments	Yield (Rs ha^{-1})				Total cost	Gross return	Net return	B:C ratio
	2007-08	2008-09	2009-10	Pooled	(kg ha^{-1})	(Rs ha^{-1})	(Rs ha^{-1})	
FYM								
0 t FYM ha^{-1}	2035	1681	2337	2017	15392	60510	45118	2.45
5 t FYM ha^{-1}	2176	1791	2542	2170	17892	65100	47208	2.20
SE (m) ±	38	39	34	26	—	1039	1039	—
CD at 5%	113	114	96	79	—	2989	NS	—
Phosphorus								
0 kg P_2O_5 ha^{-1}	1848	1672	2103	1874	15900	56220	40320	2.10
30 kg P_2O_5 ha	2100	1953	2316	2123	16642	63690	47048	2.34
60 kg P_2O_5 ha^{-1}	2319	2055	2715	2363	17385	70890	53505	2.55
SE (m) ±	48	48	48	35	—	1272	1272	—
CD at 5%	138	140	136	106	—	3660	3660	—
PSB								
Without PSB	2053	1724	2346	2041	16592	61230	44638	2.25
With PSB	2158	1764	2533	2151	16692	64530	47838	2.40
SE (m) ±	39	39	34	26	—	1039	1039	—
CD at 5%	NS	114	96	79	—	NS	NS	—
Interaction								
CD at 5%	NS	NS	NS	NS	—	NS	NS	—
CV%	9.2	10.6	7.8	6.1	—	10.3	10.3	—

Selling price Grain : Rs. 3000 q^{-1}, SSP Rs.396 q^{-1}, FYM- Rs.500 t^{-1}

60 kg P_2O_5 ha^{-1} registered highest net monetary return (Rs.56964 ha^{-1}) and it was 15.44 per cent higher over lower level of 30 kg P_2O_5 ha^{-1} (Rs.49347 ha^{-1}). The aforesaid treatment was significantly superior over control. Similarly, the highest benefit cost ratio was recorded with 60 kg P_2O_5 ha^{-1} (Rs.2.55). This was due to greater increase in gross return as compared with lesser increase in cost of cultivation. However, the benefit cost ratio was reduced with the application of FYM @ 5 t ha^{-1} whereas, it was marginally improved with seed inoculation of PSB.

LITERATURE CITED

Gyneshwar, P., G.N. Kumar, L.J.Paresh and P. S. Pole, 2002. Role of soil micro-organism in improving P nutrition of plants, Plant and Soil 245: 83-93.

Kamla, K. and S.S.Paliyal, 2002. Influence of phosphorous management and organic manuring on uptake and yield of chickpea (*Cicer arietinum*), Annals Agri. Res., 23: 642-645.

Kumar, J., 1997. Missed opportunities, In: Hindu Survey of Indian Agriculture : 49-53.

Lakepale, R, G. K. Srivastav, N.K. Choubey, A.P. Singh, B.S. Joshi and R.L. Pandey, 2003. Response of gram (*Cicer arietinum*) to integrated nutrient management in vertisols of Chhattisgargh plains, Indian J. Agri. Sci., 73: 162-163.

Meena, L.R., R.K. Singh and R.C. Gautam, 2005. Effect of conserved soil moisture, phosphorus levels and bacterial inoculation on dry matter production and uptake pattern of phosphorus by chickpea, Indian J. Pulses Res., 18 (1): 32-35.

Mukharjee, S. and B. Rai, 2000. Effect of *Vesicular Mycorrhizae* and *Phosphate Solubilizing Bacteria* on growth, yield and phosphorous uptake by wheat and chickpea, Indian J. Agron., 45: 602-607.

Pandey, S.K., 1987. Tracer studies on phosphorous utilization by wheat at varying levels of nitrogen and moisture regimes, Ph.D.Thesis (Unpub.), Division of Agronomy, IARI, New Delhi.

Reddy, G.S, V. Maruthi and M. Shree Rekha, 2004. Assessing the method of application of farmyard manure on dryland crops, Indian J. Agron., 49: 104-107.

Siag, R.K., 1995. Response of *Kabuli* chickpea (*Cicer arietinum*) to genotypes phosphorus, Indian J. Agron., 40: 431-433.

PKV Res. J. Vol. 36 (2), July 2012

Studies on Economic Feasibility of Sorghum Cropping System under Different Sources of Nutrient Management

A. N. Chimote[1], M. D. Yenpreddiwar[2], R. M. Deshpande[3] and S. T. Dangore[4]

ABSTRACT

A field experiment was conducted during *Kharif* season of 2008-09 to 2010-11 at Agronomy farm, College of Agriculture, Nagpur to evaluate sorghum based intercropping system under different levels and sources of manuring. The results revealed that sorghum-soybean (2:1) intercropping system found most remunerative and recorded significantly more sorghum equivalent yield (38.16 q ha^{-1}), GMR (Rs. 53220 ha^{-1}), NMR (Rs. 28284 ha^{-1}) and B:C ratio (2.34) over other intercropping system. As regards manuring, application of RDF (80:40:40 NPK kg ha^{-1}) responded well and recorded significantly higher sorghum equivalent yield (34.16 q ha^{-1}), GMR (Rs. 50,022 ha^{-1}), NMR (Rs. 33794 ha^{-1}) and B:C ratio (3.08). Fertility status of soil was improved slightly by adoption of intercropping system as well as integrated nutrient management system.

Intercropping is the most remunerable and popular farming practice under rainfed condition. Simultaneously growing of two or more crops having different growth habits provides more returns through additional benefits besides maintaining yield of components crops as a bonus. Compact short duration and quick growing legume crops like green gram, black gram, soybean and pigeonpea are found to be more compatible for intercropping in different regions.

The object of intercropping is to maximize production per unit area per unit time, by better utilization of agricultural resources and land more intensively in intercropping system than sole crops resulting in substantial increase in yield over sole cropping.

However, sorghum being a heavy feeder crop depletes soil fertility if it is not properly fertilized. Inclusion of legume crop like green gram, black gram, cowpea, soybean, etc., in cereal based cropping system proved to be the most effective in reducing expenditure on nutrient (fertilizer) and getting more profit. Moreover, leguminous intercrop also improves the nutrient status of soil by way of atmospheric nitrogen fixation.

In view of this background, an experiment was planned to evaluate sorghum based intercropping system under different levels and sources of nutrients and to find out suitable intercrop to get more monetary returns and improvement in soil fertility and also to overcome the total failure of these crops by achieving balanced nutrient management for crop growth. So, it will help to boost up the productivity.

MATARIAL AND METHODS

A field experiment was conducted during *Kharif* season of 2008-09 to 2010-11 on evaluation of sorghum based intercropping system under different sources of nutrient at Agronomy farm, College of Agriculture, Nagpur(Maharastra). The experimental soil was *vertisol* with initial values of pH-7.65, EC-0.28 (dsm^{-1}), organic carbon 6.30 g kg^{-1}, available NPK 269.75,22.28, and 390.82 kg ha^{-1}, respectively. The experiment was conducted on same site with same randomization in split plot design replicated thrice. The treatments were sorghum based intercropping system as main plots viz,. C_1- sole sorghum, C_2-Sorghum + greengram (2:1), C_3-Sorghum + blackgram (2:1), C_4- Sorghum + cowpea (2:1) and C_5- Sorghum + soybean(2:1) and sub plot treatments were manuring to base crop viz., M_1- RDF (recommended dose of fertilizer) (80:40:40 NPK kg ha^{-1}), M_2- 50 % RDF (40:20:20 NPK kg ha^{-1})+FYM (Farmyard manure) @ 5 t ha^{-1} and M_3- FYM @ 10 t ha^{-1}. The crop wise varieties were CSH-9 of sorghum, AKM-8802 of greengram, TAU-1 of blackgram, Pusa Komal of cowpea and JS-335 in soybean. Sowing was done as per recommended seed rate for sole cropping and for intercrops on the area basis. (Sole as well as intercrops were sown at recommended spacing). Five plants from each net plot were randomly selected for recording yield attributes.

RESULTS AND DISCUSSION

It was observed from the data presented in table 1 (mean of 3 years) that, maximum mean sorghum grain yield (26.75 q ha^{-1}) and fodder yield (109.78 q ha^{-1})

1) Assistant Professor , 2) Senior Research Assistant, 3) Associate Professor and 4) Junior Research Assistant, College of Agriculture, Nagpur.

Table 1 Grain and fodder yield (q ha^{-1}) as influenced by various treatments

Treatments	Sorghum crop								Intercrop							
	Grain				Fodder				Grain				Straw			
	2008-09	2009-10	2010-11	Mean	2008-09	2009-10	2010-11	Mean	2008-09	2009-10	2010-11	Mean	2008-09	2009-10	2010-11	Mean
Intercropping systems																
C_1 - Sole Sorghum	20.49	27.96	31.81	26.75	97.97	109.97	121.41	109.78	-	-	-	-	-	-	-	-
C2 - Sorghum+ Greengram (2:1)	20.56	21.10	23.95	21.87	80.12	82.57	85.59	82.76	2.45	2.42	2.72	2.53	1.60	1.88	2.22	1.90
C_3 - Sorghum+ Blackgram(2:1)	20.34	20.89	23.30	21.51	78.74	83.50	85.96	82.73	2.86	2.36	2.81	2.68	1.62	1.73	2.17	1.84
C_4 - Sorghum+ Cowpea (2:1)	20.80	21.98	23.62	22.13	78.59	82.34	83.68	81.54	1.30	1.33	1.47	1.37	1.54	1.53	1.57	1.55
C_5 - Sorghum + Soybean (2:1)	20.46	20.05	24.78	21.76	78.64	83.17	86.13	82.65	4.35	5.98	6.15	5.49	5.65	6.83	5.96	6.14
Manuring to base crop																
M_1 - RDF (80:40:40 NPK kg ha^{-1})	22.45	23.89	25.98	24.11	85.28	90.35	93.97	89.87	2.81	3.07	3.37	3.08	2.67	3.11	3.06	2.95
M_2 - 50% RDF (40:20:20 NPK kg ha^{-1}) + FYM @ 5 t ha^{-1}	21.37	22.44	25.78	23.20	82.36	87.70	93.20	87.75	2.76	3.02	3.32	3.03	2.61	2.94	2.84	2.80
M_3 - FYM @10 t ha^{-1}	20.78	20.85	24.62	22.08	80.75	86.88	90.49	86.04	2.65	2.98	3.17	2.93	2.53	2.92	2.83	2.76

Table 2 Sorghum equivalent yield (q ha^{-1}) and monetary returns as influenced by various treatments

Treatments	Sorghum equivalent yield (q ha^{-1})				Gross monetary returns (Rs. ha^{-1})				Net monetary returns (Rs. ha^{-1})				B:C
	2008-09	2009-10	2010-11	Mean	2008-09	2009-10	2010-11	Mean	2008-09	2009-10	2010-11	Mean	Ratio
Intercropping systems													
C_1 - Sole Sorghum	25.49	27.96	31.81	28.42	32091	45855	51549	43165	16824	29038	26695	24186	2.42
C2 - Sorghum+ Greengram (2:1)	28.96	32.63	35.78	32.45	33429	46614	50534	43526	18040	29774	25598	24471	2.44
C_3 - Sorghum+ Blackgram(2:1)	28.18	29.66	32.64	30.16	32610	43767	46942	41106	17221	29227	22006	22818	2.32
C_4 - Sorghum+ Cowpea (2:1)	25.54	25.41	28.65	26.53	30286	39110	42727	37374	14914	17991	17808	16905	2.08
C_5 - Sorghum+ Soybean (2:1)	31.85	34.15	38.16	34.72	35722	48678	53220	45874	20141	31320	28284	26582	2.52
SE (m) ±	0.42	0.40	0.35	0.19	392	380	402	275	392	532	402	290	-
CD at 5%	1.36	1.31	1.13	0.62	1278	1240	1310	897	1278	1736	1310	946	-
Manuring to base crop													
M_1 - RDF (80:40:40 NPK kg ha^{-1})	29.07	31.58	34.16	31.60	34095	46763	50022	43627	21689	32788	33794	29424	3.17
M_2 - 50% RDF (40:20:20 NPK kg ha^{-1}) + FYM @ 5 t ha^{-1}	27.91	30.00	33.61	30.51	32555	44768	49315	42213	17289	26652	24399	22780	2.24
M_3 - FYM @10 t ha^{-1}	27.04	28.31	32.47	29.27	31833	42882	47646	40787	13307	22969	14042	16773	1.72
SE(m) ±	0.21	0.41	0.35	0.14	236	520	417	180	221	520	417	163	-
CD at 5%	0.61	1.22	1.04	0.41	697	1535	1231	515	651	1535	1231	466	-
Interaction													
SE(m) ±	0.46	0.92	0.78	0.32	528	1164	933	403	493	1164	933	365	-
CD at 5%	NS	NS	NS	NS	NS	NS	NS	1152	NS	NS	NS	1042	-

Table 3. Gross monetary returns and net monetary returns (Rs. ha^{-1}) as influenced by intercropping system X manuring to base crop

Main plot	Gross monetary returns (Rs. ha^{-1})				Net monetary returns (Rs. ha^{-1})			
	Sub plot				Sub plot			
	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean
C_1	45275	43356	40864	43164	31648	24377	16533	24186
C_2	44952	43340	42286	43526	31245	24287	17881	24471
C_3	42547	40888	39883	41106	24847	21835	17772	22818
C_4	37826	37789	36507	37374	21896	16779	12039	16905
C_5	47534	45695	44396	45874	33484	26622	19641	26582
Mean	43627	42213	40787	-	24424	22780	16773	-
SE(m)$\pm$	403.02	364.50						
CD at 5%	1151.89	1041.82						

was obtained in sole sorghum.Intercropping reduce the yield of sorghum markedly. Mean sorghum grain and fodder yield was more or less similar in all intercropping treatments. However, in respect of manuring to base crop, application of RDF (80:40:40 NPK kg ha^{-1}) recorded higher grain and fodder yield ha^{-1} and was closely followed by 50 per cent RDF + 5 t FYM. Lowest yield was found incase of FYM application alone (10 t ha^{-1}).

On the basis of pooled data of 3 years, sorghum + soybean intercropping system registered significantly higher sorghum equivalent yield (34.72 q ha^{-1}), gross monetary returns (Rs. 45874 ha^{-1}) and net monetary returns (Rs.26582 ha^{-1}) as compared to other intercropping treatments and sole sorghum. Similarly, B:C ratio was also higher in sorghum + soybean intercropping system (2.52), next in order was sorghum + greengram intercropping system. Higher GMR in case of sorghum + soybean intercropping was due to similar yields of main crop sorghum in different intercropping system and higher yield of sorghum than other intercrops. Results of present investigation thus indicate that soybean as an intercrop has similar effect on sorghum productivity as that other intercrops. The results corroborate the findings of Balasubramanium *et.al*. (1986), Malvi *et.al*.(1992), Khistaria *et.al*. (1996), Nagrajan and Balchandar(2001) and Balchandar *et.al* (2003).

It was interesting to note that there was increasing trend of yield level from year to year successively. Difference in yield due to nutrient management continued year to year.

In respect of manuring to base crop, application of RDF (80:40:40 NPK kg ha^{-1}) recorded highest sorghum equivalent yield (31.60 q ha^{-1}), GMR (Rs. 43627ha^{-1}), NMR(Rs. 29424 ha^{-1}) Highest B:C ratio (3.17) was also recorded in 100 per cent RDF treatments. Integrated nutrient management with 50 per cent RDF+ 5 t FYM ha^{-1} also recorded significantly more sorghum equivalent yield, gross and net monetary returns over application of 10 t FYM treatments. B:C ratio was also more and was next to RDF treatment. The above results are in line with the findings of Malvi *et.al*., (1992), Mishra *et.al*.(2000), Ponuswamy *et. al*., (2002) and Raguwanshi *et.al*.(2004).

Interaction effect was also found significant in respect of GMR and NMR ha^{-1}. However, data presented in table 3 showed that Sorghum + Soybean intercropping system (2:1) along with application of RDF (80:40:40 kg ha^{-1}) to base crop recorded significantly highest GMR (Rs.47534 ha^{-1}) and NMR (Rs.33484 ha^{-1}) of all the treatments. The results are in conformity with the findings of Gode and Bobde(1993) and Bhagat (2004). Next in order was sole sorghum with application of RDF (80:40:40 kg ha^{-1}) and intercropping of sorghum + greengram + RDF (80:40:40 kg ha^{-1}) in respect of GMR and NMR, respectively.

Regarding soil studies, data in table 4 indicated that organic carbon and available nitrogen improved slightly by intercropping system and integrated nutrient management treatment.Thus, it is concluded that sorghum + soybean intercropping system (2:1) with application of RDF (80:40:40 NPK kg ha^{-1}) to base crop was found suitable in getting higher GMR, NMR and B:C ratio.

Table 4 Soil fertility status at harvest as influenced by various treatments

Treatments	pH	EC (dSm^{-1})	Organic carbon ($g\ kg^{-1}$)	Available N($kg\ ha^{-1}$)	Available P_2O_5($kg\ ha^{-1}$)	Available K_2O($kg\ ha^{-1}$)
Intercropping system						
C_1 - Sole Sorghum	7.71	0.25	6.69	290.46	28.23	436.60
C_2 - Sorghum+Greengram(2:1)	7.68	0.24	6.80	295.71	27.59	427.20
C_3 - Sorghum+Blackgram (2:1)	7.68	0.25	6.75	294.85	27.78	434.23
C_4 - Sorghum+Cowpea (2:1)	7.71	0.25	6.73	292.03	28.09	419.63
C_5 - Sorghum+Soybean (2:1)	7.69	0.24	6.77	299.94	28.20	433.66
Manuring to base crop						
M_1 - RDF(80:40:40 NPK kg ha^{-1})	7.77	0.26	6.66	290.98	27.52	428.91
M_2 - 50% RDF (40:20:20 NPK kg ha^{-1}) + FYM @ 5 t ha^{-1}	7.70	0.25	6.78	298.37	28.54	435.48
M_3 - FYM @ 10 t ha^{-1}	7.61	0.24	6.80	294.44	27.87	426.41
Initial soil fertility status	7.65	0.28	6.30	269.75	22.28	390.82

LITERATURE CITED

Balasubramanin, A.B. Gururajan and P Palaniswamy, 1986. Optimising the yield recovery of intercrops in sorghum based intercropping system, Sorghum Newsletter, 29 : 388-390

Balchandar,D.P. Nagrajan and Gunasekaran, 2003. Effect of organic amendments and micronutrients on nodulation and yield of Blackgram in acid soil, Legume Res., 26(3) : 192-195

Bhagat, G.J.,2004. Influence of integrated nutrient management on growth, yield and economics of sorghum based legume intercropping system, Ph.D. Thesis (Un pub). Dr. PDKV, Akola.

Gode,D.B. and G.N. Bobde, 1993. Intercropping of soybean in sorghum, PKV Res. J., 17(2): 128-129

Khistaria, M.K, M.G.Khokhani and D.R. Padmni, 1996. Intercropping of important pulses and oilseeds in sorghum under rainfed conditions, J. Maharashtra Agric Unvi. 21(3) : 388-390

Malvi,S.D., M.A. Khot., P.G. Ingole, P.R. Hanwante and A.B. Turkande., 1992. Effect of row spacing , rate of fertilizer application and intercropping on growth and yield of hybrid sorghum CSH-9 (*Sorghum bicolor*), PKV Res. J. (2): 108-109

Mishra,O.R., A.M.Rajput, P. K. Wani and H.S. Thakur, 2000. Study on planting patterns, nutrients management and economics in sorghum-soybean intercropping, Crop Res. 19 (1): 138-141.

Nagrajan, P and D. Balchandar, 2001. Influence of rhizobium and organic amendments on nodulation and grain yield of blackgram and greengram in acid soil, Madras Agric. J., 88.(10-12):703-705

Ponuswamy, K.P.Subhain, P.Santhi and N. Sankaran, 2002. Integrated nutrient management for rainfed sorghum, Crop Res. 23(2):243-246

Raguwanshi,R.K., V.S. Gautam, S.S. Kushwa and N.K. Shrma,2004. Effect of intercropping of soybean with sorghum on yield and N uptake and available N status in vertisol of Madhya Pradesh, Crop Res. 27(1) : 70-76

❖ ❖ ❖

Response of Sulphur Nutrient on Seed and Oil Yield of Safflower under Rainfed Condition

A. N. Paslawar[1], D. V. Mali [2], S. N. Deshmukh[3] J. P. Deshmukh[4] and A. B. Kandalkar[5]

ABSTRACT

An investigation on different sources and levels of sulphur on rainfed safflower was conducted during 2003-2007. Applied sulphur was significantly increased the seed and oil yield of safflower over control. Among the levels, sulphur application @ 45 kg ha^{-1} produced significantly higher seed yield than that of 15 kg S ha^{-1}but it was at par with 30 kg S ha^{-1}. Sulphur application through single super phosphate recorded significantly higher seed and oil yield as compared to other sources viz., Ammonium sulphate, elemental sulphur and gypsum.

Safflower (*Carthamus tinctorious* L.) an important *Rabi* oilseed crop is grown on either residual soil moisture or grown after *Kharif* short legumes. Adoption of suitable fertilizer management with respect to secondary and micronutrients including standardization of correct source of fertilizers are known to help in improving the crop productivity and enhancing the quality. The productivity of oilseeds can be increased by application of sulphur. Continuous cropping with oil seeds with use of fertilizer devoid of sulphur such as Di-ammonium phosphate and urea under intensive crop sequences appear to be the probable reason for aggravating the sulphur deficiency. Sulphur is required for the formation of chlorophyll, proteins and oil in plants. It is involved in the formation of glucosides, glucosinolates and sulphydral (SH-1) linkages. It is constituent of three essential amino acids (cysteine, cystine and methionine) which are the building blocks of protein. Sulphur also activates the enzymes which aids in bio-chemical reactions within the plant (Tandon and Merrick, 2002). Sulphur application in suitable quantities through appropriate sources may be correct approach to improve the safflower yield under sulphur deficient areas. Thus, it is imperative to study the sulphur sources with suitable dose for safflower crop. Keeping these in view, the present investigation had been undertaken.

MATERIAL AND METHODS

A field experiment was laid out in factorial arrangement in Randomized Block Design with three replications at Oilseed Research Unit, Dr. P.D.K.V., Akola during post rainy season of 2003-04 to 2006-07 to find out the effect of sources and levels of sulphur on seed and oil yield of safflower. The soil was clay in texture with 7.8 pH and low in organic carbon 4.2 g kg^{-1} of soil, 203.8 kg ha^{-1} available nitrogen, 14.5 kg ha^{-1} available P_2O_5 and 17.53 kg ha^{-1} available sulphur. The rainfall received during 2003, 2004, 2005 and 2006 amounted to 357.6, 412, 697 and 986.5 mm against 770.4 mm normal (June - Dec). The treatment consisted of four sources of sulphur viz. ammonium sulphate (24% S), single super phosphate (12% S) and elemental sulphur (commercial grade 86% S) and gypsum (15% S) and three levels (15, 30 and 45 kg ha^{-1}) and absolute control (No S application). In all 13 treatments were tried and statistical analysis was carried out as per factorial concept using control v/s rest treatments. The recommended dose of safflower was applied @ 25:25:0 N, P_2O_5 and K_2O kg ha^{-1}.Elemental sulphur was applied 15 days before sowing for better utilization of sulphur and harrowed the field to control emgered weeds. The sowing was done during last week of september. Variety Bhima was used and kept 45x20 cm spacing and all other recommended practices were followed.

RESULTS AND DISCUSSION

Seed and oil yield:

Levels of sulphur

Application of sulphur to safflower brought significant increase in seed yield in all the individual years of investigation as well as on pooled basis. The pooled data revealed that both sources and levels of sulphur significantly influenced the seed and oil yield of safflower. The highest seed yield was recorded with application of S with 45 kg ha^{-1} (1556 kg ha^{-1}) which was

1, 3 & 4 Associate prof. and 2& 5 Assistant Prof., Department of Agronomy, Dr. PDKV Akola

Table 1: Effect of levels and sources of sulphur on seed and oil yield of safflower and economics

Treatments	Seed yield(kg ha^{-1})					Yield	Oil yield	Gross	Net returns	B:C
	2003-04	2004-05	2005-06	2006-07	Pooled mean	increase over control	(kg ha^{-1})	returns (Rs ha^{-1})	(Rs ha^{-1})	
Control	771	877	1628	1302	1135	-	330	17025	10825	2.74
SEm(±)	33	69	105	24	24	-	7	367	-	-
CD at 5%	99	201	307	72	72	-	22	1072	-	-
Levels of sulphur (kg ha^{-1}):										
15	951	1074	1773	1488	1325	16.7	383	19875	12937	2.86
30	1025	1196	2056	1639	1480	30.4	424	22200	15070	3.11
45	1102	1260	2183	1680	1556	37.1	441	23340	15992	3.17
SEm(±)	16	35	55	36	39	-	12	58	-	-
CD at 5%	48	103	163	106	115	-	37	1713	-	-
Sources of Sulphur:										
Ammonium sulphate	1015	1136	2016	1642	1451	27.8	425	21765	14280	2.90
Single super phosphate	1228	1283	2249	1716	1618	42.5	480	24270	17101	3.38
Elemental sulphur	987	1182	1993	1537	1430	25.9	414	21450	14584	3.12
Gypsum	876	1104	1769	1510	1316	15.9	382	19740	12704	2.80
SEm(±)	19	41	64	42	23	-	7	343	-	-
CD at 5%	55	119	188	123	67	-	21	1002	-	-
Interaction (SxL)	NS	NS	NS	NS	NS	-	NS	NS	NS	-

on par with 30 kg S ha^{-1} (1480 kg ha^{-1}) but produced higher seed yield than that of 15 kg ha^{-1}. It might be due to lower dose of recommended P_2O_5 kg ha^{-1} to safflower, which is insufficient to meet out P_2O_5 and sulphur dose of safflower crop . Seed yields were higher during high rainfall years particularly post monsoon which helped in better absorption of applied fertilizers. These findings are in agreement with Kar and Babulkas (1999).Same trend was found in case of oil yield of safflower. Increase in S levels significantly enhanced the yield up to 30 kg S which resulted in 30.4 percent yield of safflower, which is just double than 15 kg S application over control.

Sources of sulphur

Among different sources, meeting the sulphur requirement of crop through single super phosphate recorded the highest seed yield (1618 kg ha^{-1}), followed by ammonium sulphate. Application of sulphur @ 30kg ha^{-1} with any one of sulphur sources could be used. Interaction effect was found to be nonsignificant. Similar results were in accordance with the findings of Patel *et al*. (2002). Application of sulphur recorded significantly the highest seed and oil yield over no application of sulphur (1135 kg ha^{-1}). The highest percent of seed yield (42.5) was recorded with single super phosphate, which supply P, S and Ca. Improvement in growth and yield could partly be attributed to the sulphur fertilization as an essential nutrient.

Economics:

Data indicated that sulphur application had remarkable influence on economic returns of safflower. Among the various sources of sulphur, single super phosphate resulted in significantly superior over other sources in respect of gross returns similarly with net returns and B:C ratio (3.18). Significantly highest gross returns were received from 45 kg S application to safflower (Rs. 23,340/-) and which was at par with 30 kg S and similar trend was observed with net returns and B:C ratio (3.11).

It is concluded that , sulphur fertilization upto 30 kg ha^{-1} through single super phosphate along with recommended dose of nitrogen and phosphorus (25 :25:0) had enhanced yield and net returns of safflower.

LITERATURE CITED

Kar,Dinesh and P.S. Babulkas,1999. Response of safflower (*Carthmus tinctorius* L.) to sulphur and zinc in vertisols. Indian J .Dryland Agric. Res. and Develop.,t 14(1),17-18.

Patel P. T., G. G. Patel,G. A. Patel,V. V. Sonani and H. B. Patel, 2000. Effect of sources and levels of sulphur on seed and oil yield of Safflower (*Carthmus tinctorius* L .) J.Oilseeds Res., 19 (1) : 76-78.

Singh,H.G and M.P. Sahu,1986. Response of Oilseeds to Sulphur, Fertilizer News 31(9):23-30

Tandon,H. L. S. and D. L. Merrick, 2002. Technical Bullentin, Practical sulphur Guide, The Sulphur Institute,1140 Connected Avenue,N.W.,Suite 612 Washington D C.,2006,USA : 20.

❖ ❖ ❖

PKV Res. J. Vol. 36 (2), July 2012

Nutrient Management Through Drip System of Irrigation in Cotton

S. S. Hadole[1], G. J. Bhagat[2], A. H. Nagone[3] and V. R. Thakur[4]

ABSTRACT

The pooled data revealed that application of fertilizers through fertigation was significantly superior over the conventional methods. The yield increased progressively with the increase in fertilizer dose at both the splits and highest yield (15.77 q ha^{-1}) was obtained with 100 per cent RDF in 5 splits which was at par with 100 per cent RDF in three splits. DM: Yield ratio indicated that it was quite higher under conventional methods which indicated vigorous vegetative growth incapable of converting into yield proportionately. The pooled means indicated highest dry matter with 100 per cent RDF through 5 split and the lowest under crobar. There was progressive increase in the dry matter accumulation with the increase in fertilizer dose and the dry matter was slightly higher in 5 splits than 3 splits.

Indian agricultural economy continued to receive great support from the most important commercial cotton crop. In India the area under cotton crop is estimated about 10.74 m ha with 3.25 m metric tonnes of production and 310 kg ha^{-1} productivity of lint (Anonymous, 2005). In Maharashtra, the area under cotton is 45.30 lakh ha with 6.46 lakh tonnes lint production (Annoymous, 2005). The seed cotton productivity however, is very low (about 174 kg ha^{-1}) in the state as compared to that of national average (310 ka ha^{-1}) . The obvious reasons for low productivity of cotton can be attributed to large area (> 90 %) under rainfed conditions, cultivation on marginal soils, use of sub-optimum doses of fertilizers, application of nutrients and irrigation at improper stages of crop growth as well as the use of imbalanced plant nutrition. To overcome these problems, it is imperative to apply optimum doses of nutrients with judicious use of irrigation water at proper crop growth stages. This could be possible only through the use of drip irrigation and fertigation. Drip irrigation is one of the most latest technologies for applying water most efficiently and effectively. Another constraint in cotton production is the nutrient management. In conventional method, there is a heavy loss of nutrients due to leaching, denitrification, NH_3 volatilization and fixation in the soil. Sometimes, nutrients get leached beyond the active root zone and become no longer useful to plant. In many cases, the fertilizer use efficiency is less than 40 per cent.

The fertilizer use efficiency can be increased by applying fertilizers through drip irrigation. The present investigation was carried out with the objectives to study the response of cotton to different levels of fertilizers through drip and other methods of irrigation, to study the water and fertilizer use efficiency and to study the uptake pattern of nutrients.

MATERIAL AND METHODS

The field experiment was carried out in 2000-2003 on the field of Department of Soil Science and Agril.Chemistry, Dr. PDKV, Akola. The experimental soil was classified as Inceptisol, slightly alkaline in reaction, low in total N and available P and high in available potash (Typic ustochrept) with clay texture having bulk density1.32 Mg m^{-3}.The experiment was laid down in Randomized block design with three replications. The treatments details are given below

Treatment Details

T_1 - 50% RDF through fertigation in 3 splits

T_2 - 75% RDF through fertigation in 3 splits

T_3 - 100% RDF through fertigation in 3 splits

T_4 - 50% RDF through fertigation in 5 splits

T_5 - 75 % RDF through fertigation in 5 splits

T_6 - 100% RDF through fertigation in 5 splits

T_7 - 100 % RDF to Cotton grown with crobar method

T_8 - 100% RDF to Cotton grown with conventional (Furrow) irrigation

Fertilizer application schedule : The fertilizer dose (kg ha^{-1}) were applied in splits, as follows :

1,3 &4. Assistant Prof., and 2. ,Senior Res. Asstt., College of Agriculture, Dr.PDKV., Akola

Table 1. Dry matter accumulation at various stages

Treatments		Square initiation stage(q ha^{-1})				50 % flowering stage(q ha^{-1})				First boll opening stage(q ha^{-1})			
		2000-01	2001-02	2002-03	Pooled mean	2000-01	2001-02	2002-03	Pooled mean	2000-01	2001-02	2002-03	Pooled mean
T_1	50% RDF 3 splits	12.99	12.35	13.58	12.97	19.64	19.35	17.50	18.82	44.14	38.13	36.87	39.71
T_2	75% RDF 3 splits	15.04	15.18	15.63	15.28	22.74	22.26	20.28	21.75	50.79	42.53	39.44	44.25
T_3	100% RDF 3 splits	17.58	18.53	17.89	18.00	26.37	27.36	23.43	25.72	59.40	45.87	41.59	48.97
T_4	50% RDF 5 splits	13.82	10.56	11.62	12.33	20.92	15.55	14.62	17.03	46.6	42.62	43.74	44.14
T_5	75 % RDF 5 splits	17.60	13.87	13.96	15.17	26.72	16.66	15.41	19.60	59.47	50.77	47.91	52.71
T_6	100% RDF 5 splits	18.27	18.44	16.49	18.06	27.56	20.77	18.73	22.35	61.39	58.51	53.38	57.75
T_7	100 % RDF crobar	11.85	13.02	13.49	12.73	18.50	14.25	15.14	15.83	40.39	43.95	45.06	43.13
T_8	100 % RDF conven.	14.85	13.13	14.86	14.27	22.36	16.33	16.99	18.56	50.19	47.29	50.41	49.30
	SE(m) ±	0.45	0.52	0.54	0.43	0.73	0.87	0.71	1.25	1.27	1.87	1.28	2.18
	CD at 5%	1.51	1.58	1.65	1.25	2.05	2.65	2.15	3.57	3.57	5.68	3.88	6.24

Stage	Three splits			Stage	Five splits		
	N	P_2O_5	K_2O		N	P_2O_5	K_2O
At sowing (Basal)	40	25	20	At sowing (Basal)	30	25	15
35 DAS	30	15	15	35 DAS	15	05	10
65 DAS	30	10	15	55 DAS	30	15	15
				75 DAS	15	–	05
				95 DAS	10	05	05

Note: 1. Recommended dose of (N:P:K) : 100 : 50 : 50 kg ha^{-1}as recommended by University for this region . 2. 50 per cent P as a basal through split application SSP at sowing and remaining through ortho-phosphoric acid in fertigation.

Application of irrigation

In drip method, water was applied on the basis of ET and moisture content in soil. Before monsoon it was applied at 0.8 ET and after monsoon at 1.00 ET (flow 2.4 mm h^{-1}). The soil and plant analysis was carried out by using standard procedure.

RESULTS AND DISCUSSION

Dry matter accumulation

The dry matter accumulation (Table 1 & Fig.1) under conventional method showed no variation with 50 per cent or 75 per cent RDF through fertigation in three splits except at square initiation stage. The seed cotton yield was recorded higher under drip than the conventional method indicating that conversion of biomass for increase in yield was used more efficiently under fertigation than the conventional method. Dry matter accumulation at 50 per cent flowering was slightly higher than at square initiation and it was enhanced prominently at first boll opening stage. The dry matter accumulation was increased progressively with the increase in the fertilizer dose through fertigation under both 3 and 5 splits at all critical growth stages. The examination of the data revealed that dry matter accumulation was slightly higher under 3 splits than 5 splits upto 50 per cent flowering stage whereas higher dry matter was recorded under 5 splits than 3 splits at first boll opening stage.

The pooled means indicated highest dry matter with 100 per cent RDF through 5 splits and the lowest under crobar. There was progressive increase in the dry matter accumulation with the increase in fertilizer dose and the dry matter was slightly higher in 5 splits as compared to 3 splits. Similar observation was also recorded by Jambunathan (1986), Ahmed, (1989) and Tomar *et al.*, (1989).

Seed cotton yield

The highest seed cotton yield (Table1) was recorded with 100 per cent recommended dose of fertilizer in 5 splits which was at par with the same dose in 3 splits except during 2001-02 (Setty *et al.*,1975). The per cent recommended dose was significantly superior over 75 per cent and 50 per cent RDF in all the three years, irrespective of the number of splits in fertigation. The examination of the pooled data further revealed that application of fertilizers through fertigation was significantly superior over the conventional methods.

Table 2. Seed cotton yield as influenced by various treatments

	Treatments	Seed cotton yield (q ha^{-1})			
		2000 -01	2001 -02	2002 -03	Pooled mean
T_1	50% RDF 3 splits	13.76	10.67	7.07	10.44
T_2	75% RDF 3 splits	14.52	11.94	9.89	12.00
T_3	100% RDF 3 splits	17.66	13.08	12.53	14.42
T_4	50% RDF 5 splits	14.53	11.37	8.94	11.53
T_5	75 % RDF 5 splits	16.29	12.79	11.66	12.47
T_6	100% RDF 5 splits	18.14	14.90	14.29	15.77
T_7	100 % RDF crobar	5.83	3.84	3.83	4.50
T_8	100% RDF Conventional	8.59	5.46	5.60	6.55
	SE(m)±	0.47	0.26	0.714	0.61
	CD at 5%	1.34	0.812	2.166	1.76

The yield increased progressively with the increase in fertilizer dose at both the splits and highest yield (15.77 q ha^{-1}) was obtained with 100 per cent in 5 splits which was at par with 100 per cent RDF in three splits. The 50 per cent and 75 per cent RDF in 3 splits and 5 splits were also at par with each other at each level (Setatou and Simonis, 1996).

Table 3. Earliness index, harvest index and lint index of cotton (2002-03)

	Treatment	Earliness index	Harvest index	Lint index	DM : yield ratio
T1	50% RDF 3 splits	0.603	26.10	3.45	3.99
T2	75% RDF 3 splits	0.726	27.24	3.63	3.67
T3	100% RDF 3 splits	0.550	29.45	4.26	3.39
T4	50% RDF 5 splits	0.710	26.09	3.51	3.94
T5	75 % RDF 5 splits	0.700	25.63	3.87	3.90
T6	100% RDF 5 splits	0.706	27.28	4.56	3.67
T7	100 % RDF crobar	0.760	10.55	2.83	10.04
T8	100% RDF Conventional	0.736	13.25	3.15	7.83
	SE(m)±	0.0197	1.39	0.0984	0.571
	CD at 5%	0.0552	3.90	0.276	1.60

The data in respect to earliness index, harvest index and lint index (Table 2) revealed that the crop showed early maturity when the dose at 50 per cent and 100 per cent RDF was applied in 3 splits. The crop was prolonged slightly when the dose was applied in 5 splits. The harvest index was lowest in crobar and conventional method and it was increased with fertigation indicating efficient utilization of the biomass for conversion in yield (Fabry,1978). Highest harvest index was obtained with 100 per cent RDF in 3 splits. Similarly harvest index with 3 splits was slightly higher than with 5 splits. The data regarding the lint index revealed that it was appreciably and significantly higher with fertigation than conventional method. Further, it was observed that the lint index was slightly higher in 5 splits than 3 splits with 100 per cent RDF level.These results are also supported by Giri *et. al.*,(1994) and Khawale and Prasad (2001).

LITERATURE CITED

Ahmed S.K., 1989.Yield, Dry matter production and nitrogen uptake of drip irrigated cotton, Disser. Abst. International Sci. Engg., 49 (12) 5068.

Anonymous, 2002. All India Co-ordinated Cotton Improvement Project, Annual Report (2001-2002) CICR, Nagpur.

Anonymous, 2005. Economic survey of Maharashtra. Directorate of Economics and Statistics,Plannning Department, Mumbai.

Fabry,C. 1978. One crop at a time, fertilizer solution southern liquid fertilizers, USA, 7 (5) ,141.

Giri, A.N., D.G.Giri, S.V.Raikhelkar and S.T.Shirle 1994 . Performance of cotton (*Gossypium spp*.) genotypes under different levels of nitrogen, Indian.J. Agron. 39 (3) :432-436

Jambunathan, U.T., 1986 . Study of the effect of the application of nitrogen, phosphorus and potash on the economics and quality characteristics of cotton Hybrid –4, J.S.C.T.J. 11 (1) : 26-29.

Khawale, V.S. and M. Prasad, 2001. Effect of nitrogen, bio-fertilizer and growth regulator on growth , yield and quality of cotton, Fert. News. 46 (5): 57-58.

Setatou,H.B., and A.D. Simonis, 1996 . Effect of time and rate of nitrogen application on cotton,. *Fert.Res*. 43 (3):49-53.

Setty, M. V. N., K.C. Ramakrishnaiah and S. Thimmegowda, 1975 . Cotton responds well to foliar nutrient application, Current Res.Univ. Agric. Sci., 12 (2) : 27-31

Tomar ,S.P., S.Tomar and U.K.Shrivastav, 1989 . Effect of soil and foliar application of nitrogen and phosphorus on yield of seed cotton (*Gossypium hirsutum*), Indian Agric. Sci., 29 (8) : 506-508

❖ ❖ ❖

PKV Res. J. Vol. 36 (2), July 2012

Economics and Uptake of NPK by Weeds as Affected by Different Methods of Weed Control in Chilli

S. U. Nemade[1], S. S. Hadole[2], V. R. Thakur[3], P. U. Ghatol[4] and G. J. Bhagat[5]

ABSTRACT

An experiment was conducted during *Kharif* season of 2000-01 and 2001-02 at Chill and Vegetable Research Unit, Dr.Panjabrao Deshmukh Krishi Vidyapeeth, Akola to compare cultural, chemical and integrated methods of weed management. The cultural method of two hoeings at 30 and 60 days, followed by two weedings recorded lowest uptake of N,P and K by weeds and highest fruit yield, gross return, net return and B:C ratio. The next profitable method was that of integrated weed management in which pre plant soil incorporation of Trifluralin @ 1 kg ha^{-1} in combination with one hoeing and one weeding at 45 and 60 days after transplanting, respectively. It was superior to other integrated nutrient management with fluchloralin and Alachlor and where herbicides were used.

Chilli (*Capsicum annum* L.) plays a vital role in Indian economy. It has become an essential item in our diet. It is popularly used in both the forms, fresh green and dry as an ingredient in preparation of several spicy dishes, sauces, salads and in number of different preparations of daily diet. Green chilli contain lot of vitamin "C" and a good source of vitamin A and B (Venkateswara, 1969).The pungency is due to an alkaloid "Capsaicin" contained in the pericarp and placenta. The Chilli seed contain only trace of pungency with a content of 0.005 per cent. The Capsaicin content in red chilli varies from 0.7 to 0.9 per cent (Pankar and Magar, 1978) . It has significant physiological action which is used in many pharmaceutical preparation like lineaments and ointments for cold, sorethorat, chest congestion, etc. It is also used in cosmetics, tonic and stimulants (Singh and Singh, 1980).

A large number of constraints limit the production of chilli. Among them weeds constitute one of the greatest hazards in the successful chilli cultivation. In *Kharif* season, weed intensity is more. Adoption of wider rows spacing, slow germination and initial growth, coupled with adequate moisture, frequent rains, use of higher dose of fertilizers and intensive cropping system lead to heavy weed infestation resulting in severe crop -weed competition. The weeds compete with chilli for water, light, nutrient and space. Apart from this, weeds also harbour some of the insect pests and diseases, which further cause drastic reduction in fruit yield (Mariappan and Naryansamy, 1977 and Alegbejo, 1987). So timely and effective weed management practices play an important role in increasing the production of chilli.To obtain a sustained crop productivity, elimination of crop weed competition is of prime and major importance.

Among the four regions of Maharashtra, Vidarbha grows chilli in more than 42 per cent area of the state but the productivity of dry Chilli in Vidarbha (4.66 q ha^{-1}) is very low as compared to productivity of Maharashtra state (5.35 q ha^{-1}) and also country's productivity (7.53 q ha^{-1}) (More *et. al.*, 1996). Disparity in productivity of chilli in Vidarbha is mainly attributed to the lack of appropriate production technologies. Weeds are considered to be one of the major production constraints. In chilli, information on weed management is limited and no work has been done on weed management in chilli crop particularly in a newly released variety "Jayanti" (AKC 86-39).The present investigation was undertaken to study integrated weed management in chilli as compared to cultural and chemical weed control.

MATERIAL AND METHODS

A field experiment was conducted on chilli to study the effect of weed control methods on fruit yield, economics and uptake of NPK by weed during 2000-01 and 2001-02 at Chilli and Vegetable Research Unit, Dr.Panjabrao Deshmukh Krishi Vidyapeeth,Akola (Maharashtra). The design adopted was randomised block design with nine treatments replicated four times. The site of the experiment, the plan of layout and randomisation were same for both the years. The seed of Jayanti variety was obtained from Chilli and Vegetable Research Unit, Dr.Panjabrao Deshmukh Krishi

1. Associate Professor, ZARS, Yavatmal and 2,3,4 & 5 Assistant Prof., College of Agriculture, Akola.

Vidyapeeth, Akola. Herbicides, Trifluralin (Treflan 48 % EC) and Fluchloralin (Basalin 45 % EC) manufactured by De-Nocil crop protection Ltd.,Mumbai and BASF India Ltd., Mumbai, respectively were received from Weed Science Laboratory, Department of Agronomy, Dr.PDKV, Akola. Quantity of pre-plant incorporation (PPI) of herbicides, Trifluralin, Fluchloralin and Alachlor required for gross plot area (3.6 m x 6.0 m) was calculated as per the dose and dissolved in two litres of water and sprayed uniformly over an area of 21.6 m^2 according to different treatments. Trifluralin, Fluchloralin were applied as pre-plant soil incorporation while, Alachlor was sprayed uniformly with knapsack sprayer fitted with flat fan nozzle, one day before transplanting of chilli seedings. The treatment details are given Table 1.

Table 1. Treatment details

S.N.	Treatments	Symbol
1	Pre-plant soil incorporation of Trifluralin @ 1Kg a.i. ha^{-1}	T_1
2	Pre-plant soil incorporation of Fluchloralin @ 1Kg a.i. ha^{-1}	T_2
3	Pre-plant soil incorporation of Alachlor @ 1Kg a.i. ha^{-1}	T_3
4	Pre-plant soil incorporation of Trifluralin @ 1Kg a.i. ha^{-1}+ one hoeing at 45 days + one weeding at 60 days after transplanting	T_4
5	Pre-plant soil incorporation of Fluchloralin @ 1Kg a.i. ha^{-1}+ one hoeing at 45 days + one weeding at 60 days after transplanting	T_5
6	Pre-plant soil incorporation of Alachlor @ 1Kg a.i. ha^{-1}+ one hoeing at 45 days + one weeding at 60 days after transplanting	T_6
7	One hoeing at 30 days + one weeding at 45 days after transplanting	T_7
8	Unweeded control (Weedy check)	T_8
9	Two hoeings at 30 and 60 days followed by two weedings at 30 and 60 days after transplanting	T_9

RESULTS AND DISCUSSION

Weed Flora

In general during 2001-02 monocot weeds like *Cyperus rotundus, Cynodon dactylon* and *Echinochloa crusgalli* and dicot weeds Viz., *Psorulea corylifolia, Corchorus acutangulas, Lagasca mollis, Euphorbia hirta* and *Parthenium hysterophorus* were dominant in the experimental plot. During both the years, the proportion of monocot weeds was more than that of dicot weeds. The influence of weather condition and weed competition was probably responsible for low yield of chilli crop.

Uptake of nitrogen by weeds

The data presented in Table 2 reveal that there was significant difference among the treatments during both the seasons in respect of uptake of nitrogen by weeds. An average uptake of nitrogen by weeds was 11.06 and 10.36 kg ha^{-1} in 2000-01 and 2001-02, respectively.

Cultural treatment, two hoeings + two weedings at 30 and 60 DAT (T_9) recorded lowest nitrogen upkake.Thus, during both the years it was most effective in reducing nitrogen removal by weeds and proved significantly superior to the remaining treatments. The unweeded plot recorded the highest uptake of N and it was followed by pre plant incorporation of herbicides .

Among the herbicides Trifluralin recorded significantly lower N uptake than Fluchloralin and Alachlor. Integrated weed management further brought a decrease in nitrogen uptake, indicating more effectiveness on weed control. Here also Trifluralin was better than other two herbicides. Between Fluchloralin and Alachlor there was no significant difference.One hoeing and one weeding recorded higher uptake than integrated weed management but lower N uptake as compared to herbicides use alone.Thus integrated weed management was found beneficial in reducing nitrogen uptake by weeds.

Uptake of phosphorus by weeds

An average uptake of phosphorus by weeds was 2.48 and 2.43 kg ha^{-1} in the first and second season, respectively. The uptake of phosphorus by weeds was significantly influenced by various treatments in both the seasons of experimentation. The removal of phosphorus through weeds in unweeded control (T_8) treatment was highest i.e.5.91 and 5.44 kg ha^{-1}in 2000-01 and 2001-02, respectively.

During both the years, treatment two hoeings + two weedings at 30 and 60 DAT (T_9) was found most effective in reducing the uptake of phosphorus by weeds. In case of integrated weed management the

Table 2 : Uptake of nitrogen, phosphorus and potassium by weeds (Kg ha^{-1}) during 2000-01 and 2001-02 as influenced by different treatments.

Treatments	Uptake of nitrogen (Kg ha^{-1})		Uptake of phosphorus (Kg ha^{-1})		Uptake of potassium (Kg ha^{-1})	
	2000-01	2001-02	2000-01	2001-02	2000-01	2001-02
T_1	10.82	10.73	2.56	2.72	15.16	10.96
T_2	15.96	14.78	3.35	3.30	20.70	15.81
T_3	16.63	15.66	3.67	3.50	22.93	16.46
T_4	4.65	4.02	1.09	1.03	6.32	4.99
T_5	6.85	5.91	1.49	1.55	8.76	6.72
T_6	7.29	6.64	1.57	1.62	9.21	7.37
T_7	9.24	9.23	1.98	2.18	12.16	9.61
T_8	25.17	23.11	5.91	5.44	34.41	24.45
T_9	2.96	3.16	0.69	0.52	3.86	4.03
S.E. (m) $\pm$	0.53	0.33	0.12	0.16	0.77	0.25
C.D at 5%	1.55	0.97	0.36	0.48	2.24	0.73
Mean	11.06	10.36	2.48	2.43	14.83	11.15

uptake of phosphorous showed a similar trend as that nitrogen uptake but the quantity of phosphorus removal and the differences were very small though significant.

Uptake of potassium by weeds

The data on the potassium uptake by weeds at harvest as influenced by different methods of weeds control presented in table 2 indicate that average uptake of potassium by weeds was 14.83 and 11.15 kg ha^{-1} in the first and second season of the experimentation, respectively. The data further showed, the potassium losses through weeds are significantly influenced due to various treatments in both the years. The removal of potassium by weeds was highest in unweeded control.

During both the years, treatment two hoeings + two weedings at 30 and 60DAT (T_9) proved significantly superior in reducing the uptake of potassium by weeds to all other treatments. PPI of trifluralin @ 1 kg a.i. ha^{-1} one hoeings + one weedings at 45 and 60 DAT (T_4) was the next best treatment, followed by other two integrated weed management treatments, which were observed to be at par. In general, uptake of potassium also behaved similarly as that of N and P uptake.

Nutrient uptake by weeds has a great significance because it is related with weed population and biomass weight. Higher nutrient uptake by weeds indicate greater nutrient loss to the crops. Therefore, the weed control methods which reduced nutrient uptake by weeds were found effective and beneficial. In the present investigation integrated weed management recorded lower nutrient uptake than that of herbicide use alone. The results obtained are in agreement with those of Yaroslaskaya *et. al.*, (1970), Rethinam (1978) and Maurya *et. al.*, (1990).

Integrated method reduced the uptake of nutrient significantly due to lower weed population and weed growth than the single use of either herbicides or the cultural operation (one hoeing and one weeding).The results were in conformity with the findings of Ajay Kumar *et. al.*, (1995) and Biradar (1999).

Economics of weed control

Use of herbicides by farming community largely depends on the comparative economics. Hence, operation cost of cultural, chemical and integrated weed control treatments and profit or loss were found out for different treatments for two seasons (Table 3). Cost of integrated weed management treatments i.e. preplant incorporation of Trifluralin or Fluchloralin or Alachlor in combination with one hoeing at 45 days and one weeding at 60 days was highest.It was followed by cultural treatment of two hoeings and two weeding while herbicide use alone recorded low cost. It was observed that maximum gross and net returns were obtained under cultural treatment two hoeings + two weedings at 30 and 60 DAT followed by integrated treatment PPI of

Table : 3. Economics of different weed control treatments.

Treat	Fruit yield (q ha^{-1})		Gross return (Rs. ha^{-1})		Cost of cultivation (Rs. ha^{-1})		Net return loss (-) (Rs ha^{-1})			Net return or loss (-) $rupee^{-1}$		Cost : benefit ratio	
	2000-01	2001-02	2000-01	2001-02	2000-01	2001-02	2000-01	2001-02	mean	2000-01	2001-02	2000-01	2001-02
T_1	31.72	27.52	31720	27520	30563	29395	1157	(-) 1875	(-)359	0.04	(-)0.06	1:1.04	1:0.94
T_2	27.96	22.92	27960	22920	30426	29210	(-)2466	(-)6290	(-)4378	(-)0.08	(-)0.22	1:0.92	1:0.78
T_3	27.71	22.05	27710	22050	30394	29142	(-)2684	(-)7092	(-)4888	(-)0.09	(-)0.24	1:0.91	1:0.76
T_4	49.54	43.49	49540	43490	32579	31305	16961	12185	14573	0.52	0.39	1:1.52	1:1.39
T_5	45.13	39.15	45130	39150	32405	31135	12725	8015	10370	0.39	0.26	1:1.39	1:1.26
T_6	45.09	39.98	45090	38980	32384	31107	12706	7873	10290	0.39	0.25	1:1.39	1:1.25
T_7	36.94	32.99	36940	32990	30343	29189	6597	3801	5199	0.22	0.13	1:1.22	1:1.13
T_8	14.67	13.19	14620	13190	28074	27061	(-) 13404	(-)13871	(-) 13638	(-)0.48	(-)0.51	1:052	1:0.49
T_9	53.20	47.66	53200	47660	32017	30772	21183	16888	19036	0.66	0.55	1:1.66	1:1.55

trifluralin @ 1 kg a.i. ha^{-1}, PPI of fluchloralin @ 1 kg a.i. ha^{-1} and pre plant soil application of alachlor @2 kg a.i.ha^{-1} (T_6) each supplemented with one hoeing + one weeding at 45 and 60 DAT, during both the years. In spite of higher cost of Integrated method, it was profitable due to high chilli fruit yields. Similar findings were also observed by Irfan Raza (1998) and Biradar (1999) in respect of cultural treatment and Patel *et. al.*, (1986) and Sharma *et. al.*, (1990) in respect of integrated treatments.

Cultural treatment of one hoeing + one weeding at 30 and 45 DAT recorded more gross and net returns than the chemical treatments. Among the herbicidal treatments (T_1,T_2 and T_3) during both years, PPI of trifluralin @ 1 kg a.i. ha^{-1} recorded the higher gross returns than the treatments of Fluchloralin and Alachlor alone. In respect of net returns during 2000-01, Trifluralin recorded the profit (Rs. 1157 ha^{-1}) while other two herbicides recorded the loss but during 2001-02, all the chemical treatments recorded loss in net returns, which was due to low yield during second season of experiment. Ignatov (1972) also observed similar effect of herbicide Trifluralin on weed control. Considering reduction in nutrient uptake by weeds and high fruit yield in case of integrated weed management, it was found effective and profitable in weed management along with the cultural method of weed control.

LITERATURE CITED

Ajay Kumar,K.K.Thakra and P.S. Partap, 1995. Studies on effect of weed management practices and nitrogen levels on weed biomass with special reference to *Trianthema portulacastrum* in chilli, Haryana J.Hort.Sci., 24 (2):136-140.

Aleg bejo, M.D., 1987. Identification of weed host of pepper veinal mottle virus in northern Nigeria, Samaru J. Agric.Res., 5:65-70 (C.F. Crop Prot., 1987 :6(10):283-288).

Biradar, S., 1999. Integrated weed management in chilli under northern transitional tract of Karnataka, M.Sc. Thesis (Unpub.), UAS, Dharwad, Karnataka J.Agri Sci., 12 (1-4): 279.

Ignatov, B.,1972. The effect of some herbicides on different capsicum varieties grown on calcareous chenozem soil, Lozarka Nouka , Bulgaria.9 (2):61-68 (C.F.Weed abst., 1974:23(4):593).

Irfan Raza, 1998. Effect of different pre-emergence herbicides on growth and yield of chilli (*Capsicum annum* L.) CV. Jayanti,M.Sc. Thesis (Unpub.), Dr. PDKV, Akola

Mariappan, V. and P. Narayansamy,1997. Characterization of Virus affecting weeds II-leaf curl disease, Madras Agric.J., 64(11):740-744.

Maurya, B.M., N.M.Gogulwar and J.P. Tiwari, 1990. Herbicidal weed control efficiency and nutrient removal by weeds in soyabean, Indian. J. Weed Sci., 22 : 51-56.

More,T.A., P.B.Kale and B.W. Khule, 1996. Chilli in Vegetable Seed Production tech. Pub.by MSSC, Ltd., Akola (M.S.) India : 45-52.

Pankar,D.S. and N.G. Magar, 1978. Capsaicin total colouring matter and ascorbic acid contents in some selected varieties of chilli, J.Maharashtra Agric.Univ., 3(2) : 116-119.

Patel,C.L., Z.G. Patel and R.B.Patel, 1986. Efficacy and economics of some new herbicides for weed control in onion, Gujrat Agric. Univ. Res.J., 12 (1) : 14-17.

Rethinam, P., 1978. Studies on the efficacy of herbicides in cotton with certain soil supplied chemicals, Ph.D Thesis (Unpub.), TNAU.,Coimbatore.

Sharma, P.P., Arya and G.M. Lankroo,1990. Economics of different herbicides used in bell pepper (*Capsicum annum* L.), Indian J. Weed Sci. 20(3):107-108.

Singh V.B. and K. Singh, 1996. Spices, New Age International publisher, New Delhi : 86-89.

Venkateswara, 1969. Hand book of Agriculture ICAR, New-Delhi, India : 267.

Yaroslaskaya, P.M., D.M. Visilve and N.T. Agarkova, 1970. The effect of trifluralin on the nutrient regime of the soil in caster bean crops (C.F.Weed abst., 21: 665).

❖ ❖ ❖

PKV Res. J. Vol. 36 (2), July 2012

Evaluation of Suitability of Medicinal Trees for Wasteland Management

S. G. Wankhade[1], S. B. Nandanwar[2], R. B.Sarode[3], N. M. Shendre[4] and A. V. Autkar[5]

ABSTRACT

The experimental soils under study were marginal, mostly shallow to medium in depth, ranging from 15.00 to 50.00 cm, alkaline in soil reaction (pH range of 7.8 to 8.55).The bulk density was in the range of 1.18 to 1.25 Mg m-3 and the maximum water holding capacity was in the range of 30.18 to 46.86 per cent. On the basis of soil test values, the soils were having low to medium fertility status in respect of organic carbon (0.266-0.459 %) and available nitrogen and low in available phosphorus (14.36-17.51 Kg ha^{-1}) and low to medium in available potassium content. In order to assess the over all suitability of medicinal tree species under shallow to medium depth soils, the suitability index was worked out. Among 16 medicinal tree species studied the tree species *Gmelina arborea* (Gambhari) gave the highest suitability index value of 295.58 followed by 256.35 for *Emblica officinalis* (Amla) and 243.98 for *Pongamia pinnata* (Karanj). The least value of suitability index 140.99 was recorded for *Thespesia populnea* Soland. Under shrub species the highest suitability index was noticed with *Vitex nigundo* Linn.(298.33),followed by *Adhatoda vasica* Nees (221.06) and *Commiphora mukul* (220.74) grown in marginal soils having shallow depth and low fertility status.

India has 20 agro-ecological zones (NBSS&LUP, 1992).Agronomist have been able to fit the best suited crops/cropping systems in all the zones. However, a very meager work has been done in identification of most suitable medicinal and aromatic plants in different agro-ecological zones. There is practically no scope in increasing the area under these crops because of priority given to the other more essential and productive crops. There are several medicinal and aromatic plants having ability to grow well under abiotic stress conditions, particularly adverse soil conditions, without affecting their economic yield and medicinal value. In India a very large area of waste lands viz, saline, alkaline, acid, sodic soils, waterlogged soils, calcareous soils and dry lands are being unutilized to their full potential for want of more suitable and remunerative crops. Therefore, there is only way to utilize these degraded/wastelands for cultivation of medicinal and aromatic plants as per their adaptability under varied soil types and agro-climatic conditions. Moreover, the water stress may have positive reactions in improving the quality of these crops through biosynthesis of secondary metabolites and these secondary metabolites may improve the drought resistance to plants. The quality of this crops is also enriched under dryland conditions (Duke, 1982, Yaniv and Palevitch, 1982, Pratibha and Korwar 2002).Thus, the cultivation of medicinal and aromatic crop plants have become a highly desirable proportion for realising higher water productivity and replace the existing uneconomical arable crops and play vital role in sustained environmental restoration of degraded lands and provide livelihoods for the poor farmers.

In Maharashtra and particularly in Vidarbha the dry-land agriculture has a prime role in food crop production. However, the undependable and erratic rainfall in the region introduces an element of risk, uncertainty and instability in crop production, which resulting into financial deterioration of rural farming sector. Farming community is in search of non-traditional cropping systems, suitable for dry-land agriculture, indicating the diversification in agriculture. Diversification with high value crops like medicinal and aromatic plants, which do not have critical stages or reproductive stages, help in increasing the water productivity and provide stability to rainfed agriculture. With these view, the present investigation was carried out to evaluate the suitability of medicinal plants under marginal soils.

MATERIAL AND METHODS

Soil characteristics

The land (Field No.18 and 19) selected for the project is under Mission School Block of Central Research Station, Dr. PDKV, Akola .The total area under the new plantation is of 2.96 hectares in addition to the 8.0 ha area of Nagarjun Medicinal Plants Garden. The physico chemical properties of the site presented in the Table-1 showed that the soils are marginal, mostly shallow to medium in depth, ranging from 15.00 to 50.00

1. Professor & Head, 2.Sr.Res.Fellow, 3.Assistant Prof., 4 & 5. Tech. Assistant, AICRP on Medicinal, Aromatic Plants & Betelvine (ICAR), Dr.PDKV, Akola

cm, having pH in the range of 7.8 to 8.55 and EC 0.21-0.35 .The bulk density was noted in the range of 1.18 to 1.25 Mg m^{-3} and the maximum water holing capacity was in the range of 30.18 to 46.86 %. On the basis of soil tests value the soils were having low to medium fertility status in respect of organic carbon (0.266-0.459 %) and available nitrogen and low in available phosphorus (14.36-17.51 Kg ha^{-1}) and low to medium in available potassium content.

Selection of plant species:

A successful management of these soils requires choice of plants species, which are capable to withstand water stress conditions and yet to produce satisfactory growth, yield, and quality. The choice of species also depends upon climatic conditions, purpose of plantation, soil type, and land topography and growth habit. With this view ,15 medicinal plants species were planted during *Kharif* 2006-07 and additional one species, namely Bixa was planted during 2007-08 to evaluate their suitability for wasteland management.

Plantation:

Prior to planting, field was clean and layout plan was prepared by dividing lands in to plots of convenient sizes. The plants with its earth ball was taken out and placed in the center of a pit by excavating as much soil as to accommodate the root ball. The river soil mixed with well decomposed compost was then filled in and pressed around the root ball for firm contact.

In monoculture, tree medicinal plant species were planted in square system, where plant to plant and row to row distance is same (7 x 7m), where as shrub medicinal plant species were planted at a distance of 3.5 x 3.5m. Multistoried plantation was carried out by planting Guggul plants in between two plants of Amla planted at 7 x 7m.

RESULTS AND DISCUSSION

Growth performance:

The preliminary observations regarding growth parameters viz., plant height and DBH were recorded

Table 1: Physico-chemical characteristics of soils

SN	Plant species planted	Soil depth (cm)	pH (1:2.5)	EC (dSm^{-1})	Bulk density ($Mg\ m^{-3}$)	MWHC (%)	O.C. (%)	Av. N ($kg\ ha^{-1}$)	Av. P ($kg\ ha^{-1}$)	Av. K ($kg\ ha^{-1}$)
MISSION SCHOOL BLOCK (Field No.-18)										
1	*Emblica officinalis*	30	8.41	0.29	1.18	39.75	0.413	185.02	14.66	240.30
2	*Commiphora mukul*	22	8.37	0.30	1.20	37.95	0.407	182.33	14.37	211.00
3	*Gmelina arborea*	34	8.38	0.28	1.19	37.74	0.360	206.08	16.00	240.90
4	*Semicarpous anacardium*	21	7.90	0.35	1.19	33.59	0.343	198.50	16.42	186.60
5	*Pongamia pinnata*	15	7.94	0.21	1.19	30.18	0.285	127.68	16.55	177.10
MISSION SCHOOL BLOCK (Field No.-19)										
6	*Commiphora myrrha*	18	8.55	0.28	1.19	34.12	0.266	119.16	15.12	178.20
7	*Adhatoda vasica*	50 (15)	8.21	0.30	1.19	46.17	0.433	238.93	17.70	240.20
		50 (30)	8.43	0.25	1.19	41.15	0.459	250.87	17.91	245.80
8	*Aloe barbadensis*	38	8.50	0.22	1.19	41.60	0.408	227.58	17.51	239.20
9	*Bixa orellena*	15	8.35	0.29	1.19	34.49	0.322	189.06	16.25	184.10
10	*Simarouba glauca*	18	8.14	0.29	1.19	43.52	0.394	221.31	16.72	192.70
		22	8.10	0.27	1.25	46.86	0.419	232.50	14.36	190.00
11	*Vitex nigundo*	27	7.93	0.26	1.19	45.58	0.320	188.16	15.29	189.10
12	*Sapindus trifoliatus*	25	7.86	0.29	1.19	43.68	0.332	193.53	15.93	191.40
13	*Thespesia populnea*	20	8.24	0.27	1.19	41.09	0.312	184.60	13.48	180.10
14	*Emblica officinalis*	25	8.02	0.30	1.19	38.93	0.353	203.10	15.93	183.70
15	*Terminalia bellerica*	25	8.04	0.31	1.19	40.15	0.366	208.77	16.09	196.83

after four years of planting. The data presented in table-2 and 3 indicated that the average growth of most of the medicinal plant species was satisfactory.

Among 17 medicinal plant species, the nine species were categorized under shrub viz., *Adhatoda vasica* (Adulsa), *Commiphora mukul* (Guggul),*Bixa orellena* (Bixa/Shendri) *Bursera delpechiana* (Bursera), *Commiphora myrrha* (Guggul), *Carissa carondas* (Karonda), *Morinda citrifolia* (Noni),*Vitex nigundo* (Nirgundi) and *Aloe barbandensis* (Korphad) and eight species as medium to large size trees viz., *Emblica officinalis* (Amla), *Semicarpous anacardium* (Bibba), *Simarouba glauca*, *Thespesia populnea* (Parosa pimpal), *Pongamia pinnata* (Karanj), *Gmelina arborea* (Gambhari), *Terminalia bellerica* (Behada) and *Sapindus trifoliatus* (Ritha).

After four years of plantation the variation for plant height in *Gmelina arborea* (Gambhari/ Shivan) was from 530.00 to 800.00 cm with an average of 665.00 cm. The DBH was varied from 8.00 - 17.50 cm. In *Emblica officinalis* (Amla), the plant height was in the range of 450.00 to 595.00 cm with the DBH in the range of 6.30 to 14.50 cm. However, in *Terminalia bellerica* (Behada) it was 425.00 cm and 8.33 cm, respectively. The mean performance of *Sapindus trifoliatus* (Ritha) for plant height and DBH was 420 cm and 7.30 cm, respectively. In *Emblica officinalis* (Amla) planted under multistoried system, the plant height was in the range of 240.00 to 425.00 cm with the DBH in the range of 5.4 to 12.5 cm. The mean plant height and DBH in *Pongamia pinnata* (Karanj) was 292.50 cm and 13.00 cm. *Semicarpous anacardium* (Bibba), recorded average plant height of 255.00 cm and DBH of 8.00 cm. The mean plant height and DBH recorded in *Simarouba glauca* was 250.00 cm and 5.05 cm, respectively. The plant height in *Thespesia populnea* (Parosa pimpal) varied from 140.00 to 223.00 cm, while DBH was in the range of 1.80-3.00 cm. Under shrub species *Vitex nigundo* (Nirgundi) recorded highest plant height in the range of 220.00 to 430.00 cm with mean value of 325.00 cm and DBH from 4.80 to 11.20 cm with means value of 8.00 cm. Another species suited to arid conditions namely Bursera (an Aromatic plant) is planted during 2009-10 for evaluation studies and the average plant height of 147.30 cm and stem girth of 2.90 cm was recorded. The plant height of *Adhatoda vasica* (Adulsa), was varied from 150.00 to 190.00 cm with mean value of 170.00 cm and DBH from 2.90 to 8.10 cm with the mean value of 5.50 cm. The plant height and DBH of *Morinda citrifolia* (Noni) was in range of 109.00 to 210.00 cm and 1.90 to 3.60 cm, respectively. *Commiphora mukul* recorded average plant height of 165.00 cm and DBH of 5.70 cm. *Commiphora myrrha* recorded average plant height and DBH of 147.30 and 5.70 cm, respectively. Bixa (*Bixa orellana*) planted in July 2007 was survived for two years .Only three plants with the average plant height of 104.25 cm and DBH 3.06 cm were survived. The failure of this species was mainly due to the shallow depth of soil. The mean height and stem girth in Karonda was 147.30 cm and 2.90 cm, respectively. In *Aloe vera* the average length of leaves recorded was 57.25 cm and number of leaves was in the range of 10.00 to 23.00.

In general, under tree species the highest plant height was recorded by *Gmelina arborea* (665 cm) followed by *Emblica officinalis* (513 cm) *Terminalia bellerica* (425 cm) *and Sapindus trifoliatus* (420 cm). Under shrub species *Vitex nigundo* recorded highest plant height (325.00 cm) grown in marginal soils having shallow depth and low fertility status (Table-2).

Absolute growth rate:

The absolute growth rate (plant height) was calculated by the standard formula.

$$AGR\ (Plant\ height) = (H_2 - H_1)/ t_2 - t_1$$

Where-

H_2 is the height at t_2, while H_1 is the height at t_1.

The data generated are presented in table-4. From the data, it is revealed that the highest AGR values were recorded in *Emblica officinalis* (Amla), followed by *Simarouba glauca* and *Terminalia bellerica* (Behada) during 2010-11. After four years plantation the survival percentage was in the range of 7.14 to 100 per cent and the highest 100 per cent survival was noticed with *Adhatoda vasica, Morinda citrifolia* and *Pongamia pinnata* and the lowest survival per cent was noticed *in Bixa orellana.*

Suitability index:

In order to assess the over all suitability of plant species under shallow to medium depth soils, the suitability index was worked out (Nath et al, 1990 ; Singh et al , 1992).On the basis of survival per cent, plant height and DBH, by giving 100 points to the highest value of each parameter and finding total score of each species. The tree species *Gmelina arborea* (Gambhari) gave the highest suitability index value of 295.58, followed by 256.35 for *Emblica officinalis* (Amla) and 243.98 for *Pongamia pinnata* (Karanj). The least value of

Table: 2 Plant height during 2006-07 to 2010-11

SN	Plant Species	Plant height (cm)				
		2006-07	2007-08	2008-09	2009-10	2010-11
TREE SPECIES						
1	*Gmelina arborea*	106.79	323.39	377.81	617.50	665.00
		(61-167)	(160-420)	(250 – 590)	(525-700)	(530-800)
2	*Emblica officinalis*	46.64	181.77	252.76	361.50	513.60
		(11-78)	(77-308)	(90 – 390)	(275–425)	(450-595)
3	*Terminalia bellerica*	40.22	84.85	159.28	332.00	425.00
		(11-57)	(40-146)	(70 – 270)	(225-405)	(350-550)
4	*Sapindus trifoliatus*	16.84	148.76	255.75	358.00	420.00
		(7-45)	(41-275)	(130-350)	(210-575)	(230-610)
5	*Emblica officinalis* +	91.68	158.00	271.23	284.00	332.50
		(50-162)	(90-279)	(150-410)	(225-375)	(240-425)
6	*Pongamia pinnata*	64.21	135.43	202.50	264.00	292.50
		(27-102)	(45-192)	(70-310)	(200-350)	(205-380)
7	*Semicarpous anacardium*	21.29	59.38	130.00	216.00	255.00
		(10-41)	(10-138)	(60 – 200)	(146-300)	(161-350)
8	*Simarouba glauca*	31.51	110.75	209.79	227.00	250.00
		(7.52)	(47-168)	(130-300)	(180-320)	(170-330)
9	*Thespesia populnea*	17.25	124.95	145.95	165.50	181.50
		(12-22)	(110-196)	(100 – 190)	(130 – 200)	(140-223)
SHRUB SPECIES						
1	*Vitex nigundo*	85.41	256.30	273.42	292.50	325.00
		(35-127)	(160-306)	(250-310)	(210-375)	(220-430)
2	*Bursera delpechiana*	–	–	–	–	173.50
						(120-235)
3	*Adhatoda vasica*	55.39	114.53	137.08	146.00	170.00
		(46-75)	(85-135)	(95-230)	(130-175)	(150-190)
4	*Morinda citrifolia*	22.92	78.53	108.57	148.50	160.20
		(11-35)	(28-205)	(40 – 230)	(100 – 180)	(109-210)
5	*Commiphora mukul*	104.34	150.90	156.69	160.50	165.00
		(20-210)	(74-225)	(40-290)	(125-200)	(110-220)
6	*Commiphora myrrha*	88.42	105.47	144.0	146.0	147.30
		(51-159)	(81-170)	(95-190)	(110-175)	(135-172)
7	*Bixa orellena*	–	70.06	104.25	–	–
			(13-120)	(45 – 160)		
8	*Carissa carondas*	23.00	55.90	55.90	75.60	147.30
		(16-30)	(45-70)	(45 – 70)	(65 – 105)	(110-195)
9	*Aloe barbandensis*	37.75*	51.84*	48.92*	54.10*	57.25*
	*Leaf length (cm)	(18-56)	(36-62)	(36 – 67)	(42 – 65)	(39-72)

Table: 3 DBH during 2006-07 to 2010-11

SN	Plant Species	DBH(cm)				
		2006-07	2007-08	2008-09	2009-10	2010-11
TREE SPECIES						
1	*Gmelina arborea*	3.24	9.09	9.07	11.08	12.75
		(1.4-5.0)	(5.14-14.33)	(4.0-17.60)	(8.6-18.20)	(8.0-17.5)
2	*Emblica officinalis*	0.74	4.23	6.68	8.75	10.40
		(0.3-1.2)	(1.90-8.00)	(2.0-12.10)	(5.0-12.5)	(6.3-14.5)
3	*Terminalia bellerica*	0.73	2.72	3.80	6.60	8.33
		(0.5-0.9)	(1.10-4.35)	(1.70-5.60)	(4.0-10.0)	(7.2-10.2)
4	*Sapindus trifoliatus*	0.51	1.91	2.28	6.90	7.30
		(0.2-0.9)	(0.80-3.00)	(1.40-3.10)	(4.0-8.0)	(4.8-9.8)
5	*Emblica officinalis* +	2.03	3.39	7.75	7.85	8.95
		(0.7-3.1)	(0.60-5.60)	(4.0-18.00)	(5.2-19.50)	(5.4-12.5)
6	*Pongamia pinnata*	1.36	2.93	9.54	11.54	13.00
		(0.3-1.9)	(0.96-5.25)	(3.80-17.00)	(4.0-19.00)	(5.5-20.5)
7	*Semicarpous anacardium*	0.55	1.85	5.52	7.40	8.00
		(0.1-1.3)	(0.38-5.10)	(2.10-10.90)	(4.2-12.00)	(4-12)
8	*Simarouba glauca*	1.33	3.14	4.10	4.63	5.05
		(0.7-1.9)	(1.50-4.65)	(2.50-5.50)	(2.80-6.60)	(3.2-6.9)
9	*Thespesia populnea*	0.48	1.62	1.86	1.90	2.40
		(0.4-0.5)	(1.15-2.00)	(1.0-2.80)	(1.6-2.90)	(1.8-3.0)
SHRUB SPECIES						
1	*Vitex nigundo*	1.36	5.68	7.41	7.50	8.00
		(1.0-2.5)	(3.20-7.60)	(4.0-9.50)	(4.3-9.50)	(4.8-11.20)
2	*Bursera delpechiana*					1.95
						(1.3-2.8)
3	*Adhatoda vasica*	1.66	4.0	3.16	4.30	5.50
		(1.1-2.6)	(3.0-5.10)	(2.10-5.60)	(2.18-7.60)	(2.9-8.10)
4	*Morinda citrifolia*	0.62	1.87	2.13	2.75	3.14
		(0.3-0.9)	(0.70-5.00)	(0.70-6.30)	(1.20-6.30)	(1.9-3.6)
5	*Commiphora mukul*	1.92	3.28	4.54	5.44	5.70
		(0.3-3.2)	(1.60-5.10)	(2.0-7.60)	(2.0-7.80)	(2.8-8.6)
6	*Commiphora myrrha*	1.66	3.11	3.80	4.15	5.70
		(1-2.3)	(2.30-4.10)	(2.60-5.60)	(2.60-6.90)	(2.8-8.6)
7	*Bixa orellena*	-	2.04	3.06	-	-
			(0.20-3.60)	(1.0-5.60)		
8	*Carissa carondas*	1.09	2.31	2.31	2.60	2.9
		(0.8-1.4)	(1.60-3.50)	(1.60-3.50)	(2.30-3.50)	(2-3.80)
9	*Aloe barbandensis*	-	4.80**	6.84**	13.80**	16.50**
	*Leaf girth (cm)		(4.0-7.0)	(6.0-16.00)	(11-25)	(10-23)

Table: 4 Absolute Growth Rate (plant height) and Suitability Index

SN	Plant Species	Absolute Growth Rate (cm month^{-1})				After 4th year plantation	
		2007-08	2008-09	2009-10	2010-11	Survival %	Suitability Index
TREE SPECIES							
1	*Gmelina arborea* Linn.	18.05	4.53	19.98	3.95	97.50	295.58
2	*Emblica officinalis* Gaertn	5.52	9.43	7.52	12.68	99.12	256.35
3	*Terminalia bellerica* Roxb.	3.71	6.25	14.40	7.75	97.62	225.61
4	*Sapindus trifoliatus*	10.99	8.91	8.53	5.17	75.00	194.31
5	*Pongamia pinnata* Pierre	5.93	5.58	5.13	2.37	100.00	243.98
6	*Semicarpous anacardium*	3.17	5.88	2.29	3.25	77.50	177.38
7	*Simarouba glauca* DC	6.60	8.25	3.44	8.69	96.80	173.24
8	*Thespesia populnea* Soland	8.97	1.75	1.63	1.34	95.24	140.99
SHRUB SPECIES							
1	*Vitex nigundo* Linn.	14.24	1.42	1.59	2.70	93.88	293.88
2	*Bursera delpechiana*	—	—	—	—	—	147.76
3	*Adhatoda vasica* Nees	4.92	1.87	0.75	2.00	100.00	221.06
4	*Morinda citrifolia* L.	4.63	2.50	3.33	0.98	100.00	188.542
5	*Commiphora mukul*	3.88	2.42	1.31	0.38	98.72	220.74
6	*Commiphora myrrha*	1.42	3.21	1.17	0.11	99.13	215.703
7	*Bixa orellana*	-	2.84	—	—	7.14	77.4669
8	*Carissa carondas*	2.74	0.34	0.38	7.64	88.57	170.143
9	*Aloe barbadensis* Mill	-	-	-	-	97.58	-

suitability index 140.99 was recorded for *Thespesia populnea* Soland.

Under shrub species the highest suitability index was noticed with *Vitex nigundo* Linn.(298.33), followed by *Adhatoda vasica* Nees(221.06) and *Commiphora mukul* (220.74) grown in marginal soils having shallow depth and low fertility status.

LITERATURE CITED

Duke, J.A., 1982. Ecosystematic data on Medicinal Plant. In : Cultivation and Utilization of Medicinal Plants (eds. C.K. Atal and B.M. Kapur) RRL (CSIR) Jammu 13-23.

Nath, S, Das, P.K. Gangopadhyay,S.K.Banerjee and B.Singh, 1990. Suitability of different forest species for Social Forestry Programme under different soil conditions, Part-II Lateritic soils. Indian Forest, 116 : 464-473.

Pratibha G.and G.R.Korwar, 2002. Crop diversification through medicinal,aromatic and dye yielding plants for sustainability in semi-arid regions.Proceedings of First National meet on Medicinal and Aromatic Plants(eds. Mathur A.K,S.Dwivedi, D.D.Patra, G.D.Bagchi, N.S.Sangwan, A.Sharma and S.P.S. Khanuja) CIMAP,Lukhnow :129-132.

Singh,A.K., R.B. Singh, A.K. Bhowmik and S.K. Banerjee, 1992. Suitability and performance of different tree species in skeletal soils of Sambalpur (Orrisa), Indian Agric., 36 : 231-235

Yaniv; Z and D. Palevitch, 1982. Effect of drought on the secondary metabolites of medicinal and aromatic plants, A review *In* : Cultivation and Utilization of Medicinal Plants (eds. C.K. Atal and B.M. Kapur) RRL, Jammu : 1-12.

❖ ❖ ❖

PKV Res. J. Vol. 36 (2), July 2012

Integrated Nutrient Management in Sweet Orange

A.B. Kandalkar[1], R.S. Wankhade[2], H. H. Dikey[3] , S. P. Patil[4] and C.U. Patil[5]

ABSTRACT

The present investigation to study the integrated nutrient management in sweet orange was carried out at Regional Research Centre, Amravati of Dr.Panjabrao Deshmukh Krishi Vidyapeeth, Akola (Maharashtra) during 2005-06 to 2009-10. The result revealed that, maximum increase in tree volume plant^{-1} (11.80 cu.m.) was observed (March, 2010) in T_2- FYM (125 Kg tree^{-1}) over initial (June, 2005) and maximum no. of fruits plant^{-1} was observed in T_8- 1/2 RDF(500 gm N+ 180 gm P) + 100 Kg green manuring *In situ*. There was no noticeable change in Soil P^H and bulk density where as available N and organic carbon content of soil was significantly influenced by different nutrient treatments. Highest carbon (4.47g kg^{-1}) content was observed in T_6 -1/2 RDF (500 g N+ 180 g P) + 62.5 Kg FYM. In respect of available N and P, significantly highest increase in both (199.06 Kg ha^{-1} and 18.78 Kg ha^{-1}, respectively) was observed in T_1-RDF (1000g N+360g P) while available K was highest (318.44 Kg ha^{-1}) in T_3- Vermicompost (84 Kg tree^{-1}).

Sweet orange is the most important species of *Citrus*, of great economic importance and most widely cultivated all over world. Like other plants sweet orange also requires and removes huge amount of plant nutrients from the soil for proper growth and development. If they are not re-supplied to the soil, the soil will be gradually exhausted and the trees will suffer from lack of nutrients.

If organic manures are supplemented with additional mineral fertilizers, optimum conditions may be created for healthy and abundant growth. It is always advantageous to give a liberal dressing of bulky organic manure as it keeps the soil mellow and in a good physical condition besides supplying plant nutrients. It also aids in increasing the buffering capacity of the soil, which is a very important factor in successful citrus growing. Citrus is a nutrient sensitive and responsive plant and it requires adequate nutrition for proper growth and development (Ghosh, 1990). Hence present study was undertaken to study the integrated nutrient management in sweet orange.

MATERIAL AND METHODS

The present investigation was carried out on four years (start of experiment) old sweet orange plants of uniform growth and vigor at Regional Research Centre,Amravati of Dr.Panjabrao Deshmukh Krishi Vidyapeeth, Akola (Maharashtra) during 2005-06 to 2009-10. The general characteristics of experimental soil and treatment details are mentioned in Table 1. The Sunhemp was used as a green manuring crop and sown in June. All the fertilizers and organic manures were applied in the month of June. The treatments were applied in randomized block design with three replications having four plants under each treatment. Growth of plant and number of fruits per plant were recorded.

Table 1. General characteristics of experimental soil (Soil status (2009-10) mentioned in Table-4)

Soil status	Initial	
	(2005-06)	(2009-10)
pH	7.53	7.66
Organic carbon (g Kg^{-1})	3.90	4.01
Bulk Density (g cm^{-3})	1.38	1.42
N Kg ha^{-1}	178.00	177.00
P_2O_5 Kg ha^{-1}	15.12	16.63
K Kg ha^{-1}	290.80	275.75

Treatment details

T_1 - RDF (1000 g N+ 360 g P_2O_5) control

T_2 - FYM (125 Kg tree^{-1})

T_3 - Vermicompost (84 Kg tree^{-1})

T_4 - Green manuring in situ (200 Kg)

T_5 - 1/2 RDF (500 g N+ 180 g P_2O_5)

T_6 - 1/2 RDF (500 g N+ 180 g P_2O_5)+ 62.5 Kg FYM

T_7 - 1/2 RDF (500 g N+ 180 g P_2O_5)+ 42 Kg Vermicompost

T_8 - 1/2 RDF (500 g N+ 180 g P_2O_5)+ 100 Kg green manuring in situ

1. Assistant prof., 2. Junior Res. Asstt. 3. Assistant Prof., 4. Agriculture Assistant and 5. Head, Regional Research Centre, Dr. P. D. K. V., Amravati

Table 2- Tree volume plant^{-1} (cu.m.) of sweet orange as influenced by different nutrient management treatments

Treatments	Mean volume (cu.m.)										Increase over initial
	June 2005	March 2006	June 2006	March 2007	June 2007	March 2008	June 2008	March 2009	June 2009	March 2010	
T_1 - RDF (1000 g N+ 360 g P_2O_5) control	1.11	1.94	2.41	3.42	7.19	8.25	9.17	10.26	10.80	12.05	10.94
T_2 - FYM (125 Kg tree^{-1})	1.95	3.32	4.63	5.78	9.30	10.78	11.51	12.59	12.45	13.75	11.80
T_3 - Vermicompost (84 Kg tree^{-1})	1.52	2.55	3.53	4.51	7.18	8.73	9.37	10.39	10.27	12.05	10.53
T_4 - Green manuring in situ (200 Kg)	1.56	2.67	4.10	4.82	8.12	9.31	10.26	11.44	11.24	12.85	11.29
T_5 - 1/2 RDF (500 g N+ 180 g P_2O_5)	1.67	2.61	3.90	4.67	8.03	9.41	10.32	11.40	11.02	12.9	11.23
T_6 - 1/2 RDF (500 g N+ 180 g P_2O_5) + 62.5 Kg FYM	1.49	2.44	3.27	4.41	7.16	8.28	9.29	10.32	11.3	12.0	10.51
T_7 - 1/2 RDF (500 g N+ 180 g P_2O_5) + 42 Kg Vermicompost	1.52	2.43	3.08	3.86	7.75	9.09	10.34	11.20	12.36	12.45	10.93
T_8 - 1/2 RDF (500 g N+ 180 g P_2O_5) + 100 Kg green manuring in situ	1.43	2.48	3.47	4.13	7.95	9.21	10.37	11.47	12.9	12.98	11.52

RESULTS AND DISCUSSION

Data regarding tree volume plant^{-1} (cu.m.) of sweet orange as influenced by different nutrient management treatments presented in Table 2 revealed that highest increase in mean tree volume (11.80 cu.m.) over initial tree volume was noticed in T_2- FYM (125 Kg tree^{-1}), followed by T_8-1/2 RDF (500 g N+ 180 g P_2O_5)+ 100 kg green manuring *In situ* (11.52 cu.m.) and T_4- Green manuring *In situ* (200 Kg). Pooled mean of No. of fruits plant^{-1} as influenced by different nutrient management treatments presented in Table 3 revealed that No. of fruits plant^{-1} was significantly influenced by different nutrient management treatments and higher number of fruits plant^{-1}(381.4) was obtained from the trees applied with T_8 (1/2 RDF (500 g N+ 180 g P_2O_5) + 100 kg green manuring *In situ*), followed by 367.13 fruits tree^{-1} in T_1 [RDF (1000 g N+ 360 g P_2O_5)]. These results conform the earlier findings of Rokba, *et. al.*, (1975).

The results of Table 4 reveled that there was no noticeable change in soil pH and bulk density where as available N and organic carbon content of soil was significantly influenced by different nutrients treatments. Highest carbon (4.47g kg^{-1}) content was observed in T_6 -1/2 RDF (500 g N+ 180 g P) + 62.5 Kg FYM. In respect of available N and P in soil , significantly highest increase in both (199.06 kg ha^{-1} and 18.78 kg ha^{-1}, respectively) was observed in T_1-RDF (1000g N +3 60 g P) while available K in soil was highest (318.44 Kg hasoil) in T_3-Vermicompost (84 kg tree^{-1}).

From above findings, it may be concluded that integrated nutrient management treatment; T_8-1/2 RDF (500 g N+ 180 g P_2O_5) + 100 kg green manuring *In situ* may be found beneficial for increased yield without damaging the soil.

LITERATURE CITED

Ghosh, S.N., 1990. National requirement of orange (Citrus sinesis, osbeck) cv. Mosambi, Haryana, J. Hort. Sci. 19 (1-2) : 39-44.

Rokba, A.M., El. L.T. Mahmoudi and El.E. Menshawi, 1975. Effect of organic and inorganic fertilizers on annual orange trees, Agric.Res.Rev., 53(3): 7-14.

❖ ❖ ❖

Study on Nutrient Content and Uptake in Gladiolus Influenced by Varieties and Plant Growth Regulators

Neha Chopde[1], V. S. Gonge[2] and Ommala Kuchanwar[3]

ABSTRACT

Present experiment was conducted at Main Garden, Department of Horticulture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *Rabi* season of the years 2008-09 and 2009-10, to study the effect of GA_3 (100 and 150 ppm) and NAA (200 and 300 ppm) spray at 30th and 60th day after planting on nutrient content and uptake by three gladiolus varieties viz., Phule Neelrekha, Phule Tejas and Phule Ganesh. The results revealed that, the maximum nitrogen and phosphorus content and uptake by the gladiolus plants were recorded with the variety Phule Tejas and $GA_3$150 ppm. However, the variety Phule Ganesh and treatment with $GA_3$150 ppm had registered the maximum potassium content and uptake by the plants.

Gladiolus (*Gladiolus grandiflorus* L.) is one of the most important cut flowers grown almost all over the world. It is a herbaceous, perennial, flowering bulbous plant. Gladiolus has earned tremendous popularity due to its attractive shades, varying sizes of flowers, brilliance of colour tones and long lasting flower life. Suitable variety for the region is one of the factors affecting the yield and quality of gladiolus spikes and corms. Plant growth regulators play an active role in influencing the physiology as well as chemical content of the plant, which in turn put forth many changes in plant growth, flowering and yield. Various research workers have reported that the application of growth regulators like gibberellic acid and naphthalene acetic acid influence nutrient content and uptake by the plant. Keeping this in view, the present study was undertaken to find out the variety of gladiolus and concentration of the growth regulators like GA_3 and NAA influencing the content and uptake of major nutrients like nitrogen, phosphorus and potassium.

MATERIAL AND METHODS

Present experiment was carried out at the Main Garden, Department of Horticulture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.) during *Rabi* season of the years 2008-09 and 2009-10. The experiment was laid out in split plot design with four replications and fifteen treatment combinations. The main factor comprised of three gladiolus varieties viz., Phule Neelrekha (V_1), Phule Tejas (V_2) and Phule Ganesh (V_3) and sub factor comprised of five foliar spraying treatments of plant growth regulators viz., P_1 – GA_3 100 ppm, P_2- GA_3 150 ppm, P_3 - NAA 200 ppm, P_4 – NAA 300 ppm and P_5 – control (water spray). The field was laid out with ridges and furrows spaced at 45 cm and planting of the uniform sized corms of gladiolus was done at 20 cm apart. Plant growth regulators were sprayed as per the treatments at 30th and 60th day after planting. For estimation of nitrogen, phosphorus and potassium content in gladiolus plants, composite sample of whole plant were taken after harvest and ground to powder as per treatments and then these were used for the chemical analysis. Nitrogen was estimated by Kjeldahl's method (Jackson, 1967), phosphorus was estimated by Vanado-molybdo phosphoric acid yellow colour method (di-acid extract) and potassium was estimated by using the flame photometer (Jackson, 1967). The total uptake of nitrogen, phosphorus and potassium by the gladiolus plants at the harvesting stage of corms was calculated by multiplying the dry matter production of crop with the corresponding values of nutrient content and were expressed in kg ha^{-1}. Two years data were pooled together and statistically analyzed.

RESULTS AND DISCUSSION

Content and uptake of nitrogen

The data from Table 1 revealed that, during the years 2008-09, 2009-10 and pooled result, the variety Phule Tejas was found to be significantly superior in respect of nitrogen content of the plant (2.19, 2.2. and 2.20 %, respectively) and it was found to be at par with the variety Phule Ganesh (2.16. 1.17 and 2.17 %, respectively). Similarly, total uptake of nitrogen was significantly maximum by the plants of the variety Phule Tejas (270.46, 278.25 and 274.36 kg ha^{-1}), however, significantly minimum uptake of nitrogen (211.97, 219.92 and 215.95 kg ha^{-1}) was registered with the variety Phule Neelrekha during the years 2008-09, 2009-10 and pooled result, respectively. The superior results in respect of uptake of nitrogen by the gladiolus plants of the variety Phule Tejas might be due to more dry matter produced by the plant which might have exhausted more quantum

1&3. Assistant Prof. and 2. Horticulturist, College of Agriculture, Nagpur

of nitrogen from the soil and also due to genetic makeup of the variety.

The effect of foliar application of growth regulators on nitrogen content of the gladiolus plant during both the years of experimentation and a pooled result was found to be non-significant. However, the total uptake of nitrogen by the gladiolus plant had recorded significantly maximum with the treatment of GA_3 150 ppm (265.05, 270.64 and 267.85 kg ha^{-1}, respectively) which was found to be at par with the treatment of GA_3 100 ppm. However, an uptake of nitrogen was minimum with the control treatment (220.81, 229.34 and 225.08 kg ha^{-1}, respectively) which was found to be at par with the foliar treatments of NAA 200 ppm and NAA 300 ppm during the years 2008-09, 2009-10 and pooled result. This might be due to the fact that the spraying of gibberellic acid might have increased the vigour of gladiolus plants due to enhanced cell elongation and faster cell division which might have enhanced an uptake of the nitrogen by the plants of gladiolus from the soil compared to NAA. The earlier research workers viz., Gowda *et. al.* (1990) in Jasminum sambac and Shah et al. (2006) in black cumin also reported enhanced nitrogen content and uptake due to the treatment of gibberellic acid. On the contrary, NAA at its higher concentration might have caused ethylene formation which is correlated with an inhibition of the plant growth instead of promoting the cell division (Krishnamurthy, 1981) and this might have reduced the content and total uptake of nutrients by the plants.

Content and uptake of phosphorus

The data from Table 2 indicated that, the variety Phule Tejas was found to be significantly superior in respect of phosphorus content of gladiolus plant (0.360, 0.364 and 0.362 %) and it was found to be at par with the variety Phule Ganesh (0.348, 0.351 and 0.350 %). Similarly, total uptake of phosphorus was significantly the maximum by the variety Phule Tejas (44.68, 46.04 and 45.36 kg ha^{-1}) and it was followed by the variety Phule Ganesh (39.41, 40.46 and 39.94 kg ha^{-1}) during both the years and pooled result, respectively. The variations in content and total uptake of phosphorus by different varieties of gladiolus might be attributed due to difference in genetic composition of the varieties that responded differently to the environment.

The data presented in Table 2 revealed that an effect of foliar spraying treatments of the plant growth

Table 1. Effect of varieties and growth regulators on nitrogen content (%) & uptake by gladiolus plant (kgha^{-1})

Treatments	Nitrogen content (%)			Total uptake of nitrogen(kg ha^{-1})		
	2008-09	2009-10	Pooled	2008-09	2009-10	Pooled
Main factor – Varieties (V)						
V_1 – Phule Neelrekha	2.09	2.09	2.09	211.97	219.92	215.95
V_2 – Phule Tejas	2.19	2.20	2.20	270.46	278.25	274.36
V_3 – Phule Ganesh	2.16	2.17	2.17	243.17	251.27	247.22
'F' test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE(m)$\pm$	0.02	0.02	0.02	3.98	3.87	3.55
CD at 5%	0.06	0.05	0.06	12.55	12.20	12.29
Sub factor – Plant growth regulator sprayings (P)						
P_1 – GA_3 100 ppm	2.16	2.16	2.16	252.95	259.49	256.22
P_2– GA_3 150 ppm	2.17	2.17	2.17	265.05	270.64	267.85
P_3 – NAA 200 ppm	2.14	2.16	2.15	236.62	244.47	240.54
P_4 – NAA 300 ppm	2.13	2.14	2.14	233.89	245.12	239.51
P_5 – Control (Water spray)	2.12	2.13	2.13	220.81	229.34	225.08
'F' test	NS	NS	NS	Sig.	Sig.	Sig.
SE(m)$\pm$	0.03	0.03	0.02	8.65	9.59	8.42
CD at 5%	-	-	-	24.81	27.51	24.14
Interaction effect (V X P)						
'F' test	NS	NS	NS	NS	NS	NS
SE(m)$\pm$	0.06	0.05	0.04	14.98	16.61	14.58
CD at 5%	-	-	-	-	-	-

regulators on phosphorus content of the gladiolus plant was found to be non-significant for both the years of experimentation and for pooled result too. Total uptake of phosphorus due to the gladiolus plant was observed to be significantly the maximum with the plants treated with GA_3 150 ppm (42.43, 43.80 and 43.11 kg ha^{-1}, respectively) and it was found to be at par with the treatment of GA_3 100 ppm, however, significantly minimum uptake of phosphorus was registered under the control treatment (34.61, 35.86 and 35.24 kg ha^{-1}, respectively) which was found to be at par with the treatments of NAA 200 ppm and NAA 300 ppm during both the years and pooled result. An increased status of phosphorus in response to the foliar application of gibberellic acid might be either due to the higher uptake of the nutrient from the soil or the hormonal directed nutrients transport. Goyal and Gupta (1994) also noted that, the phosphorus content of the leaves was the maximum due to application of gibberellic acid in roses.

Content and uptake of potassium

The data presented in Table 3 exhibited that amongst the varieties of gladiolus during the years 2008-09, 2009-10 and pooled result, the variety Phule Ganesh had recorded significantly the maximum potassium content (1.83, 1.92 and 1.87 %, respectively) in the plant which was found to be at par with the variety Phule Neelrekha (1.79, 1.89 and 1.84 %, respectively). However, total uptake of potassium was found significantly maximum by the variety Phule Ganesh (205.87, 222.57 and 214.19 kg ha^{-1}, respectively) and it was found to be at par with the variety Phule Tejas (205.81, 220.67 and 213.27 kg ha^{-1}, respectively). The plants of the variety Phule Ganesh might have absorbed more quantum of potassium from the soil and produced overall better plant growth resulting into more dry matter production by the plant as compared to other varieties.

An effect of foliar spraying of the growth regulators on potassium content of the gladiolus plants was found to be non-significant for both the years of experimentation and for pooled result too. The total uptake of potassium by the plant was recorded to be significantly maximum with the treatment of GA_3 150 ppm (218.07, 233.36 and 225.72 kg ha^{-1}, respectively) and it was found to be at par with the treatment of GA_3 100 ppm, however, total uptake of potassium was minimum with the control treatment (178.29, 192.75 and 185.52 kg

Table 2. Effect of varieties and growth regulators on phosphorus content (%) and uptake by the gladiolus plant (kg ha^{-1})

Treatment	Phosphorus content (%)			Total uptake of Phosphorus(kg ha^{-1})		
	2008-09	2009-10	Pooled	2008-09	2009-10	Pooled
Main factor – Varieties (V)						
V_1 – Phule Neelrekha	0.313	0.315	0.314	31.60	33.13	32.37
V_2 – Phule Tejas	0.360	0.364	0.362	44.68	46.04	45.36
V_3 – Phule Ganesh	0.348	0.351	0.350	39.41	40.46	39.94
'F' test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE (m)$\pm$	0.006	0.005	0.004	1.16	0.62	1.35
CD at 5%	0.02	0.02	0.01	3.67	1.94	4.66
Sub factor – Plant growth regulator (P)						
P_1 – GA_3 100 ppm	0.343	0.344	0.344	40.32	41.28	40.80
P_2– GA_3 150 ppm	0.348	0.351	0.349	42.43	43.80	43.11
P_3 – NAA 200 ppm	0.340	0.343	0.341	37.82	39.20	38.51
P_4 – NAA 300 ppm	0.340	0.342	0.341	37.63	40.24	38.94
P_5 – Control (Water spray)	0.330	0.334	0.332	34.61	35.86	35.24
'F' test	NS	NS	NS	Sig.	Sig.	Sig.
SE (m)$\pm$	0.01	0.01	0.01	1.80	1.77	1.34
CD at 5%	-	-	-	5.15	5.07	3.86
Interaction effect (V X P)						
'F' test	NS	NS	NS	NS	NS	NS
SE (m)$\pm$	0.02	0.02	0.01	3.11	3.06	2.33
CD at 5%	-	-	-	-	-	-

Table 3. Effect of varieties and growth regulators on potassium content (%) and uptake by the gladiolus plant (kg ha^{-1})

Treatment	Potassium content (%)			Total uptake of potassium(kg ha^{-1})		
	2008-09	2009-10	Pooled	2008-09	2009-10	Pooled
Main factor – Varieties (V)						
V_1 – Phule Neelrekha	1.79	1.89	1.84	180.85	198.82	189.83
V_2 – Phule Tejas	1.67	1.74	1.70	205.81	220.67	213.27
V_3 – Phule Ganesh	1.83	1.92	1.87	205.87	222.57	214.19
'F' test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE (m)$\pm$	0.02	0.03	0.016	4.82	2.52	3.54
CD at 5%	0.06	0.08	0.06	14.17	7.92	12.23
Sub factor – Plant growth regulator (P)						
P_1 – GA_3 100 ppm	1.77	1.86	1.82	206.21	222.52	214.36
P_2 – GA_3 150 ppm	1.80	1.88	1.84	218.07	233.36	225.72
P_3 – NAA 200 ppm	1.77	1.85	1.81	192.67	210.72	201.70
P_4 – NAA 300 ppm	1.76	1.81	1.79	192.32	210.76	201.54
P_5 – Control (Water spray)	1.72	1.77	1.75	178.29	192.75	185.52
'F' test	NS	NS	NS	Sig.	Sig.	Sig.
SE (m)$\pm$	0.05	0.05	0.04	7.75	8.83	7.10
CD at 5%	-	-	-	22.21	25.32	20.36
Interaction effect (V X P)						
'F' test	NS	NS	NS	NS	NS	NS
SE (m)$\pm$	0.09	0.08	0.06	13.42	15.29	12.30
CD at 5%	-	-	-	-	-	-

ha^{-1}, respectively) during the years 2008-09, 2009-10 and pooled result. Birbal et al. (2008) on the basis of two years experimentation also noted that, an application of gibberellic acid recorded the maximum total nutrient uptake viz. nitrogen, phosphorus and potassium than the other growth regulator treatments in potato.

However, an interaction effect of the varieties and the plant growth regulator treatments on nitrogen, phosphorus and potassium uptake was found to be non-significant for both the years of experimentation and for pooled result too. Overall, it may be concluded that the variety Phule Tejas and foliar treatment with GA_3 150 ppm comparatively had maximum nutrient content (NP) and uptake, while, for potassium content and uptake variety Phule Ganesh with GA_3 150 ppm was better.

LITERATURE CITED

Birbal, Vinod Kumar and R.K. Singh, 2008. Quality and nutrient uptake of potato (*Solanum tuberosum* L.) cv. Kufri Chipsona-1 as influenced by varying fertility levels, bio-fertilizers and plant growth regulators, International J. Trop. Agric., 26: (1-2):45-48.

Gowda, J.V.N., Venkate Gowda, Nage Gowda and A.A. Farooqi, 1990. Effect of growth regulators on growth, flowering and composition in gundumallige (Jasminum sambac Ait), Proceedings of the 11th International congress of essential oils, fragrances and flavours, New Delhi, India,12-16 November, 1989 : 105-112.

Goyal, R.K. and A.K. Gupta, 1994. Effect of growth regulators on nutritional status, anthocynin content and vase life of rose cv. Superstar, Harayana J. Hort. Sci., 23(2):118-121.

Jackson, M.L., 1967. Soil Chemical Analysis. New Dehli, Prentice Hall of India Pvt. Ltd.: 498.

Krishnamurthy, H.N., 1981. Plant Growth Substances - Including Applications in Agriculture, New Delhi, Tata McGraw- Hill Publishing Co.Ltd.

Shah, S.H., I. Ahmad and Samiullah, 2006. Effect of gibberellic acid spray on growth, nutrient uptake and yield attributes during various growth stages of black cumin (*Nigella sativa* L.), Asian J. Plant Sci., 5(5):881-884.

❖ ❖ ❖

PKV Res. J. Vol. 36 (2), July 2012

Effect of Foliar Application of Napthalene Acetic Acid and Micronutrients on Yield and Quality of Mango CV. Ratna

Priya Gawande, B. N. Shinde and U. B. Deshmukh

ABSTRACT

A field experiment was conducted to find out the effect of foliar application of Napthalene acetic acid and micronutrients on yield and quality of mango cv. Ratna at Paralgaon under Parbhani condition during the year 2009-10. The aqueous solution of 50 and 100 ppm Naphthalene acetic acid and commercial grade micronutrient mixture 0.5 per cent and 1.0 per cent alone as well as in combination was sprayed during third week of December and third week of February. The treatment NAA 50 ppm + Micronutrients 0.5 per cent significantly increased yield i.e. (98.93 kg $tree^{-1}$). These treatments also improved quality significantly as compared to control.

Mango is the most popular and favorite fruit of India and is relished by people because of its attractive appearance, pleasant aroma and delicious taste. Amongst various varieties grown in India, Ratna is considered as choicest variety owing to wide adaptability and excellent fruit quality regular bearer and free from spongy tissue disorder. However, it is prone to immature fruit drop and poor fruiting due to abscission layer formation across the pedicel which affect the fruit yield.

Deficiency symptoms of Zn , Mn and B has been observed in the mango cultivar (Agarwal *et. al.*, 1988). Deficiency of micronutrients generally shown abnormal symptoms. Zn deficiency causes vegetative and reproductive growth with short internodal length and rosette leaves, Fe causes bleaching symptoms, cracking of fruit is the characteristic symptoms of B deficiency, brown area in pulp is conspicuaus (Anonymous, 2009). The favorable effect of micronutrients was attributed to the fact that Zinc is essential in nitrogen metabolism (Asana *et al*. 1971) and it also increases the synthesis of auxin which promotes the cell size (Agarwal and Sharma 1978) like wise beneficial effect of boron in increasing the fruit size was perhaps due to increased cell division and elongation according to Rajput and Chand (1976). Magnesium being the metallic constituent of chlorophyll is directly involved in the process of photosynthesis besides regulating the uptake of other nutrients (Willstates, 1960).

In view of this, studies were made to evaluate the influence of foliar spray of NAA and micronutrients on yield and quality parameters of mango.

The experiment was conducted on twenty years old Ratna mango trees, located at Paralgavan under Parbhani condition during 2009-10. The experiment was laid out in Randomized Block Design with nine treatments and replicated thrice. The micronutrients used for the experiment was commercial grade micronutrient mixture and trade name was micnelf. The composition of micronutrient mixture was analyzed in laboratory as Fe-2.5%,Zn-3.0%,Mo-0.1%,Mn-1%,Cu-1%,B-0.5%. NAA weight on an electrical balance, NAA @50 mg per liter and 100 mg per liter of water was taken to make 50 ppm and 100 ppm concentration, respectively. NAA was firstly dissolved in a little amount of alcohol and finally in water. To required concentration of micronutrients 5 g. per liter and 10 g. per liter were dissolved 0.5 and 1.0 per cent concentration of micronutrients, respectively. Aqueous solution of different treatments, alone as well as in combination treatments was sprayed during third week of December at flower emerging stage and third week of February at pea size stage of fruit. Yield of fruit per plant was recorded on the basis of weight of total fruit harvested. The TSS was recorded by using hand refractometer in ^{0}Brix. Titratable acidity was determined by titration against N/10 sodium hydroxide, using phenolphthalene indicator. Weight of pulp, stone and peel was expressed in percent, and diameter of fruit was measured by using vernier caliper in cm.

Result shown in Table 1 revealed that different concentrations of NAA and micronutrients treatments significantly influenced the fruit weight. Maximum fruit weight (312.67 g) was recorded with NAA 50 ppm + micronutrients 0.5 per cent which was significantly superior over all other treatments, while minimum fruit

1& 3. P.G. Student and 2. Associate Prof., Department of Horticulture, MAU, Parbhani

Table 1. Effect of foliar application of NAA and micronutrients on yield and quality of mango. cv. Ratna

Tr. No.	Treatment	Fruit weight (g)	Volume (ml)	Per cent pulp (mesocarp)	Diameter of fruit (cm)	Per cent peel (exocarp)	Per cent stone (endocarp)	TSS (%)	Acidity (%)	Yield (kg tree^{-1})
T_1	NAA 50 ppm	268.32	262.30	68.45	7.30	16.21	15.32	20.66	0.217	80.27
T_2	NAA 100 ppm	265.85	256.39	67.43	7.21	16.80	15.75	20.33	0.227	77.32
T_3	Micronutrients 0.5 %	259.45	251.18	66.18	7.10	17.30	16.49	20.97	0.210	74.05
T_4	Micronutrients 1.0%	250.18	239.00	64.51	7.06	18.08	17.18	20.57	0.220	72.00
T_5	NAA 50 ppm + micronutrients 0.5%	312.67	308.00	74.24	7.94	13.19	12.55	22.19	0.179	98.93
T_6	NAA 50 ppm + micronutrients 1.0%	290.79	285.67	70.99	7.89	14.50	13.81	21.97	0.193	95.41
T_7	NAA 100 ppm + micronutrients 0.5%	284.87	281.34	70.66	7.68	15.01	14.31	21.73	0.201	90.00
T_8	NAA 100 ppm + micronutrients 1.0%	278.17	272.00	69.61	7.41	15.59	14.78	21.41	0.218	86.73
T_9	Control	244.83	240.50	62.07	6.65	19.12	18.42	19.10	0.249	68.10
	SE (m) ±	1.52	1.45	0.48	0.07	0.58	0.30	0.10	0.010	3.14
	CD at 5%	4.57	4.34	1.44	0.20	1.76	0.91	0.32	0.032	9.42

weight (244.83 g) was recorded under control. This increase in fruit weight might be due to property of auxin to stimulate cell division, cell elongation and cell enlargement and greater accumulation of sugar and water in expanded cell (Pandey and Sinha, 1999).The results are inconformity with the observations recorded by (Dhinesh Babu *et al*. 2007, Veera and Das 1971, Kachave, 2004).

The maximum volume of fruit (308 ml) and diameter (7.94 cm) was recorded when (T5) NAA 50 ppm + micronutrients 0.5 per cent was applied where as minimum volume (240.50 ml) and diameter (6.65 cm) was observed under (T9) control. The results are in agreement with the findings of (Gupta and Bramhachari, 2004; Dhinesh Babu *et al*., 2007) in mango and kinnow mandarin respectively.

Application of NAA and micronutrients at different concentrations and their combinations had significant effect al TSS and titratable acidity. Highest total soluble solids was found in treatment (T5) NAA 50 ppm + micronutrients 0.5 per cent (21.97%). The increase in TSS may be account to the hydrolysis of polysacharides. Conversion of organic acids in to soluble sugars and enhanced solubilizations of insoluble starch and pectin present in the cell wall and middle lamella. Regarding titratable acidity, highest acidity was found in (T9) control (0.24 %) and lowest acidity was found in NAA 50 ppm + micronutrients 0.5 per cent (0.17 %). The deletion in organic acids could be due to fast conversion of acids in to sugars and their derivatives or their utilization in respiration or both. These findings are also in accordance to results obtained (Singh *et al*., 2007) in aonla.

The maximum mesocarp per cent was noticed in NAA 50 ppm + micronutrients 0.5 per cent (74.24 %). In case of per cent endocarp smallest stone (12.55 %) was seen in (T5) NAA 50 ppm + micronutrients 0.5 per cent and largest (18.42 %) in control. when deal with NAA 50 ppm + micronutrients 0.5 per cent showed minimum exocarp observed in (T9)control (19.12 %).

Foliar application of boric acid at bud swelling stage resulted in the promotion of vegetative growth, fruit weight and pulp weight all possibly due to the promoting effect of boron on cell division and elongation process.

The application of B resulted in a increased proportion of hermaphrodite flower and improved fruit retention due to maintenance of physiological concentration of auxin in the plant tissue Auxins are reported to be involved with the boron requirements of plant (Pilbean and Kirkby, 1983). The results are in conformity with those of (Singh and Rajput, 1976, Gupta and Bramhachari, 2004).

Yield is a complex character which depends on yield contributing characters. In the present investigation it was found that the treatments of growth regulating chemicals were more effective in increasing the fruit production mainly through increase in fruit number. Significantly the highest number of fruit per tree and yield per tree was produced by NAA 50 ppm + micronutrients 0.5 per cent (98.93kg tree^{-1}) while the lowest yield tree^{-1} (68.10 kg tree^{-1}) was found in case of control.

Thus, the results clearly indicated that the immature fruit drop down due to abscission layer formation across pedicel besides external factors like heat, water, mineralize supply, diseases and pests. The positive effect of on yield was due to their favorable influence on yield attributing characters like increase in fruit retention size and weight of individual fruit. These results are in close conformity with those of (Gilani, *et al*., 1989, Shinde *et al*. 2006 and Singh and Rethy, 1996) in Kinnow mandarin, mango and kagzi lime, respectively.

LITERATURE CITED

Agarwal, S.C., B.D. Nautiya, F. Chatterjee and C.P. Sharma, 1988. Manganese, Zinc, and Boron deficiency in mango Scientia Horti., 35 (1-3) : 99-107.

Agarwal, S.C., C.P. Sharma, 1978. Plant nutrients their functions and uptake. Soil fertility theory and practices, ICAR, New Delhi : 26-32.

Annonymous, 2009. Nutritional requirement in mango, www.Ikisan.com.

Asana, R.D., R.D.Sarin and M.N. Saxena, 1971. Handbook of manures and fertilizers, ICAR New Delhi : 164-194.

Dhinesh Babu K., A.K. Dubey and D.S. Yadav, 2007. Effect of micronutrients on enhancing the productivity and quality of Kinnow mandarin, Indian J. of Horti., 64(3) : 353-356.

Gilani, A.H. Yusuf, Ali, M.A. Tariq and Faqir Mohammad, 1989. Studies on the effect of growth regulators and chemical fertilizers on the growth and yield in Kinnow mandarin (*Citrus reticulate* Blanco), Sarhad J. of Agriculture. 5(1):47-51.

Gupta, R. and V. S. Bramhachari, 2004. Effect of foliar application of urea ,potassium nitrate and NAA on fruit retention, yield and quality of mango cv. Bombai, The Orissa J. Hort., 31: 2.

Kachave, D.B., 2004. Effect of growth regulators and micronutrients on yield and quality of Kagzi lime *(Citrus aurantifolia* swingal), Ph.D. Thesis (Unpub), M.A.U; Parbhani.

Pandey, S.N. and B.K. Sinha, 1999. Plant Physiology. Vikas Publication House Pvt. Ltd., New Delhi : 438.

Pilbean, D.J. and E.A., Kirkby, 1983. The physiological role of boron in plants. J. Plant Nutrition 6: 563-582.

Rajput, C., B.S and S. Chand, 1976. Effect of boron and zinc on the Physico -chemical composition of guava *{Psidium guava* L.) fruits, J. Nation ofAgril. Soc. Cylon, 13:49-54.

Shinde, A.K., B. P. Patil, K.H. Pujari, B.Jadhav; A.B. Chandelkar and M. Khandalkar, 2006. Investigation on the control of fruit drop in Alphanso mango, Indian J. Plant Physiol., 11.

Singh B., and P. Rethy, 1996. Effect of certain micronutrients and NAA on yield of Kagzilime (*Citrus aurantifolia* swingal), Advances in Horticulture and Forestry 5:43-49

Singh, J.K. J. Prasad and H.K. Singh, 2007. Effect of micronutrients and plant growth regulators on yield and physicochemical characteristics of Aonla fruit in cv. Narendra Aonla -10, Indian J. Hort., 64(2): 216-218

Singh P.N. and C.B.S. Rajput, 1976. Effect of various concentrations of Zinc on vegetative growth character, flowering fruiting and physic-chemical composition of mango fruit mango cv. Chausa, Haryana J. Horti. Sci. 145(1-2): 10-14.

Veera, S.S. and R.C. Das, 1971. Effect of growth regulators on development and quality of fruit in mango *(Mangifera indica* L.) South Indian Horti., 19 (l-4) : 29-35.

Willstates, R., 1960. Zur kenntiss der zusamen set zung der, Warophys. Ann. Chem., 350: 40-82.

❖ ❖ ❖

PKV Res. J. Vol. 36 (2), July 2012

Estimation of Reference Evapotranspiration Using Artificial Neural Networks

M. M. Deshmukh[1] and M. K. Awasthi[2]

ABSTRACT

Accurate estimation of reference crop evapotranspiration (ETo) is of paramount importance in water resources planning. ETo depends on several interacting climatological factors. Artificial Neural Networks (ANN) is effective tool and universal approximators to model complex and nonlinear process like ETo. The multilayer back propagation feed forward neural networks were developed for estimating ETo at Akola having semi-arid climate, using different ANN model strategies with different input combinations, as ANN1 (Tmax, Tmin), ANN2 (Tmax, Tmin, SH), ANN3 (Tmax, Tmin, RHmax, RHmin), ANN4 (Tmax, Tmin, RHmax, RHmin, SH), and ANN5 (Tmax, Tmin, RHmax, RHmin, SH, WS). During ANN model validation using independent evaluation data set of the same location, mean absolute error (MAE), mean absolute relative error (MARE), root mean square error (RMSE), correlation coefficient (r), determination coefficient (R2), index of agreement (D) and model efficiency (E) were found to be good enough for all network models and showed that ANN1 to ANN5 models are suitable and can be used for estimation of ETo, according to the availability of data. However, Akola ANN5 model ranked first, followed by ANN2, ANN4, ANN3 and ANN1 models. Akola ANN5 model provided accurate estimation of ETo with 0.2247 mm day-1 RMSE and 0.9849 model efficiency and followed by Akola ANN2 model with 0.3628 mm day-1 RMSE and 0.9608 model efficiency.

Evapotranspiration is an important component of the hydrologic cycle, which continues to be of foremost importance in water resources planning and management. Thus, its accurate estimation is of paramount importance in a wide array of problems in hydrology, agronomy, forestry and land resources planning.

A common practice for estimating crop evapotranspiration (ETc) is to first estimate reference crop evapotranspiration i.e. grass reference evapotranspiration (ETo), from a standard surface and to then apply an appropriate empirical crop coefficient. ETo can be either measured with a lysimeter or water balance approach, or estimated from climatological data. However, it is not always possible to measure ETo. Thus, indirect methods based on climatological data are used for ETo estimation. Numerous researchers have analyzed the performance of various calculation methods for different locations. The FAO Penman-Monteith method is now recommended as the sole standard method for the definition and computation of the reference evapotranspiration, as the method provides consistent ETo values in all regions and climates (Allen *et al*., 1998; Jensen *et al*., 1990; Kashyap and Panda, 2001).

ETo values obtained using Penman-Monteith equation is used as reference values to develop different models and also to evaluate the performance of different models (Kisi, 2006; Landeras, *et al*., 2008). The main difficulty in ETo estimation with this method is the requirement of large number of meteorological parameters that are not easily available and this is the most important drawback of this equation. In many places, limited meteorological information is available. Hence, other methods though less accurate and location specific, continue to remain popular among researchers either because of traditional usage or due to shortage of input data. However, ETo is a complex and nonlinear phenomenon because it depends on several interacting climatological factors.

Such difficulty can be overcome by application of Artificial Neural Networks (ANN). ANN is a mathematical construct whose architecture is essentially analogous to the human brain. Basically, the highly interconnected processing elements, arranged in layers are similar to the arrangement of neurons in the brain. Recently, artificial neural networks have been applied in meteorological and agro ecological modelling. ANNs are effective tools to model nonlinear systems, pattern recognition and classification problems. One significant advantage of the ANN models over other classes of nonlinear model is that ANNs are universal approximators, which can approximate a large class of functions with a high degree of accuracy (Kumar *et al*., 2002; Sudheer *et al*., 2003; Trajkovic, 2005; Zanetti *et al*., 2007; Landeras, *et al*., 2008). The model may require significantly less input data than a similar conventional mathematical model. Thus ANN approach may prove to

1. Associate Professor, Department of Irrigation & Drainage Engg., Dr.PDKV, Akola and 2. Associate Professor, Department of Soil & Water Engg., JNKVV, Jabalpur

be an effective and efficient way to model the reference evapotranspiration under the conditions of availability of data on limited weather parameters.

MATERIAL AND METHODS

Mean weekly meteorological data, viz. maximum temperature (Tmax), minimum temperature (Tmin), maximum relative humidity (RHmax), minimum relative humidity (RHmin), bright sunshine duration (SH) and wind speed (WS) were obtained from Agricultural Meteorological Observatory, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola for a period of 30 years (1978-2007). Akola comes under semi arid eco region.

The mean weekly ETo was estimated using Penman-Monteith (FAO-56) method, as measured data on ETo was not available at the station. The methodology suggested in FAO-56 was used for estimation of each parameter of equation (Allen et al., 1998). The FAO-56 Penman-Monteith (PM) model is expressed as:

$$ET_o = \frac{0.408\Delta(R_n - G) + \gamma\left(\frac{900}{T+273}\right)u_2(e_s - e_a)}{\Delta + \gamma(1 + 0.34u_2)} \quad \ldots(1)$$

Modelling using Artificial Neural Networks

The multilayer back propagation feed forward neural networks were trained to estimate the ETo based on various combinations of climatological parameters as input, to evaluate the degree of dependence of these parameters. Thus number of neurons in input layer corresponded to number of input climatological parameters considered in the respective combination, whereas output layer node corresponded to ETo estimated by Penman-Monteith equation. Summary of the inputs used for the implementation of each ANN model strategy for estimation of ETo is as given in Table 1.

Table1: Summary of inputs used for the implementation of ANNs

ANN1	ANN2	ANN3	ANN4	ANN5
Tmax	Tmax	Tmax	Tmax	Tmax
Tmin	Tmin	Tmin	Tmin	Tmin
	SH	RHmax	RHmax	RHmax
		RHmin	RHmin	RHmin
			SH	SH
				WS

Thus, five feed forward neural networks were developed for Akola, to estimate the ETo. Available data were divided into a model development set (1978-2005 i.e. 28 years) and an independent evaluation data set (2006-2007 i.e. 2 years). The source code programme was developed and analysis was carried out using MATLAB software. Data files were loaded into workspace. The data were then randomized and normalized in order to train the network. The model development data set was further divided into three subsets; training, cross validation and testing in 60:20:20 proportions. The first subset was the training set, which was used for computing and updating the network weights and biases. The second subset was the cross validation set. The error on the validation set was monitored during the training process. When the validation error increases for a specified number of iterations, the training was stopped, and the weights and biases at the minimum of the validation error were returned. The test set was not used during the training, but it was used to compare different models and to plot the test set error during the training process.

The most common architecture; composed of the input layer, the hidden layer and the output layer; was used in this study with back-propagation algorithm. In order to train the network the Levenberg-Marquardt algorithm (trainlm) was used, because on function approximation problems the Levenberg-Marquardt algorithm have the fastest convergence and obtain lower mean square errors (Kisi, 2007). The network was trained for 5000 epochs and with goal for mean squared error of 0.001. The number of neurons in the input and output layers were fixed as per given combination. The numbers of neurons in the hidden layer were varied up to three times of number of neurons in input layer, in order to get the minimum mean square error (m.s.e) and high correlation coefficient. The number of iterations when the training stopped and errors were noted down.

In the next step the network response was analyzed. For this purpose the network outputs were unnormalized and a linear regression between the network outputs and corresponding targets for test data set was carried out. Mean squared error variation with respect to number of neurons in hidden layer was plotted to select the best model. Then the trained network was used for predicting the ETo for the years 2006 and 2007.

Performance evaluation of ANN models

Each developed model was evaluated for estimation of ETo using independent evaluation data set of Akola. The estimated values from each model were compared to the target values. The variation of the ANN predicted and target data were presented graphically. Statistical analysis of data has been carried out. For scientific sound model evaluation a combination of different efficiency criteria complemented by the assessment of the squared, absolute or relative error was used. Finally the comparisons have been made between different ANNs developed under study using performance criteria and error statistics.

RESULTS AND DISCUSSION

Model development

For each of input combination (i.e. ANN1, ANN2, ANN3, ANN4, and ANN5 model strategies) the best architecture of network was selected on the basis of mean square error of training data set obtained during training phase of different architectures. The data in respect of mean square error for training set, correlation coefficient for test set, number of epochs required; for different architectures tried in each model strategy are presented in Tables 2 to 6. Similarly, for the best architecture, the scatter plot between target and ANN predicted values for test data set obtained during training phase is presented in Fig. 1 for each model strategy.

Table 2: Architectures of Neural Networks with their performance indices obtained during training phase of ANN1

S.N.	Architecture	Number of epochs	Training set Mean Square Error	Correlation coefficient for test set
1	2-1-1	41	0.109472	0.9383
2	2-2-1	24	0.108739	0.9387
3	2-3-1	18	0.109479	0.9380
4	2-4-1	15	0.109677	0.9379
5	2-5-1	25	0.108514	0.9385
6	2-6-1	13	0.108445	0.9393

Table 3: Architectures of Neural Networks with their performance indices obtained during training phase of ANN2

S.N.	Architecture	Number of epochs	Training set Mean Square Error	Correlation coefficient for test set
1	3-1-1	44	0.0847014	0.9525
2	3-2-1	20	0.0752135	0.9536
3	3-3-1	84	0.0719701	0.9528
4	3-4-1	13	0.0817052	0.9542
5	3-5-1	32	0.0748492	0.9536
6	3-6-1	26	0.0725439	0.9539
7	3-7-1	35	0.0744307	0.9548
8	3-8-1	12	0.0737992	0.9533
9	3-9-1	18	0.0851605	0.9523

Table 6: Architectures of Neural Networks with their performance indices obtained during training phase of ANN5

S.N.	Architecture	Number of epochs	Training set Mean Square Error	Correlation coefficient for test set
1	6-1-1	5	1.0358000	-0.5636
2	6-2-1	41	0.0032487	0.9983
3	6-3-1	46	0.0033579	0.9983
4	6-4-1	69	0.0028205	0.9985
5	6-5-1	79	0.0032619	0.9980
6	6-6-1	64	0.0031516	0.9982
7	6-7-1	129	0.0023222	0.9987
8	6-8-1	44	0.0034350	0.9983
9	6-9-1	55	0.0030251	0.9985
10	6-10-1	71	0.0033045	0.9982
11	6-11-1	45	0.0032697	0.9981
12	6-12-1	104	0.0026324	0.9982
13	6-13-1	54	0.0026980	0.9986
14	6-14-1	75	0.0029940	0.9984
15	6-15-1	64	0.0028835	0.9984
16	6-16-1	67	0.0030121	0.9985
17	6-17-1	51	0.0027871	0.9978
18	6-18-1	65	0.0028418	0.9983

It is observed from the Table 2 for ANN1 model having only two input parameters (Tmax, Tmin), that the 2-6-1 architecture (2, 6 and 1 nodes in input, hidden and output layer respectively) was enough for training the network as it gave lowest error and highest correlation coefficient. It is also observed that lowest mean square error was obtained when number of neurons in hidden layer was six. Hence scatter plot of test data set for this architecture was obtained (Fig. 1 ANN1), representing that the regression line was close to 1:1 line, which indicates the closeness of the target and predicted values. It is seen that network underestimated the ETo at higher rates, as line is slightly deviated from 1:1 line at higher rates of ETo. The standard error of estimate was low and significant correlation (0.9393) was observed between target and predicted values of test set. Therefore, for ANN1 model strategy, the model with 2-6-1 architecture was selected for evaluating its performance using independent evaluation data set i.e. for validation.

Similarly, it is observed from the Table 3 for ANN2 model, which was having three input parameters (i.e. Tmax, Tmin, SH), that the 3-3-1 architecture was enough for training the network as it gave lowest error. The scatter plot of test data set for this architecture was obtained (Fig.1 ANN2), representing the closeness of the target and predicted values. Hence, in ANN2 model strategy, the model with 3-3-1 architecture was selected for validation.

In case of ANN3 model strategy, which was composed of four input parameters (i.e. Tmax, Tmin, RHmax, Rhmin), architecture of 4-4-1 was found best (Table 4). The lowest mean square error was obtained when number of neurons in hidden layer was four. It is also seen from Fig. 1 (ANN3) that regression line was more close to 1:1 line, which indicates the closeness of the target and predicted values for test set. The standard error of estimate was low. Therefore, in ANN3 model strategy, the model with 4-4-1 architecture was selected for further evaluation.

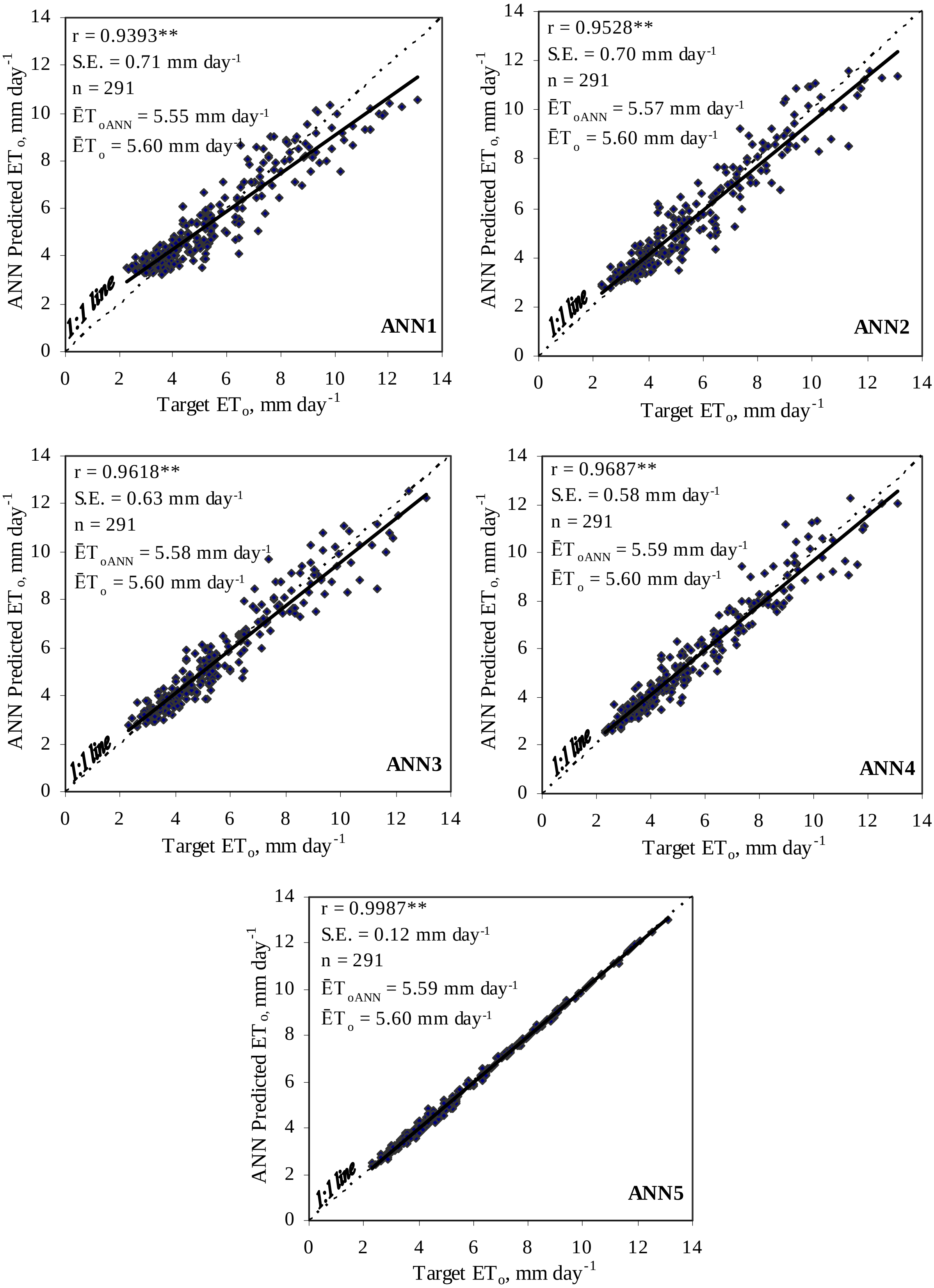


Fig. 1: Scatter plot between target and ANN predicted ET_o values for test data set obtained during training phase of different ANNs

In case of ANN4 model strategy, having five input parameters (i.e. Tmax, Tmin, RHmax, Rhmin, SH), the lowest mean square error was obtained in respect of 5-11-1 architecture (Table 5), with high the correlation coefficient between network output and target for test set data. Results indicate that lowest mean square error was observed when number of neurons in hidden layer was eleven. Similarly regression line was more close to 1:1 line, which indicates the closeness of the target and predicted values (Fig. 1 ANN4). Therefore, in ANN4 model strategy, the model with 5-11-1 architecture was selected for further evaluation.

However, in respect of ANN5 model strategy, having input vector of all six input parameters (i.e. Tmax, Tmin, RHmax, Rhmin, SH, WS), the lowest mean square error was obtained for 6-7-1 architecture (Table 6). It was confirmed that lowest mean square error was obtained when number of neurons in hidden layer was seven. The scatter plot of test data set for this architecture was obtained and it indicates that regression line coincides with 1:1 line, i.e. exact fit of the target and predicted values (Fig. 1 ANN5)). Therefore, for ANN5 model strategy, the model with 6-7-1 architecture was selected for evaluation using independent evaluation data set.

Model evaluation

ANN1, ANN2, ANN3, ANN4, ANN5 models developed were used for prediction of ETo, using only inputs from independent evaluation data set of Akola. The predicted rates of ETo were then compared with the target values of ETo. The variation and scatter plot between target and predicted ETo using ANN models are presented in Fig. 2 and 3. Different performance indices are presented in Table 7.

Performance of ANN1 model is shown in Fig. 2 & 3 (ANN1). The errors statistics were obtained to be low enough with good performance indices. Results of ANN1 model suggest that it can approximate the function of temperatures to estimate ETo and is suitable for fairly accurate estimation of ETo (Zanetti, 2007; Sudheer et al., 2003) under the conditions of availability of temperature data only, which can easily be obtained in any class of meteorological observatory.

Similarly, the performance of ANN2 is represented in Fig. 2 & 3 (ANN2). ANN2 model has accurately estimated ETo throughout the year. The regression line almost coincide the 1:1 line, with low standard error of estimate. The errors statistics were found to be very low with high efficiency indices. The results of ANN2 model indicate that even with only air temperature and sunshine duration data, it is possible to predict ETo with high degree of accuracy (Kisi, 2007) and ANN2 model is suitable for estimation of ETo at Akola having semi-arid climates.

The performance of ANN3 model is depicted in Fig. 2 & 3 (ANN3). ANN3 model predicts fairly accurate estimates of ETo for the most of periods of year. Model underestimated ETo only during premonsoon season, when ETo rates were very high. Low errors statistics were obtained and good model efficiency were observed. These results of ANN3 model indicate that ANN3 model is suitable for prediction of ETo with fair accuracy, where weather data only on air temperatures and relative humidity are available.

Fig. 2 & 3 (ANN4) shows the performance of ANN4 model. The results of ANN4 model indicate that it can approximate the prediction function of ETo without wind speed as input, in relation to full set of inputs of Penman-Monteith model. It is possible to predict ETo with high accuracy. It can be inferred from results that ANN4 model is suitable for estimation of ETo at Akola.

The performance of ANN5 model is represented in Fig. 2 & 3 (ANN5). Results indicate that ANN5 model having all six weather parameters in input vector similar to input set of Penman-Monteith model, has predicted ETo with high degree of accuracy. All the errors statistics were found to be very low and other performance indices

Table 7: Performance of different ANN models developed using evaluation data set of Akola

Akola Model	MAE, mm day^{-1}	MARE	RMSE, mm day^{-1}	Correlation coefficient	Coefficient of determination	Index of agreement	Model efficiency
ANN1	0.3657	0.0966	0.4779	0.9713	0.9435	0.9802	0.9319
ANN2	0.3024	0.0856	0.3628	0.9805	0.9613	0.9898	0.9608
ANN3	0.2883	0.0726	0.4220	0.9778	0.9561	0.9850	0.9469
ANN4	0.3034	0.0807	0.3699	0.9801	0.9605	0.9893	0.9592
ANN5	0.1841	0.0485	0.2247	0.9941	0.9881	0.9964	0.9849

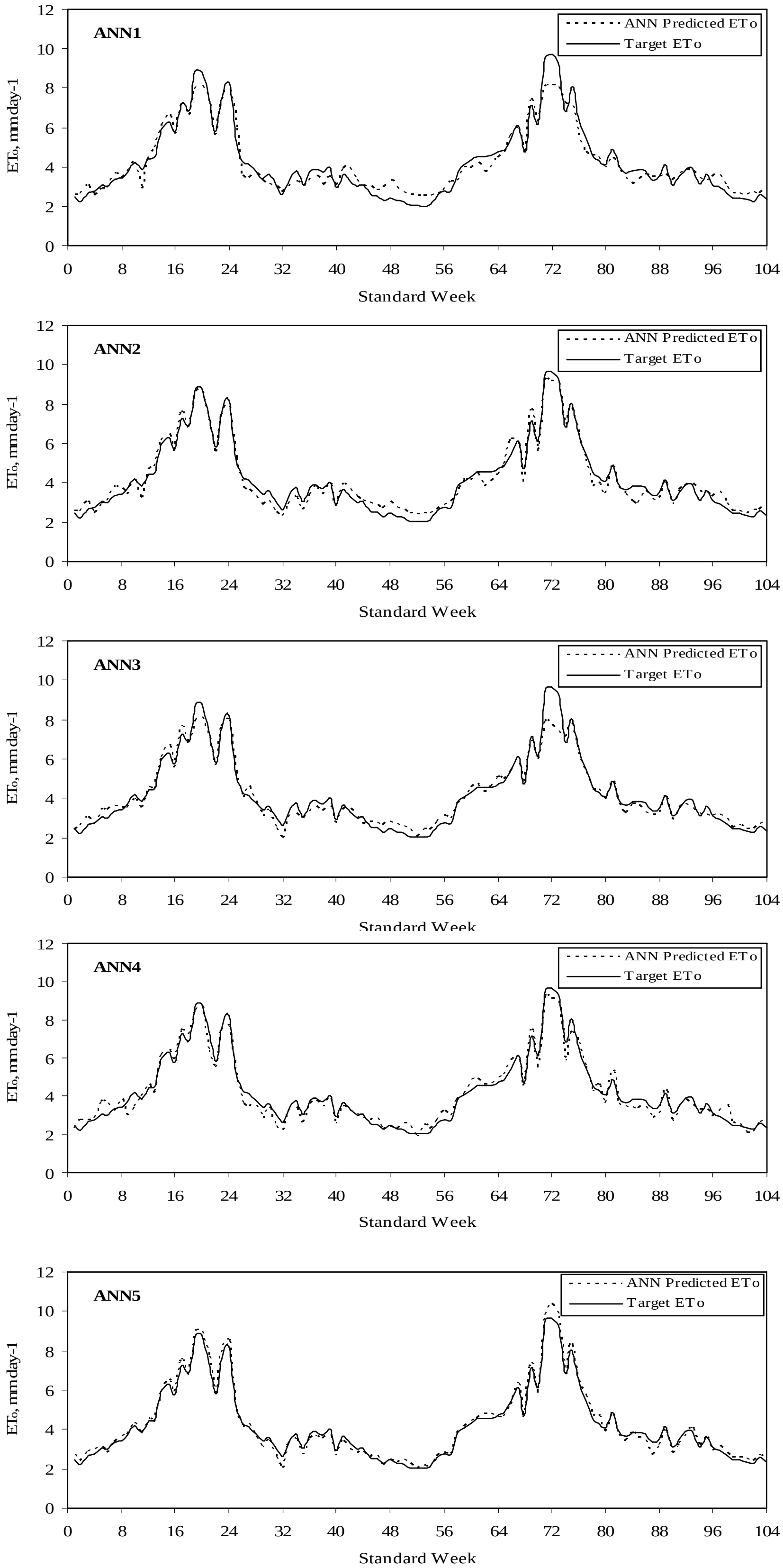


Fig. 2: Variation between target and ANN predicted ET_o using different ANN models for the independent evaluation data set of Akola

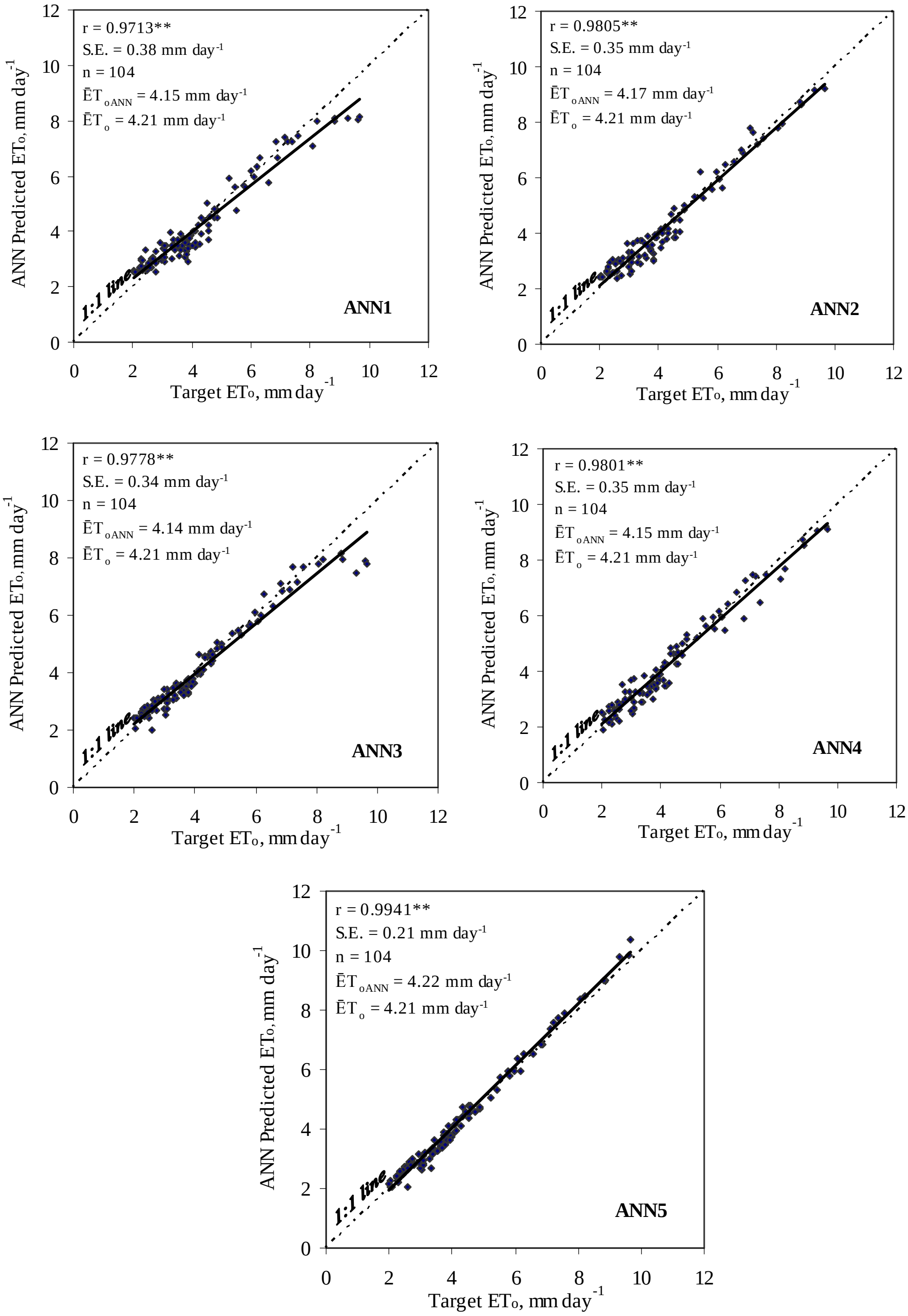


Fig. 3: Scatter plot between target and ANN predicted ET_o using different ANN models for the independent evaluation data set of Akola

were found to be very high. It means that artificial neural networks can precisely approximate the physical laws considered in relating the ETo with weather parameters without actual involving these laws in the network development process.

Comparative performance of various ANNs

From the comparison, it may become easy to identify or choose the best combination of input meteorological parameters for precise estimation of ETo. Comparison may also give an idea about the selection of alternative ANN models in the situations whenever data on limited meteorological parameters are available and the precision that can be achieved with the selected model in estimation of ETo. .

It is seen from Table 7 that all indices viz. mean absolute error (MAE), mean absolute relative error

(MARE), root mean square error (RMSE), correlation coefficient (r), determination coefficient (R2), index of agreement (D) and model efficiency (E) were found to be good enough for all network models. Hence ANN1 to ANN5 models are feasible and can be used for estimation of ETo according to the availability of data. When comparing their performance, among ANN1 to ANN5, lowest MAE, MARE, RMSE and highest r, R2, D, E were obtained for ANN5 model. It may be due to that its input vector consists of all six meteorological parameters similar to that of Penman-Monteith model. This result confirms the fact that air temperatures, relative humidity, wind speed and sunshine duration, all are influencing and necessary parameters for exact or highly accurate estimation of ETo. Kisi (2007) also reported that ANNs with these inputs performs the best. Hence ANN5 model emerged as best model and ranked first, followed by ANN2, ANN4, ANN3 and ANN1 models. Next to ANN5 model, ANN2 has produced second lowest RMSE and second highest E, D, R2 and r. One of advantage of ANN2 model is that it has input vector of only minimum and maximum air temperatures, and sunshine duration. It reflects that in situations whenever all six weather parameters are not available, ANN2 model may be used to estimate ETo. ANN with similar inputs was ranked second best by Kisi (2007). Next to ANN2 model, ANN4 has performed better which requires inputs of minimum and maximum air temperatures, minimum and maximum relative humidity, and sunshine duration. In case of ANN4, MARE and RMSE were third lowest and E, D, R2 and r were third highest; only MAE was slightly higher. ANN4 model was followed by ANN3 and ANN1. ANN3 model showed fourth lowest RMSE and fourth highest r, R2, D, E. Comparatively highest MAE, MARE, RMSE and lowest r, R2, D, E were obtained for ANN1 model, having input vector of air temperatures only.

It can be inferred from comparison that ANN5 model performs best, whereas under the situations of availability of data on limited weather parameters ANN2 model may be preferred for estimation of ETo at Akola over other models, because of its minimal requirement of input parameters. It can be used even in the absence of maximum and minimum relative humidity and wind speed data.

CONCLUSION

When all weather parameters are available artificial neural network models developed at Akola using input combination of all six parameters can be used for estimating reference evapotranspiration. But under the situations of availability of limited weather parameters, ANN model developed using maximum air temperature, minimum air temperature and sunshine duration can be used for estimating reference evapotranspiration.

LITERATURE CITED

Allen,R.G., L.S.Pereira, D.Raes and M.Smith, 1998. Crop evapotranspiration – Guidelines for computing crop water requirements, FAO Irrigation and Drainage Paper No. 56, FAO, Rome, Italy. 300.

Jensen,M.E., R.D.Burman and R.G.Allen, 1990. Evapotranspiration and irrigation water requirements, ASCE Manual and Reports Engg. Practice No. 70, ASCE, New York.

Kashyap,P.S. and R.K.Panda, 2001. Evaluation of evapotranspiration estimation methods and development of crop-coefficients for potato crop in sub-humid region, Agric. Water Manage., 50: 9 - 25.

Kisi, O., 2006. Generalized regression neural networks for evapotranspiration modelling, Hydrological Sciences J., 51(6): 1092-1105.

Kisi, O., 2007. Evapotranspiration modelling from climatic data using a neural computing technique, Hydrological Processes, 21: 1925-1934.

Kumar,M., N.S.Raghuwanshi, R.Singh, W.W.Wallender and W.O.Pruitt, 2002. Estimating evapotranspiration using artificial neural network, J. Irrig. Drain. Eng. ASCE, 128 (4) : 224-233.

Landeras,G., A.Ortiz-Barredo and J.J.Lopez, 2008. Comparison of artificial neural network models and empirical and semi-empirical equations for daily reference evapotranspiration estimation in the Basque Country (Northern Spain), Agric. Water Manage., 95: 553-565.

Sudheer,K.P., A.K.Gosain and K.S.Ramasastri, 2003. Estimating actual evapotranspiration from limited climatic data using neural computing technique, J. Irrig. Drain. Eng. ASCE, 129 (3) : 214-218.

Trajkovic,S., 2005. Temperature based approaches for estimating reference evapotranspiration, J. Irrig. Drain. Eng. ASCE, 131(4): 316-323.

Zanetti, S.S., E.F.Sousa, V.P.S.Oliveira, F.T.Almeida and S.Bernardo, 2007. Estimating evapotranspiration using artificial neural network and minimum climatological data, J. Irrig. Drain. Eng. ASCE, 133(2): 83-89.

❖ ❖ ❖

Modification of Green Chickpea Pod Stripping cum Shelling Machine

M. R. Rajput[1], B. L. Mandhyan[2] and P. A. Borkar[3]

ABSTRACT

The machine was modified in 2008 at AICRP on Post Harvest Technology, College of Agricultural Engineering, Jabalpur with objectives of identification and removal of defects in design of existing machine as well as to analyse the performance of modified machine. This machine mainly consists of three units which are stripping, shelling and cleaning unit. The shelling unit was modified by the addition of a third roller having same dimensions as the upper two rollers and also by covering the upper two rubber rollers by the corrugated metal sheet having holes of diameter 0.5 mm with 0.5 mm edges. It has 8 holes in horizontal direction and 5 holes in vertical direction per inch. This corrugated metal sheet was pasted on the upper two rubber rollers in such a way that no gap is found between the holes of the sheet. All the holes were made at uniform distance on the surface of the roller for better shelling action. The third rubber roller was operated at the medium speed and by this third roller the double shelling action was done on the pods. Hence the shelling occurred in two stages with better results as compared to earlier shelling with two rollers.

India is a major chickpea growing country of the world, accounting for 61.65 percent of the total world area and 68.13 percent of the total world production. Green Chickpea (*Cicer aritinum* L.) can be marketed after shelling, at higher profit to urban areas. Thus the profit of farmers and rural entrepreneurs will increase manifold. (Anonymous, 2002).

Agricultural development requires creation of agrobased industries in rural areas. This strategy will need designing and development of on farm processing machines for value addition. Production and marketing of green chickpea seed will be one of such activities.

The existing green chickpea pod stripping cum shelling machine was having only two rollers in shelling unit and the shelling efficiency was 71.5 per cent. This was on lower side. There was need to enhance the shelling efficiency by undertaking some modifications in the existing unit.

In new method of shelling green peas, pods which fail to be gripped by the first section pass to a second slightly modified section (Mitchell, 1969)

Keeping in view, the fact placed above, the existing machine has been modified at AICRP on Post Harvest Technology College of Agricultural Engineering, Jabalpur. The green chickpea stripping cum shelling machine consists of stripping unit, shelling unit and cleaning unit. The machine has functions like to detach the green chickpea pods from the plants, shell the pods and separate the green seeds from the green husk of pods. To improve the shelling efficiency, shelling unit of the machine was modified by the addition of a third roller having same dimensions as the upper two rollers and also by covering the upper two rubber rollers by the corrugated metal sheet having holes of diameter 0.5 mm with 0.5 mm edges. By this third roller the double shelling action was done on the pods hence the shelling occurred in two stages.

MATERIAL AND METHODS

Shelling zone and shelling length

The shelling unit comprised of three rollers. The top two rubber rollers are covered with corrugated metal sheet whereas the lower roller located below these two rollers has only rough rubber surface. This was done with the intention that the seed coat must have got cracked during first stage shelling. Therefore, in second stage shelling the hardness of the shelling surface should be reduced. The fixing of three rollers is done in such a way that their center to center distances form an inverted equilateral triangle. The gap between the third roller and the top two rollers was reduced by 1mm ($b_1 < b$) as shown in Fig. 1.

Length of travel

Length of travel is an important factor affecting the breakage. It gives the idea about relation between clearance and breakage. Determination of the complete path (L) of the pod during shelling which approximately equals to the length from B_1 to C_2 as shown in Fig. 1.

1. PG Student, 2. Head, Deptt. of Post Harvest Process and Food Engineering, JNKVV, Jabalpur and 3. Research Engineer, AICRP on PHT, Dr. PDKV, Akola,

The length of a section of path (DL_1) where primary shelling of the pod occurs depends on above three parameters considering a triangle $O_2B_1C_1$. The b is 1mm greater than b_1. Here the average of b and b_1 is not taken for calculation, only value of b is taken (10 mm, 9 mm, and 8 mm).The complete path of travel of pod is calculated by the expression.

$$L = [0.5D\,(d-b) + 0.25(d^2-b^2)]^{0.5} \quad \text{(Phirke, 2004)}$$

Where, D = roller diameter

b = clearance between the rollers

d = initial size of the pod

L = length of section of path

Here due to three rollers two shelling actions occur in sequence.

Hence $$L = 2[0.5D\,(d-b) + 0.25(d^2-b^2)]^{0.5}$$

Considering the initial size of the pod to be shelled (d) = 10.34 mm

Length of travel or path for 8mm, 9 mm and 10 mm clearance is 35.50 mm, 26.88 mm and 13.54 mm, respectively. From these calculations it is observed that as the clearance increased the length of travel also decreased. Thus, it revealed that roller clearance is a very sensitive and critical parameter such that a very slight variation in it leads to a considerable effect on shelling efficiency.

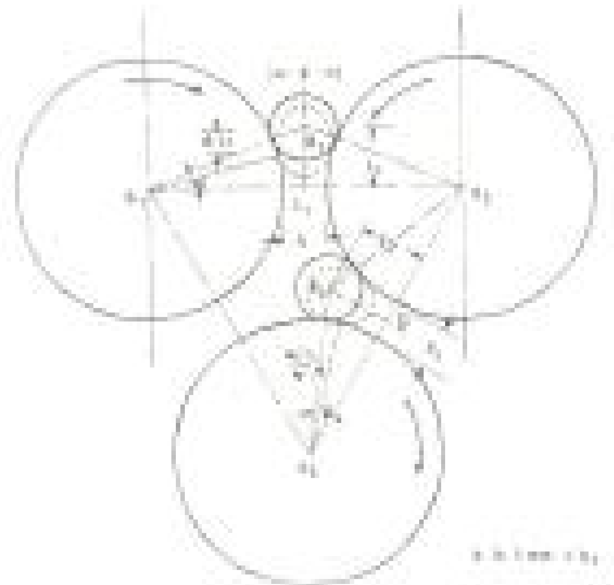
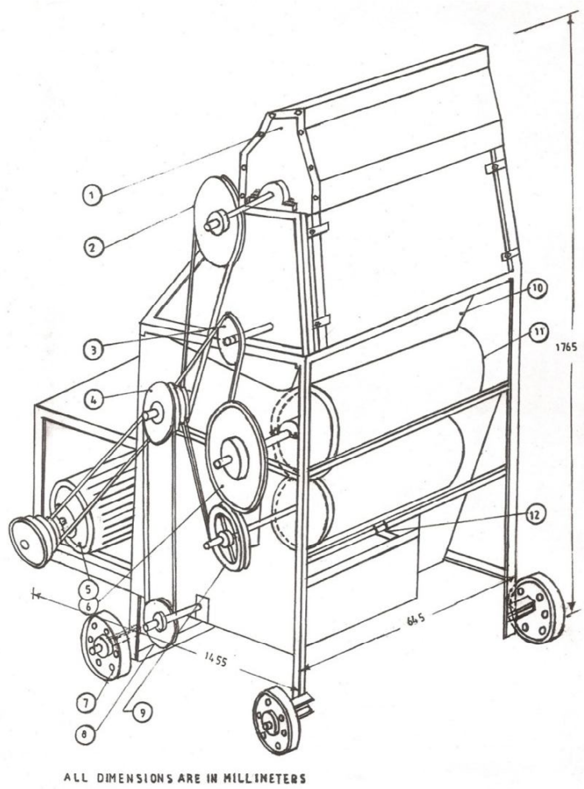


Fig. 1 Shelling principle in a three roller unit

Details and operations of machine

The details of the modified machine are shown in Fig. 2. A bunch of green chickpea plants is held in front of the stripping unit in which the pods are detached from the plants. The detached pods along with shreddings fall in the shelling unit which consists of three rollers. The upper two rollers operate at different speed ie. one is fast and other is slow in reverse direction. The third roller operates at medium speed having direction same as the fast roller. As the pod falls on the rollers the slow roller offers compression and consequently holds the pod. Fast roller develops shearing force on pod. The third roller operates at medium speed and is used for to improve the shelling. Then the husk and the green seeds drop in the cleaning unit in front of the blower, where the husk is blown off and the green seeds drop as the final product.



1. Stripping unit, 2. Stripping pulley, 3. Idler, 4. Fast roller pulley, 5. Motar, 6. Slow roller pulley, 7. Wheel, 8. Blower pulley, 9. Medium roller pulley, 10. Dashe, 11. Shelling unit, 12. Blower

Fig. 2 Isometric view of modified green chickpea pod stripping cum shelling machine

Construction of modified shelling unit

The shelling unit comprised of three rollers. Two rollers are located at the top while the third one running at medium speed is at the bottom. The length of all the three rollers was kept to be 360 mm (Fig. 3). The basic structure of all the three rollers consisted of cast iron plates acting as supports over which mild steel sheet of 12 gauge was rolled to prepare rollers of 255 mm diameter. On these rollers a corrugated synthetic rubber sheet (thickness- 5 mm) was pasted and then a rope was wound round the roller to hold the rubber sheet properly adhered to the mild steel roller. The top two rollers were then covered with corrugated metal sheet having thickness of 0.5 mm and width 38.1 mm. It has 8 holes in horizontal direction and 5 holes in vertical direction per inch. This corrugated metal sheet was pasted on the upper two rubber rollers in such way that no gap is found between the holes of the sheet. All the holes were made at uniform distance on the surface of the roller for better shelling action. The third rubber roller was operating at the medium speed. Shelling occurred in two stages by this third roller and the results were observed to be better.

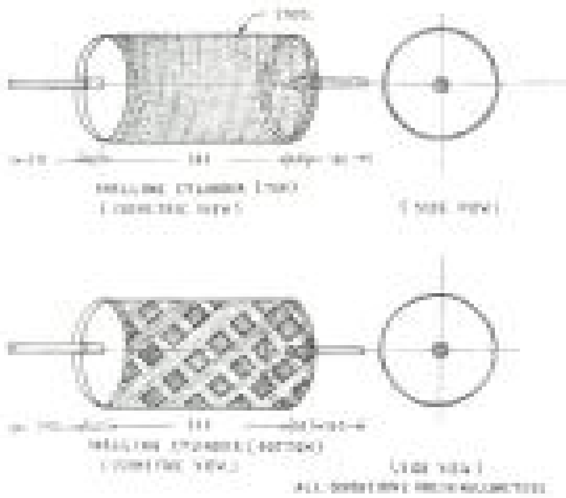


Fig. 3 Details of shelling rollers

RESULTS AND DISCUSSION

Preliminary trials were conducted to fix the range of annular gap between the top two rollers for shelling JG315 variety of green chickpea. Three gaps between top two rollers viz.8 mm, 9 mm, 10 mm were identified to which have good results. In second stage shelling the gap between top and bottom roller was kept 7 mm, 8 mm and 9 mm against the gap between top two rollers.

Comparison of results after modification

The results of green chickpea shelling done by two rollers and by three rollers are presented in Table 1, 2 and 3. In earlier machine having only two rubber rollers for shelling, the maximum shelling efficiency of the machine was 71.5% at 95 rpm of fast roller, 12 rpm of slow roller and 2 mm annular gap between these two rollers.

After modification as stated in methodology the machine was tested. The highest shelling efficiency after these modifications was observed to be 89.44% at 415 rpm of fast roller, 190 rpm of medium roller, 108 rpm of slow roller, top gap of 10 mm and bottom gap of 9 mm between rollers.

Variation of coefficient of wholeness and coefficient of hulling with respect to shelling efficiency

In the Table 3 the values of coefficient of hulling and coefficient of wholeness are given against shelling efficiency. It can be observed that the value of variation of coefficient of hulling was (0.80 to 0.97) 0.17 against maximum value of variation of shelling efficiency (52.08 to 89.44) of 37.36 per cent. Similarly maximum value of variation of coefficient of wholeness (0.56 to 1.04) was 0.48 against variation of shelling efficiency of 37.36 per

Table 1. Effect of speed, speed ratio and gap between the rollers on shelling efficiency in small seeds late variety.

S.N.	Gap (mm)	Speed ratio	Rpm of fast roller	Rpm of slow roller	Qty. of pods fed (gm)	Wt. of whole kernels (gm)	Wt. of broken (gm)	Wt. of unshelled pods (gm)	Efficiency (%)
1.	3	8:1	95	12	500	285.1	1.00	194.80	60.90
2.	3	9:1	898	108	500	325.1	1.00	161.32	67.60
			961	119	500	-	0.75	186.52	62.60
			1048	127	500	299.8	0.50	187.18	62.50
			1132	140	500	320.3	1.00	163.70	67.12
			1245	152	500	330.2	1.00	153.70	69.12
3.	2	8:1	95	12	500	330.8	85.00	69.20	71.50

(Source: Mandhyan *et al.*, 2001)

Table 2. Effect of speed, speed ratio and gap between the rollers on shelling efficiency in bold seeded early variety

S.N.	Gap (mm)	Speed ratio	Rpm of fast roller	Rpm of slow roller	Qty. of pods fed (gm)	Wt. of whole kernels (gm)	Wt. of broken (gm)	Wt. of unshelled pods (gm)	Efficiency (%)
1.	4.0	9:2	898	108	500	249.80	0.25	230.85	52.00
2.			961	119	500	284.80	0.50	200.20	59.00
3.			1048	127	500	290.00	0.05	197.45	60.50
4.			11328	140	500	300.00	2.50	184.42	62.80
5.			1245	152	500	315.00	0.50	170.37	65.66
6.	4.5	10:1	879	88	500	300.00	2.50	186.78	62.33
7.			970	97	500	300.70	1.50	165.59	66.68
8.			1058	106	500	290.70	2.00	197.20	60.30
9.			1288	129	500	140.50	5.00	236.00	52.27
10.	5.0	6.71:1	790	11.8	500	219.90	0.05	209.90	58.00
11.			877	129	500	250.10	0.15	239.90	52.00
12.			920	136	500	275.10	0.20	212.20	57.52
13.		11:1	1067	97	500	279.80	0.50	209.70	58.00
14.			1166	106	500	250.30	1.50	240.70	57.00
15.			1265	115	500	275.20	2.00	212.80	57.20
16.	5.5	11:1	1067	97	500	274.60	1.00	214.40	57.00
17.			1166	106	500	272.80	1.50	218.15	56.20
18.			1265	115	500	291.60	1.00	197.39	60.40
19.		6.17:1	790	118	500	275.00	0.10	212.40	57.50
20.			877	129	500	269.90	0.15	217.40	56.50
21.			920	137	500	290.40	0.10	196.00	60.80
22.			1005	150	500	300.40	0.15	185.40	62.90
23.	6.0	6.17:1	790	118	500	249.60	0.10	239.90	52.00
24.			877	12.9	500	259.60	0.10	229.90	54.00
25.			920	137	500	274.85	0.15	215.00	57.00
26			1005	150	500	282.30	0.15	205.00	59.00

(Source: Mandhyan *et al.*, 2001)

Table 3: The test results of the modified green chickpea pod stripping cum shelling machine Results

S.N.	Results										
	Top gap (mm)	Bottom gap (mm)	Feed rate (kg.)	RPM stripper	Stripping efficiency (%)	RPM slow shelling roller	RPM fast shelling roller	RPM medium shelling roller	Coefficient of hulling	Coefficient of wholeness	Shelling efficiency (%)
1	9	8	1	93	87.30	105 (1)	345 (3)	123 (1.5)	0.89	0.72	64.08
2	9	8	1	105	89.88	117 (1)	380 (3)	170(1.5)	0.93	0.74	68.82
3	9	8	1	126	89.63	140 (1)	460 (3)	210(1.5)	0.93	0.62	57.66
4	9	8	1	147	90.33	170 (1)	540 (3)	255(1.5)	0.94	0.61	57.34
5	10	9	1	105	85.97	126 (1)	395 (3)	170(1.5)	0.89	0.92	81.88
6	10	9	1	126	85.19	138 (1)	475 (3)	220(1.5)	0.89	0.86	76.54
7	10	9	1	147	89.55	160 (1)	525 (3)	235(1.5)	0.90	0.80	72.00
8	10	9	1	165	88.83	185 (1)	585 (3)	265(1.5)	0.90	0.74	66.60
9	8	7	0.5	48	83.32	53 (1)	190 (3)	81(1.5)	0.84	0.77	64.68
10	8	7	0.5	66	84.45	77 (1)	252 (3)	123(1.5)	0.97	0.67	64.99
11	8	7	0.5	93	83.61	96 (1)	310 (3)	129(1.5)	0.95	0.61	57.95
12	8	7	0.5	108	84.56	114 (1)	350 (3)	170(1.5)	0.95	0.68	64.60
13	10	9	1	117	88.65	108 (1)	415 (4)	190(1.5)	0.86	1.04	89.44
14	9	8	1	108	89.71	102 (1)	395 (4)	180(1.5)	0.87	0.99	86.13
15	8	7	1	108	93.66	99 (1)	370 (4)	170(1.5)	0.93	0.56	52.08
16	10	9	1	92	90.79	69 (1)	270 (4)	126(1.5)	0.80	0.74	59.20
17	10	9	1	96	89.50	78 (1)	320 (4)	150(1.5)	0.91	0.94	85.54
18	10	9	1	120	92.33	105 (1)	405 (4)	190(1.5)	0.90	0.89	80.10
19	10	9	1	131	92.70	125 (1)	425 (4)	210(1.5)	0.87	0.92	80.04

Note – Figures in parentheses shows speed ratio of the rollers cent. Thus, variation in roller speed and gap between rollers has least effect on coefficient of hulling (>0.80) but significant effect on coefficient of wholeness which is more important in shelling.

CONCLUSIONS

The modification in shelling unit improves the shelling efficiency from 71.5 per cent to 89.44 per cent. The coefficient of wholeness is more important than coefficient of hulling for increased shelling efficiency.

LITERATURE CITED

Anonymous, 2002. Post Harvest Profile of Chickpea at http:// agmarket.nic.in/bengal. gram / profile / pdf

Mandhyan, B.L., S. Ganguly and R. P. Mishra, 2001. Design and development and testing of Fresh Bengal gram stripping cum shelling machine, IE(I) J. AG, 82 : 30-33.

Mitchell R.S., 1969. A new method of shelling green peas for processing International Journal of Food Science & Technology Volume 4. Issue 1 : 51-60. at http://www.blackwell-synergy.com.

Phirke, P.S., 2004. Processing and Conveying Equipment Design, First Edition, New Delhi, Jain Brothers : 177-178

❖ ❖ ❖

PKV Res. J. Vol. 36 (2), July 2012

Studies on Storability of Kagzi Lime as Influenced by Different Gauges and Ventilations of Packaging Material

S. D. Jadhao[1], K. T. Waghmode[2], S. S. Hadole[3], R. D. Chaudhari[4] and P. A. Gite[5]

ABSTRACT

The experiment was conducted to study the effect of different gauges and ventilations of packaging materials on storability of *Kagzi* lime at Department of Soil Science and Agricultural Chemistry and Post Harvest Technology, College of Agricultural Engineering and Technology, Dr. PDKV, Akola. The result of present experiment revealed that the *Kagzi* lime fruits stored at 300 gauge polypropylene bags with 0.5 per cent ventilation recorded minimum physiological loss in weight, maximum juice content. However, minimum spoilage was observed in 200 gauge polypropylene bags with 0.5 per cent ventilation at the end of 28th day. Significantly minimum spoilage was recorded by fruits stored in polypropylene bags with 0.5 per cent ventilation which was 1.23 per cent, followed by fruits stored in one per cent ventilated polypropylene bags (1.97 %) and two per cent ventilated polypropylene bags (3.04 %). Highest spoilage was recorded by kagzi lime fruits stored in polypropylene bags with no ventilations.

Citrus is one of the most important subtropical fruit crops of the world. India is the sixth largest citrus producing country with total area of 7.12 lakh hectare with production of 89.96 lakh tonnes contributing 12.2 per cent of total fruit production. In Maharashtra, total area under *Kagzi* lime occupies about 0.34 lakh ha with production of 1.77 lakh tonnes (Anon, 2005). *Kagzi* lime is mostly cultivated in Vidarbha region particularly in Akola, Buldhana and Nagpur districts. Thus, it is indicated that acid lime is one of the economically important fruit crop of Vidarbha region next to mandarin. The fruits have a great medicinal values being acidic in nature. It contains good amount of ascorbic acid, vitamins, carbohydrates, minerals, phosphorus, iron and alkaline salts. The post harvest losses of important commercial fruits of India vary from 20-30 per cent before they reach the consumer (Chadha, 1995). In Maharashtra, *Kagzi* lime fruits available throughout the year and the losses are as high as 30 per cent during the peak season between June to December. Due to which, the growers fetch less price. For getting good economical return and to avoid the glut in the market, there is immediate need to store kagzi lime fruits by adopting proper packaging and storage facilities.

The ventilated and micro-perforated polybags reported to extend the shelf life and to reduce the storage disorders of fruits (Oliveira *et. al.*, 1998). Lime fruits could be stored in perforated polythene bags for more than a month at room temperature (Ghosh and Sen, 1984). The different gauges and ventilation of packaging material may also affect the shelf life of fruits depending upon the type of packaging material, fruits and storage condition. Thus, there is a need to find out the suitable guage and ventilation of packaging material to reduce physiological loss in weight as well as retaining the keeping quality of kagzi lime fruits.

MATERIAL AND METHODS

The experiment was conducted at AICRP on Post Harvest Technology Laboratory, Dr. P.D.K.V., Akola during 2006-07. Fully matured, uniform size, fruits green in colour and free from blemishes were procured from the Akola market. The fruits were cleaned by washing in fresh tap water and air dried room temperature. *Kagzi* lime fruits were packed in polypropylene bags of size 35.5 x 25.3 cm having different gauges viz. 200 and 300 each having 0, 0.5, 1.0, 2.0 and 4.0 per cent ventilation. The bags were sealed after the fruits packed in the bag and kept in room temperature. The experiment was designed with two sets where set-1 was exclusively used to record physiological loss in weight and spoilage in which 20 *Kagzi* limes were packed in each polypropylene bag and set-II consisting of five polypropylene bags containing 10 *Kagzi* lime fruits in each bag so as to open the bags separately at each interval for bio-chemical analysis and season evaluation. The physiology loss in weight was calculated by subtracting weight of fruits at each interval from the initial weight of *Kagzi* lime. Juice content was determined with the help of juice extractor and the juice percentage was calculated from Juice weight and total weight of the fruit. The pH of fruit juice was determined by using pH meter (Ranganna, 1986). TSS content was determined by using hand refractometer.

1 & 5. Associate Prof., 2. P.G. Student, 3. Assistant Prof., 4. Senior Res. Fellow, Department of Soil Science and Agril. Chemistry, Dr. PDKV, Akola

The titratable acidity was determined by titrating the diluted fruit juice against 0.1 N NaOH using phenolphthalein indicator (Ranganna, 1986). Whereas, ascorbic acid was determined by 2, 6 dichlorophenol indophenol dye method (Gupta and Varshney, 1986). The reducing sugar was estimated by Dinitro-salicylic acid method and total sugar was estimated by using phenol and sulphuric acid. The non reducing sugar was calculated by subtracting reducing sugars from total sugars (Sadasivam and Manickam, 1997). Sensory evaluation was carried out by a panel of four judges for colour, taste and texture using a point Hedonic scale for each attribute (Ranganna, 1986). The data recorded in respect of all the above parameters were subjected to statistical analysis and for interpretation of results (Gomez and Gomez, 1984).

Treatment Details:

The fruits were stored in 200 and 300 gauge ventilated (0.5, 1.0, 2.0 and 4 % ventilation) and non ventilated polypropylene bags. However, 10 treatment combinations replicated three times in Factorial Randomized Block Design. The treatment details are given below.

Factor A: Gauges of polypropylene bags

G_1- 200 guage
G_2- 300 guage

Factor B: Ventilations of polypropylene bags

V_0 - No ventilation
V_1 - 0.5 per cent ventilation
V_2 – 1.0 per cent ventilation
V_3 – 2.0 per cent ventilation
V_4 – 4.0 per cent ventilation

Treatments	Treatment combinations
G_1V_0	200 gauge polypropylene bags (No ventilation)
G_1V_1	200 gauge polypropylene bags (0.5 % ventilation)
G_1V_2	200 gauge polypropylene bags (1 % ventilation)
G_1V_3	200 gauge polypropylene bags (2 % ventilation)
G_1V_4	200 gauge polypropylene bags (4 % ventilation)
G_2V_0	300 gauge polypropylene bags (No ventilation)
G_2V_1	300 gauge polypropylene bags (0.5 % ventilation)
G_2V_2	300 gauge polypropylene bags (1 % ventilation)
G_2V_3	300 gauge polypropylene bags (2 % ventilation)
G_2V_4	300 gauge polypropylene bags (4 % ventilation)

RESULTS AND DISCUSSION

A. Physiological Loss in Weight :

The data presented in Table 1, indicated the cumulative weight loss of *Kagzi* lime fruits stored in polypropylene bags of different gauges and ventilations. The cumulative weight loss was found to be increased with the advancement of storage period. There were no significant differences on weight loss due to various gauges of polypropylene bags up to 21 days. However, comparatively minimum cumulative weight loss was observed by fruits stores in 300 gauged polypropylene bags at all the storage intervals. Similar results were also reported by Rao *et al.* (1967), Sadasivan *et al*. (1972) and Chaudhari and Kumbhare (1979).

The ventilation of polypropylene bags showed significant effect on physiological weight loss. As the levels of ventilation increased, weight of kagzi lime fruits decreased rapidly. Significantly minimum cumulative weight loss was recorded by *Kagzi* lime fruits stored in unventilated polypropylene bags which were 0.19, 0.59 and 0.93 per cent, followed by fruits stored in 0.5 per cent ventilated polypropylene bags viz., 3.25, 6.83 and 10.03 per cent, respectively at the end of 7,14 and 21 days of storage period. At the end of storage, the fruits stored in non-ventilated, two per cent ventilated and four per cent ventilated polypropylene bags were spoiled completely and hence the fruits were discarded for further biochemical analysis and sensory evaluation. As the levels of ventilation increased the cumulative weight loss was increased. This might be due to higher transpiration and respiration resulted to excessive moisture loss from the fruits in respective treatments.

The interaction effect of gauges and ventilations of polypropylene bag were found non-significant up to 14 days. However, the interaction effect of gauges and ventilations on cumulative weight loss was found to be significant at the end of 21 days (Table 1). The physiological loss in weight was increased with increase in storage period. The results are in agreement with the data reported by Srivastava and Ladania (1973), Dhillon *et al.* (1977), Singh and Mandal (2006).

B. Spoilage:

The data presented in Table 2 reported the spoilage of *Kagzi* lime fruits stored in polypropylene bag in different gauges and ventilations. Spoilage was observed on 14th day, thereafter the spoilage was increased rapidly with storage period. The gauge of polypropylene bags was found to be non significant in

Table 1. Effect of different gauges and ventilations of packaging material on physiological loss in weight of kagzi lime

Treatment	Storage period (days)			
	7	14	21	28
Gauge levels	**Physiological loss in weight (%)**			
G_1(200)	4.46 (1.95)	9.56 (2.87)	14.09 (3.42)	17.27
G_2(300)	4.31 (1.90)	9.20 (2.80)	13.46 (3.40)	16.29
SE (m)±	0.042	0.034	0.029	-
CD at 5 %	NS	NS	NS	-
Ventilation levels				
V_O (No. Vent)	0.19 (0.43)	0.59 (0.77)	0.93 (0.96)	Spoiled
V_1 (0.5 %)	3.25 (1.80)	6.83 (2.61)	10.03 (3.17)	13.39
V_2 (1.0 %)	4.78 (2.18)	9.87 (3.14)	14.30 (3.59)	20.07
V_3 (2.0 %)	6.32 (2.51)	13.67 (3.69)	19.45 (4.45)	Spoiled
V_4 (4.0 %)	7.36 (2.69)	15.93 (3.98)	23.75 (4.87)	Spoiled
SE (m)±	0.066	0.053	0.046	-
CD at 5 %	0.19	0.153	0.134	-
Interaction (Gauge x Ventilation)				
SE (m)±	0.094	0.075	0.066	-
CD at 5 %	NS	NS	0.19	-
CV	9.74	5.29	3.86	

Note - Figure in parenthesis is square root transformed value

Table 2. Effect of different gauges and ventilations of packaging material on per cent spoilage of kagzi lime

Treatments	Storage period (days)			
	7	14	21	28**
Gauge levels	**Spoilage (%)**			
G_1(200)	No Spoilage	6.53(21.18) *	20.71(23.46) **	66.10(62.85)
G_2(300)	No Spoilage	7.20(2.29) *	22.32(25.02) **	67.15(63.63)
SE (m)±	-	0.050	1.03	0.63
CD at 5 %	-	NS	NS	NS
Ventilation levels				
V_O (No. Vent)	No Spoilage	23.64(4.86) *	73.80(59.51) **	100.00(90.00)
V_1 (0.5 %)	No Spoilage	1.23 (1.10) *	2.16(8.23) **	8.74(16.76)
V_2 (1.0 %)	No Spoilage	1.97 (1.39) *	3.66(10.69) **	24.37(29.44)
V_3 (2.0 %)	No Spoilage	3.04(1.73) *	10.54(18.49) **	100(90.00)
V_4 (4.0 %)	No Spoilage	4.43(2.08) *	17.42(24.28) **	100 (90.00)
SE (m)±	-	0.08	1.63	0.99
CD at 5 %	-	0.23	4.71	2.87
Interaction (Gauge x Ventilation)				
SE (m)±	-	0.113	2.31	1.40
CD at 5 %	-	NS	NS	NS
CV	-	10.10	19.03	4.44

* Figure in parenthesis is square root transformed value **Figure in parenthesis is arc sin transformed value

Table 3. Effect of different gauges and ventilations of packaging material on juice content of kagzi lime fruits. (Initial value: 42.09 per cent)

Treatments	Storage period (days)			
	7	14	21	28
Gauge levels		**Juice content (%)**		
G_1(200)	38.37	36.80	35.39	35.33
G_2(300)	39.19	37.70	36.32	36.01
SE (m)±	0.503	0.288	0.349	-
CD at 5 %	NS	0.832	NS	-
Ventilation levels				
V_O (No. Vent)	41.18	41.05	40.33	Spoiled
V_1 (0.5 %)	41.01	38.08	37.48	36.24
V_2 (1.0 %)	39.83	37.34	36.16	35.09
V_3 (2.0 %)	36.55	36.00	33.75	Spoiled
V_4 (4.0 %)	35.32	33.79	31.54	Spoiled
SE (m)±	0.795	0.456	0.552	-
CD at 5 %	2.34	1.13	1.63	-
Interaction (Gauge x Ventilation)				
SE (m)±	1.12	0.644	0.781	-
CD at 5 %	NS	NS	NS	-
CV	5.80	3.46	4.36	-

respect of per cent spoilage at all the storage intervals. The lowest spoilage was found in fruits stored in 200 gauge polypropylene bags, followed by 300 gauge polypropylene bags during the entire storage.

The ventilations of packaging material had significant effect on spoilage of *Kagzi* lime fruits. At the end of 14 days storage, significantly minimum spoilage was recorded by fruits stored in polypropylene bags with 0.5 per cent ventilation which was 1.23 per cent, followed by fruits stored in one per cent ventilated polypropylene bags (1.97 %) and two per cent ventilated polypropylene bags (3.04 %). Highest spoilage was recorded by *Kagzi* lime fruits stored in polypropylene bags with no ventilation. The excessive spoilage observed in kagzi lime fruits stored in polypropylene bags with no ventilation might be due to accumulation of moisture inside the packaging material. The interaction between gauges and ventilation of polypropylene bag as regards to spoilage of fruits were found to be non significant at all the storage intervals. Similar line of work was also reported by Joshua and Sathiamoorthy (1993) and Prabha et al. (2006).

C. Juice content

The data presented in Table 3 indicated the juice content of kagzi lime fruits as affected by different gauges and ventilations of polypropylene bag. The data revealed that, the juice content of *Kagzi* lime fruits were decreased with the advancement of storage period.

The juice content at the end of 7 days of storage period was found to be non significant, whereas, it was found to be significant at the end of 14 days. Highest juice (37.70 %) retained by the fruit stored in 300 gauged polypropylene bags with different ventilation, followed by fruit stored in 200 gauged polypropylene bags which were 36.80 per cent. The juice content due to gauges of polypropylene bag did not reach to the level of significance at the end of 21 days. At the end of 28 days, the fruit stored in 300 gauge polypropylene bags recorded highest juice content (36.01 %), followed by fruits stored in 200 gauge polypropylene bags (35.33 %).

The maximum juice content was observed in *Kagzi* lime fruits stored in 300 gauge polypropylene bags that might be due to slower rate of transpiration and respiration. The ventilations of polypropylene bag showed the significant effect on juice content of *Kagzi* lime upto 21 days. At the end of 7 days, the fruits stored in unventilated polypropylene bags recorded highest juice content (41.18 %), followed by 0.5 per cent ventilated polypropylene bags (41.01 %) and 1.0 per cent ventilated polypropylene bags (39.83 %) and these treatments were found at par with each other. At the end of 28 days , the fruits stored in 0.5 % ventilated polypropylene bags recorded highest juice content (36.21 %), followed by one per cent ventilated polypropylene bags (35.09 %).The highest juice recovery in unventilated polypropylene bags may be attributed to the reduction in transpiration and respiration losses. These findings are in conformation with the data recorded by Kohli and Bhambota (1966), Bhullar (1983).

LITERATURE CITED

Anonymous, 2005. Indian Horticulture Database, 2005.

Bhullar, J.S., 1983. Storage behavior of kagzi lime fruits, Haryana J. Horti. Sci.12 (1-2):52-55

Chadha, K.L., 1995. Status of post harvest technology of fruits, Phala Samskarana, Proc. National Seminar on Post harvest Technology of Fruits, Banagalore : 16.

Chaudhari, K.G. and G.B. Kumbhare, 1979. Post harvest life of sweet oranges (Citrus sinensis) as influenced by various polythene film packs, J. Maharashtra Agric.Univ., 4 (2):228-229.

Dhillon, B. S., P. S. Bains and J. S. Randhawa (1977). Studies on storage of Kinnow mandarins, J. Res. (PAU), 14 (4) : 434-438.

Ghosh, S. K and S.K. Sen, 1984. Extension of storage life of lime, Punjab Horti. J., 24 : 46-51.

Gomez, K. A. and A. A. Gomez, 1984. Statistical procedure for Agricultural Research, A. Willey Inter Science Pub., New Delhi.

Gupta, A.K. and M.L. Varshney, 1986. Practical manual for Agril. Chemistry, Kalyani Pub New Delhi-Ludhiana.

Joshua, P. and S. Sathiamoorthy, 1993. Storage of sapota fruits in polythene bags, South Indian Horti., 41 :368-369.

Kohli, R. P. and J.R. Bhambota, 1966. Storage of lime (Citrus aurantifolia Swingle), Indian J. Horti. 23:140-145.

Oliveira, F.A.R., S.C. Fonseca, J. C. Oliveira, J.K. Brecht and K. V. Chau, 1998. Development of perforation mediated modified atmosphere packaging to preserve fresh fruit and vegetable quality after harvest, Food Sci. Tech. Intl., 4 : 339-352.

Prabha, A., H. R. Sharma, A. K. Goel and Ranjana Verma, 2006. Effect of post harvest treatments on the pathological rotting of lemon fruits under different storage conditions, J. Res. SKUAST, 5 (2) : 261-265.

Ranganna, S., 1986. Handbook of analysis and quality control for fruit and vegetable products, II ed, Tata Mc-Graw-Hill Pub. Company Ltd. New Delhi.

Rao, K. R. S., P. Narasimhan, B. Anandaswamy and N. V. R. Iyengar, 1967. Studies on the storage of mandarin oranges (Citrus reticulate Blanco) treated with wax or wrapped in Diphenyl treated paper, J. Food Sci. Tech. 4: 165-169.

Sadasivam, S and A. Manickam, 1997. Biochemical methods, II Ed. New Age. International, Pvt. Ltd.

Sadasivam, R., T.M. Subramanian and N. V. Raman (1972). Polythene packages ensure better storage of Sathgudi fruits, Indian Farming. 22 (1):32-37.

Singh, D. and G. Mandal, 2006. Post harvest quality and spoilage of peach fruits stored in perforated poly bags, Indian J. Horti. 63 (4):390-392.

Srivastava, R. K. and M. S. Ladaniya, 1973. A note on the storage behavior of Hill oranges in ventilated polythene bags, Prog. Hort. 5 (1):66-72.

❖ ❖ ❖

Changes in Milk pH, Somatic Cell Count and Transaminase Activity in Milk - Whey and Plasma in Relation to Mastitis in Cows

S. H. Vyavahare[1], S. W. Bonde[2], N. S. Mangle[3], D. G. Jagtap[4] and S. P. Waghmare[5]

ABSTRACT

The present study was conducted to assess the udder health status of the cows. A total of 60 milk samples and 60 blood samples were inspected from March to June in the year of 2008 for the assessment of subclinical (1^+,2^+,3^+) mastitis in cows by studying the parameters viz., pH, Somatic cell count (SCC) in whole milk and Alanine transaminase (ALT) and Aspartate Transaminase (AST) activity in milk-whey and blood plasma of the same cow. The milk and blood samples were collected on the basis of through clinical examinations and after screening with California mastitis Test (CMT), and grouped as normal and subclinical (1^+,2^+,3^+) and clinical. The average values of pH, SCC in whole milk samples differ significantly among different forms of mastitis and revealed a direct relationship with CMT score and the AST and ALT activity. The AST and ALT activity in milk-whey differs significantly among different udder health status; however, it did not differ significantly in blood-plasma. The alterations in AST and ALT activity in milk-whey may be helpful to assess the udder health status of the cows.

Inflammation of mammary gland i.e. mastitis, a single most costly disease of dairy cows is caused by various etiological factors which lead to lower milk production and altered milk biochemical profile viz., milk pH , enzymes, etc.

In sub-clinical form, udder and milk of the animal are apparently normal but quality of milk is affected which makes this form difficult to diagnose clinically. The potential health hazards exist in mastitis milk as it is an excellent medium for the growth of micro-organisms responsible for the spread of deadly zoonotic diseases like *Brucellosis, Tuberculosis,* etc., (Shukla *et al.*, 1998). Therefore, early identification of indicators of mastitis in the milk is essential for dairy farmers and veterinarians to ensure not only the animal well-being but also the milk quality and dairy productivity.

The enzymes being the cellular constituents, concomitant with the rupture of cell or tissue, are spilled in to milk (Shahani, 1966). Therefore, the present study was carried out to investigate the enzymatic changes in different udder heath status of cows.

MATERIAL AND METHODS

Total 60 cows were randomly selected irrespective of their age, breed, feeding practices, stages and season of lactation from Goarkshan Mandal, Mhaispur, Livestock Instructional Farm Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Gorakshan Mandal, Akola, Teaching Veterinary Clinical Complex Post Graduate Institute of Veterinary and Animal Sciences (PGIVAS), Akola, Veterinary Polyclinic of Akola and cows of farmers in and around Akola. After through clinical examination of udder four milk samples were collected and screened carefully by California Mastitis Test (CMT) as per the procedure laid down by Durry and Reed (1961). Blood samples were collected from jugular vein of the same cow. Freshly collected milk samples were subjected for estimation of pH by using digital pH meter (E. I. Model 101 E). Somatic Cell count (SCC) was measured as per the method of Schalm *et al.* (1971), followed by separation of milk whey according to Olson *et al.* (1981). Total sixty cows divided randomly into normal, subclinical (1+), Subclinical (2+), Subclinical (3+) and clinical mastitis as under

Udder healthstatus / No. of animals	Normal	Subclinical 1^+	Subclinical 2^+	Subclinical 3^+	Clinical	Total
Cows	12	12	12	12	12	60

Each blood sample was centrifuged to obtain clear plasma. Furthermore immediately the ALT and AST activity of each sample of whey and plasma were estimated (Caubad *et al.*, 1958). The standard curve of Aspartate Transaminase (AST) and Alanine Transaminase (ALT) units against optical densities were plotted at 505 nm. The data were statistically analyzed by using the procedure of Snedecor and Cochran (1994).

RESULTS AND DISCUSSION

It was observed that the pH of milk was 6.59 ± 0.03 in normal group and that for subclinical 1^+, 2^+,3^+

1. M.V.Sc. student, 2,3 & 4. Associate Prof. and 5. Hospital Superintendent, Department of Veterinary Biochemistry, PGIVAS, Akola

groups were 6.77 ± 0.01,6.93 ± 0.01 and 7.07 ± 0.01, respectively (Table 1). The average pH value in clinical mastitis was 7.36 ± 0.04, which was significantly (P<0.01) higher as compared to normal and subclinical mastitis groups. The result indicated an increase in the pH values with the increase in the severity of mastitis which corroborated with the findings of Charjan *et al.* (2000) and Sadekar (2000).

The SCC of milk was 1.56 ± 0.18 x 10^5 cells/ ml in normal group, whereas in subclinical 1^+, 2^+, 3^+ groups were 1.81 ± 0.05 X 10^5 cell/ml, 2.66 ± 0.09 X 10^5 cells/ml and 4.56 ± 0.11 X 10^5 cells/ml, respectively. The SCC was significantly higher (P<0.01) in clinical group (9.97 ± 0.18 X 10^5 cells/ml). The SCC was significantly (P < 0.01) different in all the classes of milk samples and also revealed significant correlation regression (P < 0.01) with the CMT score (Table 1). The trend of increase in SCC of milk samples with different forms of mastitis observed in the present investigation, was is in agreement with the findings of Hovarth *et al.* (1980), Tuteja *et al.* (2000) and Pyorala (2003).

Although the variation in milk pH and SCC values within and between the groups of sample used in the present investigation could be attributed to the normal physiological variation and disease condition of udder irrespective of the causative agents.

The average activity of AST in the milk whey of normal milk was 25.85 ± 0.46 U ml^{-1}. In subclinical 1^+, 2^+ and 3^+ groups were 46.64 ± 3.62 U ml^{-1}, 75.59 ± 2.54 U ml^{-1} and 98.87 ± 2.06 U ml^{-1}, respectively. The average AST activity was 143.62 ± 1.99 U ml^{-1} in clinical mastitis milk-whey. The results indicated a significant (P<0.01) increase in the milk-whey AST activity with the increase in the severity of different forms of mastitis. The average AST activity in whey differed significantly between all the groups with significant correlation and was found to increase with the severity of mastitis. The averages mean values of AST activity of milk-whey obtained in the present investigation was in concurrence with the findings of Bogin and Ziv (1973) in cows and goats (Khodke, 2007)

The average AST activity in blood plasma in normal, subclinical (1^+, 2^+, 3^+) and clinical group is shown in Table 2. The AST activities in plasma did not differ significantly between the groups and were in fair agreement with the reports of Hobeon *et al.* (2000).

The average activity of ALT in milk-whey of normal cow was 22.21± 0.46 U ml^{-1} whereas in subclinical 1^+, 2+ and 3^+ group were 34.05± 1.80 U ml^{-1}, 62.71 ± 2.53 U ml^{-1} and 87.98 ± 1.89 U ml^{-1}, respectively. The average ALT Activity was (130.75 ± 1.64 U ml^{-1}) significantly higher in clinical mastitis group. The average ALT activity in whey differed significantly (P<0.01) between all the groups with significant correlation and was found to increase with the severity of mastitis. The average activity of ALT for milk whey found during present

Table 1: Effect of stages of mastitis on pH, SCC, ALT and AST activity in cow milk-whey

Parameters	Normal	Sub-clinical			Clinical	C.D.	Regression	
		1^+	2^+	3^+			On CMT	On SCC
pH	6.59^a ± 0.03	6.77^b ± 0.01	6.93^c ± 0.01	7.07^d ± 0.01	7.36^e ± 0.04	0.096	0.19	0.07
Somatic Cell Count (x10^5cells/ml)	1.56^a ± 0.18	1.81^{ab} ± 0.05	2.66^b ± 0.09	4.56^c ± 0.11	9.97^d ± 0.18	0.92	1.96	-
Aspartate	25.85^a ± 0.46	46.64^b ± 3.62	75.59^c ± 2.54	98.87^d ± 2.06	143.62^e ± 1.99	2.6	28.78	11.53
Alanine Transaminase (U/ml)	22.21^a ± 0.46	34.05^b ± 1.80	62.71^c ± 2.53	87.98^d ± 1.89	130.75^e ± 1.64	6.78	27.10	11.04

Different superscript with in same row indicates significant (P < 0.01) difference.

Table. 2 Effect of stages of mastitis AST and ALT activity, in cow blood-plasma.

Parameters	Normal	Sub-clinical			Clinical
		1^+	2^+	3^+	
Aspartate Transaminase (U/ml)	47.34±1.32	46.87 ± 1.68	46.68 ± 1.10	45.04 ± 1.98	45.48 ± 1.43
Alanine Transaminase (U/ml)	25.05 ± 1.08	23.85 ± 0.55	24.81 ± 1.41	26.02 ± 0.98	25.30 ± 0.99

experiment had similar trend to those reported for goat milk-whey (Khodke, 2007) and the average activity of ALT in blood plasma, were close to finding of Kauppinen (1984) and Kaneko *et al*. (1997) for cows.

The damage to the udder tissue due to inflammation (Bogin *et al.*, 1977) might have contributed to the increased enzyme activity in mastitis milk. Further, according to Chaudhary *et al.* (1995), the increased level of enzyme in mastitis milk could be due to the damaged condition of mammary tissue during mastitis resulting in the physiological disturbance of blood-milk barrier.

The above result showed that the AST and ALT activity in milk-whey has increasing trend with severity of mastitis whereas; the values for blood-plasma show no trend with the same.

The findings of the present study indicate that it can be used for the detection of mastitis as there was significant increase in activity with the severity of different forms of udder health. It is possible that alanine transaminase activity alone may not be guarantee for detection of mastitis however, in combination with other enzymes or milk constituents it may be useful for this purpose. This however, needs further probe with one or more of samples to reach a final conclusion.

LITERATURE CITED

Bogin, E. and G. Ziv, 1973. Enzymes and minerals in normal and mastitis milk, Cornell Vet., 63 : 666-676.

Bogin, E., Z.V. Zager, B.Rivertz, S.Gordin and A.Saran, 1977. Distribution of lactate dehydrogenase isoenzymes in normal an inflammed bovine udder and milk, Res. Vet. Sci., 2:198-200.

Cabaud, P.G., F. Wroblewski and V. Reggiero, 1958. A colorimetric method for determination of serum lactate dehydrogenase, American J. Clin. Pathol., 30:324.

Charjan, P., N. S. Mangle, D. R. Kalorey and S. V. Kuralkar 2000. Changes in milk pH and the levels of Na and K in whey with udder health status of cow, Indian Vet. J., 77 : 1066-1068.

Chaudhary, R. K., A. B. Sarker and K. K. Baruch, 1995. Certain enzymes and trace minerals in normal and mastitic milk from crossbred cows, Indian J. Vet., 72 : 336-338.

Durry, A. R. and G. W. Reed 1961. A herd irritation index using the California mastitis test, Vet. Med., 56: 147-150.

Hoeben, D., C. Burvenich , E. Trevisi, G. Bertoni, J. Hamann, R. W. Bruckmaier and J.W. Blum 2000. Role of endotoxin and TNF-á in the pathogenesis of experimentally induced *coliform* mastitis in periparturent cows, J. Dairy Sci. 67(4):503-514.

Hovarth,G., I. H.M. Abdul, V. Verga, G. Szemerdi and L. Quarami 1980. Effect of subclinical mastitis on milk composition. Magyar Allatorvosk Lapya. 39(9):615-619.

Kaneko, J. J., W. Harvey, M.L. Bruss, 1997. Clinical Biochemistry of Domestic Animals 5th Ed. Academic Press San Diego, London Appendix VIII: Blood analyze reference values in large animals : 890-894.

Kauppinen, K. 1984. ALAT, AP, ASAT, GGT, OCT activities and urea and total bilirubin concentrations in plasma of normal and Ketotic dairy cows, Zbl.Vet. Med.A. 31:567-576.

Khodke, M.V., 2007. Enzymatic alterations in goat milk related to udder health status, M.V.Sc. Thesis (Unpub) submitted to MAFSU, Nagpur.

Olson, D. P., R. C. Bull, L. F. Woodard and K. E. Kelly, 1981. Effects of maternal nutritional restriction and cold stress on young calves, Absorption of colostral immunoglobulins, American J. Vet. Res., 42:876-880.

Pyorala, S. 2003. Indicators of inflammation in the diagnosis of mastitis, Vet. Res. 34 : 565-578.

Sadekar, R. D., S. P. Waghmare, I. Khan and V. L. Doiphode, 2000. Efficacy of 'Cobalctan LC' in clinical mastitis cows and buffaloes with reference to effect on chemical profile of milk, Indian Vet. J. 77: 867-869.

Schalm, O. W., G. Caroll and N. C. Jain, 1971. Bovine Mastitis; Lea and Febriger Philadelphia Pa, USA: 95-127.

Shukla, S.K., V.P. Dixit, D.C. Thapaliyal and A. Kumar 1998. Bacteriological studies of mastitis in diary cows, Indian Vet. Med. Jou. 22 : 261:264.

Shahani, K. M. 1966. Milk enzymes: their role and significance, J. Dairy Sci. 49: 907-920.

Snedecor, G. W. and W. G. Cochran 1994. Statistical methods, 8th Edi. East West Press Pvt. Ltd. New Delhi : 217-232.

Tuteja, F.C., M.P. Kapur, A. Sharama and A.K. Vinayaka, 2000. Studies on serum selenium status and its relationship to somatic cell count in milk of buffalo. Indian Vet. Medi., 20(2):61-63.

Zaki, M.S., N.E. Sharaf, S.O. Mostafa, O.M. Fawzi and N.E. Batraway, 2008. Effect of subclinical Mastitis in some biochemical and clinicopathological parameters in buffalo, American-Eurasian J. Agric. and Environmental Sci. 3(2):200-204.

PKV Res. J. Vol. 36 (2), July 2012

Effect of Land Holding on Productive and Reproductive Performance of Purnathadi Buffaloes

S. R. Munnarwar[1], S. D. Chavan[2], R. R. Shelke[3] and S. G. Gubbawar[4]

ABSTRACT

The present investigation entitled, effect of land holding of farmers on reproductive and reproductive performance of Purnathadi buffaloes was undertaken with the view to know the performance of buffaloes reared by different categories of people in different location. For study, the farmers were categories on the basis of landholding as large, medium, marginal and landless. The study was confined to Akola, Akot and Telhara tahsil in Akola district (Maharashtra state). It was revealed from the study that the rate of feeding was low in marginal and higher in landless category of farmer. Similarly, the daily milk yield 4.83 l. and lactational yield 1324.76 l. was more in landless as compared to other categories. The age at first calving in buffaloes was at par in all four category and was more 55.84 months in landless category. The lactation length in case of marginal farmer was 9.08 month while other categoris were at par. The difference in dry period of buffaloes belonging to all four categories were found non significant.

Buffalo population in India is 98 million which contributes 55.31 per cent of the world cattle population (Anonymous, 2010), more than 95 per cent of world buffalo population is found in tropics. Murrha, Ravi/ Nilli, Nagpuri, Mehasan, Surti and Jafrabadi buffaloes are important breeds found in tropic. Buffaloes play an important role in farmers economy by becoming an integral part of agriculture system. The milk production and meat production from buffalo in India is 23.6 million tons and 0.4 million tons, respectively. Buffalo rearing in India is mostly with small farmer who own 1 to 3 animals per farmhold. Basically dairy industries are in the hand of small farmer, 2/3[rd] of milk producers are small or marginal farmers. Wakode (1985) exhibited that the farmers had tendency in buffalo rearing than that of cow. He also found that very marginal quantity of concentrate were incorporated in buffalo feed and feeding level and milk production showed positive correction. Sohel *et.al.* (1982) observed landless farmers herd increased with increase in size of land.

MATERIAL AND METHODS

The present investigation on effect of land holding of farmers on productive and reproductive performance in Purnathadi buffaloes was undertaken by collecting the information from the buffalo owners of Akola, Akot and Telhara tahsil in Akoal district (Maharashtra state). The data regarding various aspects of Purnathadi buffaloes were collected by personal interview. The 'Purna' river Akola, Akot and Telhara tahsil comprising of 429 villages from which 12 villages were selected by random sampling.

The data were collected in order to record the required information for the study from selected farmers, as the population of Purnathadi buffalo was concentrated in Akola, Akot and Telhara tahsil of the district. The data collection was concentrated on following four major categories divided on the basis of land holding.

Categories of farmers on the basis of land holding-

L_1 - Large (above 10 ha.)
L_2 - Medium (5 to 10 ha.)
L_3 - Marginal (upto 5 ha.)
L_4 - Landless

Collection of milk sample

The milk samples were collected by attending the milking at the door of farmers and transferred to laboratory for further analysis.

Chemical analysis

The milk samples collected from individual buffalo owner were chemically analysed for fat determination as per ISI standard procedure prescribed at Department of Animal Husbandry and Dairying, Dr. PDKV., Akola. Total solids and solids not fat (SNF) were determined by using following formula

$$\text{Total solid} = \frac{CLR}{4} + 1.22F + 0.72$$

CLR - Corrected lactometer reading
F - Fat percentage
SNF = Total Solid content – Fat percentage

Statistical analysis

The data on various variables were subjected to statistical analysis to find out mean, standard deviation and co-efficient of variation so as to estimate

1. Junior Research Assistant, 2. Associate Professor, 3.Assistant Professor and 4. Assistant Professor, Dept. of Animal Husbandry and Dairying, Dr. PDKV, Akola

the central value and extent of variability in the data. The co-efficient of variation was estimated by adopting the standard formula as given by Panse and Sukhthane (1967)

$$\text{Co-efficient of Variation} = \frac{\text{S.D. X 100}}{\text{Mean}}$$

Correlation

Simple correlation coefficient was worked out between various pair of variable in order to find out wheater the relationship existed or otherwise between the components of a pair. Correlation coefficient were worked out by adopting formula as given by Snedecor and Cochran (1967)

$$r = \frac{\sum XY - \frac{\sum X . \sum Y}{n}}{\sqrt{\sum X^2 - \frac{(\sum X)^2}{n} \times \sum Y^2 - \frac{(\sum Y)^2}{n}}}$$

RESULTS AND DISCUSSION

Rate of feeding roughages and concentrates

The buffaloes maintained by different categories of farmers had different feeding rate of roughages and concentrates as illustrated in table-1. The landless buffalo owners were feeding significantly more amount of roughages (11.76kg per buffalo) and concentrate (3.76 kg per buffalo) to their buffaloes than the rest of the categories of the farmer. The large land holding farmers were feeding 10.76 kg roughages and 3.44 kg concentrates per buffalo. However, the medium farmers were feeding 10.36 kg and 2.96 kg roughages and concentrates, respectively. In the category of marginal farmers lowest amount of roughages and concentrates feeding was found as 8.12 kg and 2.24 kg, respectively.

Table 1: Feeding rate (kg animal^{-1}) of roughages and concentrates under different categories of land holding

Categories	Roughages	Concentrates
Large (L_1)	10.76	3.44
Medium (L_2)	10.36	2.96
Marginal (L_3)	8.12	2.44
Landless (L_4)	11.76	3.76
S.E. (m) $\pm$	0.188	0.133
C.D. 5%	0.522	0.369

The productive performance

It was observed that the land holding did not show any definite relationship with productive performance. The data were analyzed and presented in Table 2 which amply shows that the daily milk yield in case of landless category of farmers was 4.83 liters which was more in all the categories of farmers *viz.*,large farmers, medium farmers and marginal farmers. The daily milk yield of large category of farmers was found to 4.63 liters whereas that of medium and marginal category of farmers was 4.61 and 4.26 liters, respectively. It may be due to difference in care taking because landless farmer directly depend on the milk production and so they take more care than that of others categories of secure minimum income. The average lactation yield of landless category of farmers was highest i.e. 1324.76 liters, followed by large farmers 1295.36 liters, medium and marginal farmers which was 1275.04 and 1180.24 liters, respectively.

The average day milk yield (6.8 liters) was reported by Anonymous (1999) for Pandharpuri buffaloes located in Kolhapur, Solapur and Sangli district was more than that the present Purnathadi yield. On the contrary the daily yields reported by Netke (1997) for buffaloes under various landholding categories were substantially lower than present values, the yield reported by him was 2.00, 2.41, 2.21 and 2.3 kg per animal under landless, marginal, medium and large categories, respectively. However the daily and lactational milk yield between the land holding categories did not differ significantly but average lactation yields in all categories of farmers were higher than those reported by Hadi (1965) in Marathwada buffaloes located in Parbhani, Beed and Jalna district was also lower than the present values while the yield of farm bred Pandharpuri buffaloes reported by Anonymous (1999) was higher i.e. 1420.74 lit per lactation than present milk yield values. From the results it can be interpreted that the feeding rate of roughages and concentrate and the productive performance had direct relationship with size of land holding of farmer. However, it was observed that the productive performance of buffaloes belonging to landless category was superior than the other categories because landless farmers were feeding their buffaloes with higher amount of roughages and concentrates as compared to other categories. The average lactation yields of all categories in present study were found higher than that of 1060.20$\pm$16.921 liters as reported by Belorkar *et.al.*(1977) and 1049.66 liters reported by Khaire *et.al.* (1983) in case of Nagpuri buffaloes.

The peak milk yield of buffaloes maintained by medium and marginal farmers was significantly lower than that of buffaloes reared by Large and Landless

Table 2: Effect of land holding of farmers on productive performace of buffaloes

Character	L_1	L_2	L_3	L_4	S.E. (m) $\pm$	C.D. 5%
Daily milk yield (l)	4.63	4.61	4.26	4.83	0.149	NS
Avg. Lact. yield(l)	1295.36	1275.04	1180.24	1324.76	43.994	NS
Peak milk yield(l)	8.76	7.65	7.32	8.96	0.330	0.947
Fat %	6.8	6.7	6.9	7.0	0.030	0.104
SNF %	9.3	9.3	9.4	9.6	0.041	0.119

Table 3 : Effect of land holding of farmers on reproductive performance of buffaloes

Character	L_1	L_2	L_3	L_4	S.E. (m) $\pm$	C.D. 5%
Age at first calving (month)	55.12	54.48	54.16	55.84	0.350	1.021
Lactation length (month)	9.60	9.68	9.08	9.60	0.110	0.315
Dry period (month)	4.64	4.84	4.98	4.58	0.160	NS

farmers. It may be due to more cautious in selecting good animals and proper maintenance of animal.

Further, it was observed from Table 2 that significantly more Fat and SNF was observed in the milk of buffaloes reared by landless farmers. This means the landless farmers were maintaining the animals from business point of view as compared to farmers of other categories because the rate of milk in market is directly related to the fat content of milk. The range of Fat and SNF recorded in present study are nearer to the range given by De (1980).

Reproductive performance

Reproductive performance of buffaloes with the farmer did not show any definite relationship with size of land holding. But age at first calving was significantly more in buffaloes kept by landless category while was at par in large, medium and marginal categories. The age of first calving was 55.12 months for large farmers, 54.48 months for medium farmers, 54.16 months for marginal farmers and 55.84 months for landless farmers. The results were not so different from 54.46 months reported by Kaire *et.al*. (1983) in case of Nagpuri buffaloes, but it is substantially higher than 42.31$\pm$ 1.05 months as found by Gautam *et.al*.(1965) in Murrah buffaloes which indicated that there was scope in reducing age of first calving in Purnathadi buffaloes.

The lactation length of buffaloes belonging to large and medium farmers were 9.60 and 9.68 months, whereas in marginal farmers and landless category were 9.08 and 9.60 months, respectively. The values are in agreement with lactation length of 9.74 months as reported by Khaire *et.al*. (1983). The dry period in buffaloes belonging to all categories did not shown any significant difference as per the results show in Table 3. However, they were higher than 4.48 months than that of results reported by Hadi (1965) in Marathwada buffaloes.

Correlation and regression studies

The correlation studies indicated the association between lactation yield and different productive characters, whereas the contribution of individual character in total variability is ascertained from the regression analysis. In view of this to know the contribution of different productive characters of different categories of the farmer according to their land holding status in accounting the variation in lactational yield of buffaloes, the correlation and regression analysis data were presented in Table 4.

The correlation studies among the different productive characters under different categories of land holding indicated that daily milk yield and lactational yield of buffaloes in L_2, L_3 and L_4 categories of farmers exhibited positive significant correlation being 0.785, 0.367 and 0.844, respectively.

However, it was evident from Table 5 that age at first calving, daily milk yield, lactational length and dry period together accounted for 76.30, 41.30 and 80.90 per cent variation in lactational yield of buffaloes under L_2, L_3 and L_4 categories, respectively. The significant R^2 values showed that lactational milk yield was influenced by these factors. However, the degree of influence of daily milk yield was maximum on lactational yield of the buffaloes. The magnitude of increase would be 267.34, 115.15, 200.40 l., respectively in L_2, L_3 and L_4 categories, with the increase of content and lactation length did not establish significant relationship with that of lactational yield, in all the influence of lactation length on lactational yield of buffaloes was found in positive direction.

Table 4 : Correlation coefficient of productive characters with lactional yield in buffaloes under land holding

Characters	Land holding			
	L_1	L_2	L_3	L_4
Lacatational yield x Daily milk yield	0.267	0.785**	0.367*	0.844***
Lacatational yield x Dry period	-0.003	-0.155	-0.003	0.447*
Lacatational yield x Age at first calving	0.143	0.112	0.302	0.005
Lacatational yield x Fat percentage	-0.038	-0.155	0.157	-0.190
Lacatational length x lacational yield	0.006	0.001	0.417	0.005

Table 5 : Productive characters contributing the variations in lactional yield of buffaloes under Land holding

Character	L_1			L_2			L_3			L_4		
	Reg	SE (b)	t value	Reg	SE(b)	t value	Reg	SE(b)	t value	Reg	SE (b)	t value
AFC	40.77	37.82	1.07	40.54	24.31	1.66	30.05	22.64	1.32	1.26	9.47	0.133
DMY	208.87	135.87	1.53	267.34	37.25	7.175	115.15	62.15	1.85+	20040	29.925	6.69**
Lac.L	0.706	2.94	0.240	3.501	2.005	1.74	5.49	3.05	1.79+	2.03	0.868	2.33*
Dry p.	61.11	88.88	0.687	-73.83	52.79	1.39	46.78	36.22	1.29	63.87	35.44	1.80+
Fat %	-104.24	339.85	-203.29	276.27	-0.735	216.49	239.21	0.904	154.89	99.12	1.54	
Intercept	149.15			4156.2			-2270.50			888.59		
R^2	0.153			0.763**			0.413*			0.809**		
'F' value	0.546			9.704			2.111			12.763		

*Significant at 1% **Significant at 5% + significant at 10%

CONCLUSION

It can be concluded from the above result and discussion that the productive performance of the Purnathadi buffaloes reared by farmers was poor in marginal farmers and higher in landless farmers. Landless farmers were feeding their buffaloes with higher amount of roughages and concentrates as compared to other categories, they also take care of animals because they are fully dependant on the income of milk production, while other category farmers have source of income i.e. land and therefore they treat milk production as secondary/subsidiary business.

LITERATURE CITED

Anonymous, 1999. Report of Joint AGRESCO in buffalo Research held at Dr.PDKV, Akola.

Anonymous, 2010. Basic Animal Husbandry, Statistics Government of India, ministry of Agriculture Development of Animal Husbandry, Dairying and Fishery, New Delhi.

Belorkar, P.M., 1977. Studies on the effect of service period on lactational yield, lactational period and dry period in Nagpuri (Berari) buffaloes, Indian Vet. J. 54 : 384-388.

De, Sukumar, 1980. Out line of Dairy Technology, Published by Oxford University place, New Delhi.

Gautam, J.D.; Kumar D and P.C. Agrawal, 1965. Breeding efficiency and producing ability in Murrah buffaloes, Indian Vet. J. 42 : 512-519

Hadi, H.A., 1965. A preliminary study of certain productive and reproductive characters of Marathwada buffaloes in Maharashtra State, Indian Vet. journal, 42(9) : 692-699

Khaire, D.W.; Deshmukh S.N.; Singh S.N.; Thatte V.R.; Amin M.M. and R.T. Desai,1983. Some economic characters in Nagpuri buffaloes, Indian J. Animal Sci. 53 (4) 413-414.

Netke, R. P., 1997. A brief survey of some important breed of cattle and buffalo in India, ICAR miscellaneous bulletin, Number.

Pansey, V.G. and P.V.Sukhatme, 1967. Statistical method for Agricultural Workers, IInd Ed. ICAR, New Delhi.

Snedecor, G. V. and W. G. Conchran, 1967, Statistical methods VIth Ed. The Lowa State Univ. Press, USA.

Sohel, T.S.; J.N. Singh and J.P. Singh, 1982. Impact on intensive extension education in adoption of scientific dairy farming of landless rural families around Kernal, Indian J. of Dairy Sci.,30(4):447-453

Wakode, S.P., 1985. Pattern of feeding and management practices adopted in Washim tahsil, M.Sc. Thesis (Unpub.), Dr. PDKV, Akola.

❖ ❖ ❖

PKV Res. J. Vol. 36 (2), July 2012

Effect of Newer Insecticidal Seed Treatment on Viability of Wheat Seed During Storage

U. K. Kadam[1], P. R. Palande[2], V. R. Shelar[3] and G. M. Bansode[4]

ABSTRACT

A study was conducted at MPKV, Rahuri, Maharashtra during 2009 to 2012 to assess the effect of newer insecticides on lesser grain borer, *Rhyzopertha dominica* infesting stored wheat. The results revealed that the seed treatment of deltamethrin 2.8 EC @ 1ppm (0.04 ml kg^{-1} seed) or lufenuron 5 EC @ 5ppm (0.1 ml kg^{-1} seed) or emamectin benzoate 5SG @ 2ppm (40 mg kg^{-1} seed) were equally effective for control of storage insect, *R. dominica* and for maintaining the wheat seed germination above minimum seed certification standard (85 %) upto 9 months of storage.

Wheat is an important food crop of India, which ranks second after rice and serving as a staple food for millions of people. It accounts for an area of 26.48 million hectares with production of 69.35 million tones. It is well established fact that lot of efforts should be put for the production of "every single grain" but this is of no use if the produced seeds are not saved, which recalls the proverb "a grain saved is a grain equally produced". This adage depends mainly on how best we protect the quality of grains during storage.

Use of quality seed is the most essential basic input in crop protection as this helps in maintaining required plant population per unit area. After harvest, the seed are stored for different period for sowing in next season.

Besides production constraints the insect pest problem, improper sanitation and storing methods cause both qualitative and quantitative losses in wheat. In storage the losses are mainly due to insects, mites and pathogens. The presence of insects in stored products has always posed unique problems. Nearly 10 per cent of the grain stored after each harvest is believed to be lost due to ravages of rats, insects, mites and microbial agents (Walter, 1971). The average loss of food grains in storage due to biotic and abiotic factors accounts for 10 per cent per year, out of which insects are contributing about 2.5 to 5.0 per cent. Survey conducted by Food and Agriculture Organization revealed that, *R. dominica* is the major pest of wheat, rice and millets in India (Champ and Dyte, 1977).

Its attack is normally noticed when considerable damage is already done. To avoid such losses, periodic surveillance of godawons with monitoring devices is required for taking timely control measures. Under our condition it is not feasible for farmer to provide ideal condition of seed storage, when seeds are to be stored under ambient conditions. Some pre storage seed treatment is needed to take care of insect pests during storage with the aim of improving the shelf life of seed. With a view to test newer insecticides against *Rhyzopertha dominica* the present studies were undertaken.

MATERIAL AND METHODS

A laboratory experiment conducted at Seed Technology Research Unit. MPKV, Rahuri for three consecutive years from 2009-2010, 2010-2011 and 2011-2012 in completely randomized design having eight treatments and three replications. The different treatments viz, flubendiamide 480SC @ 2ppm (4.2mg kg^{-1} seed), emamectin benzoate 5SG @ 2ppm (40.0mg kg^{-1} seed), spinosad 45 SC @ 2ppm (4.4 mg kg^{-1} seed), thiodicarb 75 WP @ 2ppm (2.7mg kg^{-1} seed), indoxacarb 14.5SC @ 2ppm (13.8mg kg $seed^{-1}$), lufenuron 5 EC @ 5ppm (0.1ml kg $seed^{-1}$) and deltamethrin 2.8 EC @ 1.0 ppm (0.04ml kg^{-1} seed) were compared with untreated control. Freshly harvested 1 Kg certified wheat seed (HD-2189) with very high germination percentage and low moisture content was taken for each treatment. Required quantity of insecticide was diluted in 5 milliliter of water to treat 1 Kg of seed for proper coating. After drying in shade, seeds were packed in 2 Kg capacity gunny bag lets and kept in storage under ambient conditions.

Germination was determined as per ISTA rules (Annon, 1985). Insect infestation was carried out by counting damaged seed. The data were analyzed using

1. Assistant Seed Res. Officer, 2. Senior Res. Asstt., 3.Seed Res. Officer and 4. Senior Res. Asst., STRU, MPKV, Rahuri

Table 1: Performance of newer insecticides on wheat seed germination during storage. (Pooled data 2009-10 to 2011-2012)

S. N.	Treatments	0 Month	3 Months	6 Months	9 Months
1	Flubendiamide 480 SC @ 2ppm (4.2mg kg^{-1} seed)	93.67	90.33	86.67	83.11
		(75.69)	(71.99)	(68.62)	(65.85)*
2	Emamectin benzoate 5 SG @2ppm (40.0mg kg^{-1} seed)	94.11	91.67	89.33	86.11
		(76.37)	(73.43)	(71.05)	(68.18)
3	Spinosad 45 SC @ 2 ppm (4.4 mg kg^{-1} seed)	94.00	90.00	86.67	83 .44
		(76.15)	(71.72)	(68.63)	(65.63)
4	Thiodicarb 75 WP @ 2 ppm (2.7mg kg^{-1} seed)	93.78	91.00	87.22	83.11
		(75.87)	(72.60)	(69.13)	(65.03)
5	Indoxacarb 14.5 SC @ 2 ppm (13.8mg kg^{-1} seed)	94.00	90.00	86.67	84 .11
		(76.02)	(71.66)	(68.62)	(66.27)
6	Lufenuron 5 EC @ 5 ppm (0.1ml kg^{-1} seed)	94.00	92.67	89.33	87 .33
		(76.18)	(74.49)	(71.08)	(68.72)
7	Deltamethrin 2.8 EC @ 1.0 ppm (0.04 ml kg^{-1} seed)	94.00	92.33	89.67	88.11
		(76.06)	(74.08)	(71.36)	(69.29)
8	Untreated control	94.33	87.67	83.00	78 .22
		(76.62)	(69.54)	(65.67)	(62.54)
	S.E. (m) ±	1.36	1.15	1.07	0.40
	C.D. at 5 %	NS	NS	3.03	1.18

Figures in parenthesis are arcsine transformed values * Wt.mean

Table 2: Performance of newer insecticides on wheat seed infestation during storage. (Pooled data 2009-10 to 2011-2012)

S. N.	Treatments	0 Month	3 Months	6 Months	9 Months
1	Flubendiamide 480 SC @2 ppm (4.2mg kg^{-1} seed)	0	0.67	1.44	2.44
			(3.45)*	(6.43)	(8.07)*
2	Emamectin benzoate 5 SG @ 2 ppm (40.0mg kg^{-1} seed)	0	0.00	0.11	0.22
			(0.57)	(1.15)	(1.16)
3	Spinosad 45 SC @ 2 ppm (4.4 mg kg^{-1} seed)	0	0.11	1.00	2.67
			(0.81)	(5.12)	(9.28)
4	Thiodicarb 75 WP @ 2 ppm (2.7mg kg^{-1} seed)	0	0.00	0.78	2.78
			(0.57)	(4.28)	(9.67)
5	Indoxacarb 14.5SC @ 2 ppm (13.8mg kg^{-1} seed)	0	0.11	1.67	4.11
			(0.81)	(6.90)	(11.09)
6	Lufenuron 5 EC @ 5 ppm (0.1ml kg^{-1} seed)	0	0.00	0.11	0.33
			(0.57)	(1.15)	(1.52)
7	Deltamethrin 2.8 EC @ 1.0 ppm (0.04ml kg^{-1} seed)	0	0.00	0.00	0.11
			(0.57)	(0.57)	(0.94)
8	Untreated control	0	11.89	19.78	27.78
			(20.56)	(26.36)	(31.72)
	S.E. (m) ±	-	0.44	1.26	0.54
	C.D. at 5 %	-	1.29	3.60	1.59

Figures in parenthesis are arcsine transformed values * Wt. mean

Table 3: Performance of newer insecticides on wheat seed moisture during storage (Pooled data 2009-10 to 2011-2012)

S. N.	Treatments	0 Month	3 Months	6 Months	9 Months
1	Flubendiamide 480 SC @ 2 ppm (4.2mg kg^{-1} seed)	8.45	10.55	10.13	9.19
		(16.90)	(18.94)	(18.56)	(17.65)
2	Emamectin benzoate 5 SG @ 2 ppm (40.0mg kg^{-1} seed)	8.36	10.39	10.21	9.15
		(16.80)	(18.79)	(18.63)	(17.61)
3	Spinosad 45 SC @ 2 ppm (4.4 mg kg^{-1} seed)	8.39	10.58	10.34	9.15
		(16.83)	(18.96)	(18.76)	(17.60)
4	Thiodicarb 75 WP @ 2 ppm (2.7mg kg^{-1} seed)	8.53	10.47	10.14	9.24
		(16.98)	(18.86)	(18.56)	(17.69)
5	Indoxacarb 14.5SC @ 2 ppm (13.8mg kg^{-1} seed)	8.51	10.71	10.11	9.10
		(16.95)	(19.08)	(18.54)	(17.55)
6	Lufenuron 5 EC @ 5 ppm (0.1ml kg^{-1} seed)	8.35	10.43	10.35	9.37
		(16.79)	(18.83)	(18.77)	(17.82)
7	Deltamethrin 2.8 EC @ 1.0 ppm (0.04 ml kg^{-1} seed)	8.29	10.62	10.04	9.14
		(16.73)	(19.00)	(18.47)	(17.60)
8	Untreated control	8.38	10.70	10.33	9.22
		(16.82)	(19.07)	(18.75)	(17.67)
	S.E. (m) ±	0.07	0.10	0.11	0.13
	C.D. at 5 %	NS	NS	NS	NS

Figures in parenthesis are arcsine transformed values * Wt. mean

CRD design. Samples of treated seed were drawn and observation of per cent germination, per cent infestation and moisture content percentage were recorded at three months interval i.e. 0, 3, 6 and 9 months of storage period.

RESULTS AND DISCUSSION

The germination test of wheat seed treated with different insecticides were carried out at 0, 3, 6 and 9 months after storage during 2009-10, 2010-11, 2011-12 and pooled data on germination percentage are presented in table (1). It is clear from the data that the germination percentage was highest at 0 month then afterwards the percentage were lowered at 3,6, and 9 months of storage period, which is perhaps due to natural senescence. However there was no significant difference in germination percentage up to three month of storage period. Further the data on 6 and 9 month after storage revealed significant difference among the different treatments. At 6 months after storage the wheat seed treated with deltamethrin 2.8 EC @ 1ppm (0.04ml) per kg of seed recorded significantly highest germination (89.67 %) and remain at par with rest of the treatment except untreated control (83.00 %). At 9 month storage treatment with deltamethrin 2.8 EC @ 1 ppm recorded germination (88.11 %) above MSCS level (85 %) and found at par with lufenuron 5 EC @ 5 ppm (87.33 %) and emamectin benzoate 5 SG @ 2ppm (86.11%). The remaining treatments recorded germination below MSCS level (85.00%) (Table 1).

The per cent wheat seed damage in wheat seed was noticed significantly lower in all insecticidal treatment as compared to untreated control. The treatment of deltamethrin 2.8 EC @ 1ppm, lufenuron 5 EC @ 5 ppm, thiodicarb 75 WP @ 2 ppm and emamectin benzoate 5 SG @ 2ppm were found free from insect damage at 3 month after storage period. Further, at 6 moths after storage deltamethrin 2.8 EC @ 1ppm remain free from insect infestation and at par with lufenuron 5 EC @ 5 ppm (0.11%) and emamectin benzoate 5 SG @ 2ppm (0.11%). The significantly highest damage was recorded in untreated control (19.78 %). Similarly at 9 month after storage period, least infestation was found in deltamethrin2.8 EC @ 1 ppm (0.11%) treatment and which was found at par with emamectin benzoate 5 SG @ 2ppm (0.22%) and lufenuron 5 EC @ 5 ppm (0.33%). The remaining treatments recorded significantly minimum infestation compared to control (27.78%). (Table 2)

The effectiveness of deltamethrin and emamectin benzoate has been reported by Ghelani *et. al.,* (2009) against stored grain pest of pearl millet. The study conducted at various seed project showed that deltamethrin, emamectin benzoate and lufenuron were found equally effective and provided protection of storage insect infesting wheat, pearl millet and paddy seed under different agro-climatic conditions for nine months (Annon, 2012).

The moisture content in the seed for all the three years was found non significant and remained within the safe limit throughout the storage period. The moisture content ranged from 9.10 to 9.37 per cent after 9 month of storage period (Table 3). This indicates that the insecticides had no effect on seed moisture percentage (Table 3).

Thus, the study brought out the significance of storing wheat seed with minimum seed certification standard of 85 per cent up to 9 months in gunny bag after seed treatment either with deltamethrin 2.8 EC@ 1ppm or emamectin benzoate 5SG @ 2 ppm or lufenuron 5EC @5ppm by protecting them from infestation caused *by R. dominica.*

LITERATURE CITED

Anonymous, 1985. International rules for seed testing, Seed Sci. Technol., 13:307-320.

Anonymous, 2012. All India Co-ordinated National Seed Project (Crops) Annual Report, Project Co-ordinator, National Seed Project (Crops), Directorate of Seed Research (ICAR), MAU : 265-326.

Champ, B. R. and C. E. Dyte, 1977. Global survey of pesticide susceptibility of stored grain pests, FAO Pl. Prot. Sci., No. 5, FAO, Rome.

Ghelani, Y. H., K. K. Dhedhi., H. J. Joshi., K. L. Raghavani and C. J. Dangaria, 2009. Effect of insecticidal seed treatment on viability of pearl millet seed during storage, Karnataka J. Agric. Sci., 22 (3): 633-634.

Walter, B., 1971. Sorptive dusts for pest control, Annual, Rev. Entomol., 16 : 123-156.

❖ ❖ ❖

PKV Res. J. Vol. 36 (2), July 2012

Bio-rational Management of Citrus Butterfly in Nursery

A. K. Sadawarte[1], N. E. Jayewar[2] and G. K. Giri[3]

ABSTRACT

The study on bio-rational management of Citrus butterfly was undertaken during 2005-2008 at nursery of All India Co-coordinated Research Project (Tropical Fruit) Dr. Panjabrao Deshmukh Krishi Vidyapeeth Akola in RBD with seven treatments and three replications. Treatments consisting of chemical insecticides, Thoidicarb 75 WP @ 0.075 per cent, Carbaryl 50 WP 0.15 per cent, botanicals, Neem oil 0.5 per cent, Neem soap 10 g l^{-1} bio-control agents *Bacillus thuringiensis* (2 x 10^9 CFU ml^{-1}) 0.05per cent, *Bacillus thuringiensis* 0.1 per cent and control. Among all the treatments, Thiodicarb 75 WP 0.075 per cent and *Bacillus thuringiensis* 0.1 per cent was found to be the most effective treatments for management of citrus butterfly in nursery.

United Nations Conferences on Tread and Development (UNCTAD) in 2006 say that globally 140 countries are involved in citrus production. Of the world total citrus production, approximately 70 per cent has been reported from the northern hemisphere, with Brazil being the top citrus producing country, followed by USA. India ranks eighth in world citrus production (FAOSTAT 2010). In India, citrus is cultivated on 3,24,000 ha area with production of 3,25,000 mt. Vidarbha is known as major citrus growing belt in India having about 127 thousand hectare area under citrus with production of 5,00,000 mt (Anonymous, 2011). Large number of citrus seedlings are produced in this area and supplied to all over India, it is estimated that nearly 2.5 million seedlings of citrus is produced every year. However, nursery owner has to face substantial damage due to insect pest.

More than 250 insect pests have been recorded on various citrus species in India (Butani, 1979, Thakare, *et al.,* 1984). However, among theses Citrus butterfly, Citrus leaf miner and Mites are some important pest occur regularly in nursery stage causing considerable damage and thereby posing a serious threat to the citrus nursery and hence considered as major importance.

Citrus butterfly, *Papilio demoleus* L (Papilionidae: Lepidoptera) is a key pest of citrus in India, Adults are strong fliers and are introduced in to new regions with their host plant. In recent past *P. demoleous* has been recorded from new World countries like Dominican Republic (Guerrero *et al.,* 2004) Jamaica and Puerto Rico (Homziak and Homziak 2006). It is most destructive to citrus seedling as well as to new flush (Butani, 1979). Serious out break of *P. demoleus* have been recorded in 1969 on Bhera *Chloroxylon sweetenia* in Vidarbha region of Maharashtra (Thakre and Borle 1974) and on citrus in Vidharbha (Shivankar, 2003). In citrus nursery larva of citrus butterfly initially feeds on tender leaves causing defoliation and due to this the growth of seedling remain stunted and seedling become ready for budding behind the schedule and because of this nursery owner has to face economic losses and hence it is necessary to control this pest. It is also crucial to evaluate bio-agents and botanicals for management of this pest considering the adverse effect on environment and increasing cost of chemical pesticides and demand from farmers regarding organic and eco-friendly alternative of pest management, so considering all the above facts present work was planned.

MATERIAL AND METHODS

The field trial was conducted for three consecutive years from 2005-06, 2006-07& 2007-08 at nursery of All India Co-coordinated Research Project (Tropical Fruit) Dr. Panjabrao Deshmukh Krishi Vidyapeeth Akola in RBD with seven treatments and three replications. Treatments consisting of chemical insecticides, Thoidicarb 75 WP @ 0.075 per cent, Carbaryl 50 WP 0.15 per cent botanicals, Neem oil 0.5 per cent, Neem soap 10 g l^{-1} bio-control agents *Bacillus thuringiensis* (2 x 10^9 CFU ml^{-1}) 0.05 per cent, *Bacillus thuringiensis* 0.1 per cent and control.

The experiment was conducted on seedlings of citrus (Nagpur mandarin) in nursery. Five seedlings of citrus from per plot were selected and labelled. Pretreatment observation number of larvae per seedling was recorded on five seedlings per plot before spraying and post treatment observations were recorded on 3rd, 7th and 14th days after spraying. Per cent mortality was worked out transformed into arcsine values and the three year data on larval percent mortality were pooled together and analyzed which is given in Table 1 & 2

1 & 3. Associate Prof. and 2. Assistant Prof., Department of Entomology, Dr. PDKV, Akola

Table: 1 Reduction of larvae of citrus butterfly after spraying

(Pooled for 2005-06, 2006-07, 2007-08)

S. N.	Treatments	Larval reduction at 3 DAS (per cent)			Pooled	Larval reduction at 7 DAS (per cent)			Pooled
		05-06	06-07	07-08	Mean	05-06	06-07	07-08	Mean
1	*Bacillus thuringiensis* 0.05%	73.80	38.383	38.90	51.47	72.10	48.99	54.50	58.81
		(59.10)*	(38.36)	(38.56)	(45.84)	(58.11)	(44.41)	(47.58)	(50.03)
2	*Bacillus thuringiensis* 0.1%	96.30	69.19	48.51	74.66	100.00	81.21	59.90	86.40
		(78.89)	(56.40)	(44.01)	(59.79)	(90.00)	(64.21)	(50.72)	(68.34)
3	Carbaryl 50 WP 0.15%	90.20	71.03	66.10	76.80	100.00	74.73	61.34	81.90
		(71.76)	(57.48)	(54.39)	(61.21)	(90.00	(59.85)	(51.52)	(67.12)
4	Thiodicarb 75 WP 0.075%	95.80	82.78	97.42	93.17	100.00	93.89	90.56	99.24
		(78.23)	(65.51)	(80.68)	(74.80)	(90.00	(78.56)	(86.20)	(84.92)
5	Neem oil 0.5%	56.80	35.73	28.95	40.24	98.00	48.48	30.20	72.10
		(48.87)	(36.70)	(32.51)	(39.36)	(81.96)	(44.14)	(33.34)	(58.12)
6	Neem soap 10 g/l	55.70	22.62	30.57	35.66	70.40	29.90	10.22	31.78
		(48.26)	(28.18)	(33.57)	(36.67)	(57.01)	(32.72)	(18.60)	(36.11)
7	Control	20.30	3.33	3.27	6.20	55.00	5.55	5.49	20.01
		(26.70)	(6.15)	(10.37)	(14.42)	(47.82)	(14.18)	(13.53)	(26.60)
	'F' test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
	SE (m)±	9.76	3.04	3.40	3.43	5.84	4.53	3.42	4.97
	CD at 5%	27.42	8.53	9.55	9.66	16.41	12.74	9.61	13.98
	CV%	28.74	12.76	14.02	12.57	22.50	16.27	13.76	15.68

*Figures in parenthesis are arc sine values

Table 2 : Reduction of larvae of citrus butterfly 14 days after spraying (Pooled for 2005-06, 2006-07, 2007-08)

S.N.	Treatments	Larval reduction at 14 DAS (%)			Pooled mean
		05-06	06-07	07-08	
1	*Bacillus thuringiensis* 0.05%	89.27	78.19	59.20	76.70
		(70.85)*	(62.21)	(50.30)	(61.12)
2	*Bacillus thuringiensis* 0.1%	98.00	92.26	68.20	88.90
		(81.96)	(73.98)	(55.66)	(70.53)
3	Carbaryl 50 WP 0.15%	97.62	82.27	61.12	83.35
		(81.14)	(65.18)	(51.38)	(65.90)
4	Thiodicarb 75 WP 0.075%	100.00	96.11	100.00	98.70
		(90.00)	(80.96)	(90.00)	(86.89)
5	Neem oil 0.5%	97.00	48.48	60.27	72.40
		(80.00)	(44.12)	(50.91)	(58.34)
6	Neem soap 10 g l^{-1}	86.30	25.71	14.28	41.50
		(68.25)	(29.8)	(22.18)	(40.10)
7	Control	75.00	3.33	2.60	18.10
		(60.00)	(6.15)	(9.25)	(25.13)
	'F' test	N.S.	Sig	Sig	Sig
	SE (m) ±	10.63	4.07	5.56	6.39
	CD at 5%	-	11.44	15.63	17.95
	CV%	24.23	13.63	20.46	18.99

*Figures in parenthesis are arc sine values

RESULTS AND DISCUSSION

Reduction in larvae of citrus butterfly at 3 DAS :

It is revealed from data presented in Table 1 that all the treatments were significantly superior over control in their efficacy. Treatment with Thiodicarb 75 WP 0.075 per cent was found significantly superior over all the treatment after 3 days of spraying by recording 93.17 per cent reduction in larvae of citrus butterfly. It is followed by Carbaryl 50 WP 0.15 per cent and *Bacillus thuringiensis* 0.1 per cent and both these treatments are at par with each other. The remaining treatments viz. *Bacillus thuringiensis* 0.05 per cent, neem oil 0.5 per cent and Neem soap 10 g l^{-1} was found less effective and at par with each other but superior over control.

Reduction in larvae of citrus butterfly at 7 DAS:

It is concluded from the data presented in Table 1 that after 7 days of spraying treatment of Thiodicarb 75 WP 0.075 per cent registered 99.24 per cent reduction in the larval population of citrus butterfly and found significantly superior over all the other treatments. The next effective treatments were *Bacillus thuringiensis* 0.1per cent, Carbaryl 50 WP 0.15 per cent and Neem oil 0.5 per cent in reduction of larval population of citrus butterfly after 7 DAS and were at par with each other. It is followed by the treatment of *Bacillus thuringiensis* 0.05 per cent. However, the treatment with Neem soap was found least effective and found at par with control. whereas, the treatment with *Bacillus thuringiensis* 0.05 per cent was found at par with that of Neem oil 0.5 per cent.

Reduction in larvae of citrus butterfly at 14 DAS

It is found from the data presented in Table 2 that all the treatments were significantly superior over control in terms of larval reduction. After 14 days of spraying Thiodicarb 75 WP 0.075 per cent and *Bacillus thuringiensis* 0.1per cent, were found significantly superior over all the other treatments inflict 98.70 and 88.90 per cent reduction in larvae of citrus butterfly and they were at par with each other. Carbaryl 50 WP 0.15 per cent *Bacillus thuringiensis* 0.05 per cent and neem oil 0.5 per cent found to be next effective treatments in reduction of larval population of citrus butterfly. However, treatment *Bacillus thuringiensis* 0.1per cent and Carbaryl 50 WP 0.15 per cent, *Bacillus thuringiensis* 0.05 per cent and Neem oil 0.5 per cent were at par with each other. The treatment with Neem soap was found least effective and at par with control.

Finding of higher efficacy of Thiodicarb 75 WP 0.075 per cent was soundly sustained by Anonymous (2008). Similarly result of *Bacillus thuringiensis* 0.1per cent resemble the finding by Srivastava (1977) and Rafi *et al* 1991. Higher Potency *Bacillus thuringiensis* inflicting higher level mortality at tested concentrations were evident in laboratory by Zubaidi *et al.*, (2007) was found that 0.5 and 1 mg ml^{-1} of *Bacillus thuringiensis* recorded 100 per cent mortality of *Papilio demoleous.* Likewise efficacy of Carbaryl 50 WP 0.15 per cent was well supported by Abraham (1957), Sharma and Srivastava (1970), Sing and Kumar (1982). Bio-pesticides *Bacillus thuringiensis* is as effective as chemical insecticides and thus help in achieving pest management with eco-friendly approach and supporting hypothesis of present study.

CONCLUSION

It is concluded from the pooled result that Thiodicarb 75 WP 0.075 per cent was found to be the most effective treatment in reducing the larval population of Citrus butterfly, it is followed by treatments of *Bacillus thuringiensis* 0.1per cent, and others efficient treatment in descending order as Carbaryl 50 WP 0.15 per cent Neem oil 0.5 per cent and *Bacillus thuringiensis* 0.05 per cent. Hence for sustainable and ecofriendly management of citrus butterfly *Bacillus thuringiensis* 0.1per cent is a good alternative.

LITERATURE CITED

Abraham F.V., 1957. A note on the control of the Citrus butterfly *Papilio demoleus* L., South Indian Hortic., 5(1) : 22 - 24.

Anonymous, 2008. Biennial Research Report of working of All India Coordinated Research Project on Tropical fruits held at TANU Coibatore on 9th to 12th April 2008 : 262-263.

Anonymous, 2011. Area and production estimates for Horticultural crop In National Horticulture Database 2011. Published by national Horticulture Board : 61 – 65.

Butani D. K., 1979. Insect pests of Citrus and their control, Pesticides., 13(4): 15 – 21.

FAOSTAT, 2010, http: // faostat,faoorg/sit/339/ default.aspx.

Guerrero K.A., D. Veloz, S.L.Boyee,B.D. Ferrell, 2004. First New world documentation of an old world citrus pest, the lime swallowtail *Papilio demoleus* (Lepidoptera : Papilionidae) in the Dominican Republic (Hispaniola), American Entomologist, 50: 227 – 229.

Homziak, M.T., Homziak, 2006. *Papilio demoleus* (Lepidoptera : Papilionidae) a new record for the United States, Commonwealth of Puerto Rico, Florida Entomologist, 89 : 485 – 488.

UNCTASD, 2006. http: // www.fas.usda.gov/htp/ Hort_Circular/2006.

Rafi M. A., M. Irshad and M.A. Matin, 1991. Bio-ecology of P. demoleous (Lepidoptera: Papilionidae) and efficacy of Bactospeine against it's larvae, Pakistan J. Entomolo., 6 (1-2) : 53 – 61.

Sharma R. P. and O. S. Shrivastva, 1970. Studies on the chemical control of *Papilio demoleous* L *citrus reticulate*, Madrsh Agri J., 57 (50): 30- 302.

Shrivastava R.P., 1977. A studies on the feasibility of integrated control of Citrus pests, Entomol.,7(4):5-6.

Shivankar, V.J. 2003. Insect pest of Citrus and their management (In) Advances in Citriculture. (Eds. Shyam Singh, Shivankar, V.J. and I. P. Singh), Jagmandar Book Agency New Delhi.

Singh R. and V. Kumar, 1982. Efficacy of some insecticides in controlling citrus butterfly (*Papilio demoleous* L). Res. Devlop. Reporter (3) 2 : 85 – 86.

Thakre, K.R., and M.N. Borle, 1974. Outbreak of lemon butterfly in Maharashtra, PKV Res. J., 2 (2) : 82 – 85.

Thakre, K.R. , S.G. Radke, M.N. Borle and H.T. Ghuguskar, 1984 Two Decades of Research in Citrus Pest Management in Maharashtra, Directorate of Res., Dr. Panjabrao Deshmukh Krishi Vidyapeeth,Akola, Bulletin 2: 12-13.

Zubaidi. F. AL., N.A. Hailaf and Layla N. AL-Okaily, 2007 *Bacillus Thuringinsis* var. kuristaki Berliner as a biological control agent against bitterfly, *Papilio demoleus* L. (Lepidoptera : Papilionidae), J. Kerbola University., 5 (4) : 1– 4.

❖ ❖ ❖

PKV Res. J. Vol. 36 (2), July 2012

Bioefficacy of Some Insecticides Against Brinjal Shoot and Fruit Borer

S.K. Khandare[1], V.S. Thokare[2] and R.P. Chouke[3]

ABSTRACT

The present study was carried out to evaluate the bioefficacy of some insecticides with novel mode of action viz., cartap hydrochloride, emamectin benzoate, lambda cyhalothrin, spinosad, indoxacarb, chlorpyriphos, cypermethrin and azadirachtin (check) against brinjal shoot and fruit borer, *Leucinodes orbonalis* Guen. on brinjal at Department of Entomology, Dr. PDKV, Akola during *Kharif* 2009-10 with local brinjal variety, Suruchi selection -10. Application of spinosad 45SC @ 0.01per cent was found to be the most effective and statistically superior treatment in terms of minimum shoot damage and fruit infestation. The next sets of treatment in descending order of efficacy were indoxacarb 14.5SC @ 0.01 per cent, emamectin benzoate 5 SG @ 0.0015 per cent, cartap hydrochloride 50SP @ 0.1per cent. Highest brinjal yield was realized due to application of spinosad 45SC and indoxacarb 14.5SC with yield level of 81.05 q ha^{-1} and 76.29 q ha^{-1}, respectively. With reference to economic feasibility of treatment cypermethrin, lambda cyhalothrin and indoxacarb were more promising with an incremental cost benefit ratio of 1:12.05, 1:6.50 and 1:6.14, respectively.

Brinjal or egg plant (*Solanum melongena* Linn.); family Solanaceae is one of the important vegetable cash crops. It is considered to be native of India and is grown extensively in all the south East Asian countries. In India, the area under brinjal crops is 680000 ha with production is 118.96 lakh tonnes and the productivity is 17.5 t ha^{-1}. In china the area under brinjal crops is 731547 ha with production 245.02 lakh tonnes and productivity 33.5 t ha^{-1}. India occupies second position after China in area, production and productivity. (Jena *et al*. 2006; Anonymous. 2010).

Now a day, cultivation of brinjal is troublesome for the farmers, on account of the ravages of the insect pests. The crop is targeted by various insect pests right from seedling stage till harvest of the crop. Among these, brinjal shoot and fruit borer, *Leucinodes orbonalis* Guen. (Lepidoptera: pyralidae) is most destructive and is considered a major limiting factor in quantitative as well as the qualitative harvest of brinjal. It is renowned as challenging pest difficult to manage being an internal feeder. The pest accounts for 44.11 and 55.40 per cent of fruit infestation on number and weight basis, respectively (Tripathi *et al*., 1996).

Many insecticides have been reported effective against brinjal shoot and fruit borer, though residues on the fruit are a major concern. Thus present study was framed to evaluate safer and compatible alternative method of pest control in order to save the crop from these disastrous pests and safeguard to the consumer by an utilization of some botanical insecticide, viz., azadirachtin, the naturalists spinosad with some newer and conventional insecticide against target pest under studies (Natekar *et al.,* 1987; Harish *et al.,* 2011).

MATERIAL AND METHODS

The field trial was conducted to evaluate the efficacy of different insecticides for the management of brinjal shoot and fruit borer (*Leucinodes orbonalis* Guen.) at Field of Department of Entomology, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *Kharif* 2008-09. The experiment was conducted in Randomize Block Design with nine treatments replicated thrice. The treatments comprised of T_1 cartap hydrochloride 50SP @ 0.1per cent, T_2 emamectin benzoate 5SG @ 0.0015 per cent, T_3 lambda cyhalothrin 5EC @ 0.006 per cent, T_4 spinosad 45SC @ 0.01per cent, T_5 indoxacarb 14.5SC @ 0.01per cent, T_6 chlorpyriphos 20EC @ 0.05 per cent, T_7 cypermethrin 25EC @ 0.006 per cent, T_8 azadirachtin 1500ppm @ 3ml l^{-1}, and T_9 control (Water spray).

Application of insecticides was done on the basis of attainment of economic threshold level (5 per cent fruit damage) with knapsack sprayer. Efficacy of insecticide was based on per cent infestation of shoots and per cent fruits due to *L. orbonalis*. Observations were recorded on five randomly selected plants for healthy and infested plants in each plot observations were recorded on 3, 7 & 12 days after spraying (DAS) and per cent infestation of shoots $plot^{-1}$ was worked out. Similarly, fruit infestation were based on total weight of infested fruits & total weight of healthy fruits by using following formula,

$$\text{Per cent fruit damage} = \frac{\text{Weight of infested fruits}}{\text{Total weight of plucked fruits}} \times 100$$

1&2. P.G. Student, 3. Associate Prof., Department of Entomology, Dr. PDKV, Akola

The percentage damage in different treatments was transformed into corresponding arc sine value as per Gomez and Gomez (1984) and was subjected to statistical analysis of variance.

RESULTS AND DISCUSSION

Effect of insecticidal treatments on per cent shoots infestation

Data presented in (Table 1) on per cent shoot infestation by brinjal shoot and fruit borer revealed that lowest shoot infestation due to brinjal shoot and fruit borer (*Leucinodes orbonalis* Guen) was observed due to application of spinosad (10.24%) . It was followed by application of indoxacarb (11.62%) and emamectin benzoate (12.62%) and was at par with the superior treatment. Cartap hydrochloride was the next effective treatment in order of efficacy with 14.25 per cent shoot infestation but was statistically inferior to the promising treatments, whereas, untreated control plot had maximum shoot infestation of 33.62 per cent, followed by azadirachtin 1500ppm with 21.23 per cent shoot infestation.

Findings of Tayde and Sobita (2010) about insecticides, spinosad against brinjal shoot and fruit borer, (*Leucinodes orbonalis* Guen.) revealed spinosad 45SC as most effective and showed (09.84%) shoot infestation, per cent fruit infestation (06.87% on number basis and 07.35% on weight basis) are in the line of present finding.

The usefulness of indoxacarb 14.5SC has been conformed by Jayakrishnan and Madhuban, (2009) with application of indoxacarb 14.5SC at 75 and 150 g a.i. ha^{-1} effectively reduced the population of pest and increased the fruit yield of egg plant.

Effect of insecticidal treatments on per cent fruit infestation (Weight basis)

Data pertaining to effect of various treatments on per cent fruit infestation by brinjal shoot and fruit borer (*Leucinodes orbonalis* Guen.) presented in (Table 2) indicated that per cent fruit infestation varied from 12.88 to 34.53 per cent. The minimum fruit infestation was observed due to application of spinosad 45SC (12.88 %). It was followed by application of indoxacarb

Table 1. Mean per cent Shoot damage by brinjal shoot and fruit borer, *Leucinodes orbonalis*

Tr. No.	Treatments	Shoot damage (%)			Mean
		3 DAS	7 DAS	12 DAS	
1	Cartap hydrochloride 50 SP @ 0.1%	14.94 (22.71)	12.85 (20.99)	14.97 (22.74)	14.25 (22.17)
2	Emamectin benzoate 5 SG @ 0.0015%	13.71 (21.71)	11.14 (19.48)	13.01 (21.14)	12.62 (20.79)
3	Lambda cyhalothrin 5 EC @ 0.006 %	17.81 (24.92)	15.70 (23.31)	18.46 (25.42)	17.32 (24.58)
4	Spinosad 45 SC @ 0.01%	11.23 (19.56)	9.55 (17.96)	9.94 (18.35)	10.24 (18.65)
5	Indoxacarb 14.5 SC @ 0.01%	12.10 (20.34)	11.16 (19.47)	11.60 (19.87)	11.62 (19.93)
6	Chlorpyriphos 20 EC @ 0.05%	20.20 (26.69)	17.59 (24.79)	18.42 (25.41)	18.74 (25.64)
7	Cypermethrin 25 EC @ 0.006%	17.80 (24.94)	15.47 (23.13)	18.00 (25.08)	17.09 (24.41)
8	Azadirachtin 1500 ppm @ 3ml l^{-1}	21.42 (27.57)	20.87 (27.18)	21.40 (27.55)	21.23 (27.44)
9	Untreated Control	33.36 (35.28)	33.35 (35.26)	34.15 (35.74)	33.62 (35.44)
	SE (m)±	0.552	0.618	0.812	0.296
	CD at 5%	1.655	1.853	2.435	0.889

* Data subjected to arc sine transformations (Figures in parentheses are transformed values)

DAS : Days after spraying

14.5SC (14.95%) and emamectin benzoate 5SG (16.87%), whereas, plots treated with cartap hydrochloride 50SP recorded 18.51 per cent fruit infestation which was statistically inferior to best treatment. All the insecticidal treatments were significantly superior over the untreated control plot with 34.53 per cent fruit infestation due to brinjal shoot and fruit borer.

The efficacy of spinosad, indoxacarb and emamectin benzoate in the present study is substantially supported by the finding of Patra *et al.* (2009) who reported lowest mean shoot as well as fruit infestation (7.47 and 9.88%) in the plots treated with spinosad (50 g a.i. ha^{-1}) It was followed by indoxacarb (50 g a.i. ha^{-1}) with (8.89 and 13.13), emamectin benzoate (15 g a.i. ha^{-1}) with 10.95 and 16.66 per cent shoot and fruit infestation, respectively. The effectiveness of spinosad against fruit borer was also authenticated in the study made by Adiraubane and Raghuraman, (2008).

Effect of different treatments on fruit yield of brinjal

Brinjal fruit yield data (Table 3) revealed that application of spinosad recorded higher marketable brinjal fruit yield of 81.05 q ha^{-1}. It appeared as most promising treatment in getting higher brinjal fruit yield. It was followed by indoxacarb (76.29 q ha^{-1}) and emamectin benzoate (74.32 q ha^{-1}) but were lagging statistically to the most promising treatment; and the lowest yield was observed due to application of azadirachtin (56.65 q ha^{-1}) which was significantly superior over untreated control (43.45q ha^{-1}).

The superiority of spinosad with highest brinjal fruit yield of was also reported by Patra *et al.*(2009). They reported that the highest marketable fruit yield of 143.50 q ha^{-1} was recorded in spinosad treatment ,followed by indoxacarb and emamectin benzoate with 126.90 and 121.30 q ha^{-1}, respectively. Applications of cypermethrin recorded 72.96 q ha^{-1} yield of brinjal fruits. This result was supported by Duara *et al. (2003*) and Patel *et al. (2004*).

Net Profit and Incremental Cost Benefit Ratio (ICBR)

The data on the impact of various treatments and monetary returns presented in (Table 3) revealed

Table 2. Mean per cent fruit damage by brinjal shoot and fruit borer, *Leucinodes orbonalis* (weight basis)

Tr. No.	Name of Treatments	Fruit damage (%)			Mean
		3 DAS	7 DAS	12 DAS	
1	Cartap hydrochloride 50 SP @ 0.1%	18.65 (25.51)	18.25 (25.29)	18.64 (25.57)	18.51 (25.48)
2	Emamectin benzoate 5 SG @ 0.0015%	16.52 (23.90)	16.28 (23.79)	17.80 (24.93)	16.87 (24.24)
3	Lambda cyhalothrin 5 EC @ 0.006 %	18.87 (25.63)	20.22 (26.70)	18.87 (25.72)	19.32 (26.07)
4	Spinosad 45 SC @ 0.01%	13.37 (21.38)	12.57 (20.72)	12.70 (20.85)	12.88 (21.03)
5	Indoxacarb 14.5 SC @ 0.01%	15.06 (22.73)	14.09 (22.04)	15.71 (23.33)	14.95 (22.74)
6	Chlorpyriphos 20 EC @ 0.05%	22.72 (28.43)	23.50 (28.99)	22.10 (28.02)	22.77 (28.50)
7	Cypermethrin 25 EC @ 0.006%	18.40 (25.34)	21.48 (27.60)	20.84 (27.16)	20.24 (26.72)
8	Azadirachtin 1500 ppm @ 3 ml l^{-1}	25.79 (30.47)	26.14 (30.73)	25.90 (30.58)	25.94 (30.62)
9	Untreated Control	34.07 (35.71)	35.01 (36.27)	34.51 (35.96)	34.53 (35.99)
	SE(m)$\pm$	0.728	0.564	0.466	0.338
	CD at 5%	2.181	1.692	1.397	1.013

* Data subjected to arc sine transformations (Figures in parentheses are transformed values)
DAS: Days after spraying

Table 3. Yield and incremental cost benefit ratio for treatments under evaluation.

S.N.	Treatments	Yield (q ha^{-1})	Increase in yield over control (q ha^{-1})	Value of increased yield (Rs. ha^{-1})	Qty. of insecticide req. ha^{-1} for spray	Cost treatment (Rs/ha)		Total cost of plant protection	Net profit (Rs. ha^{-1})	ICBR	Rank
						Cost of insecticide	Labour + sprayer charges				
1	Cartap hydrochloride 50 SP @ 0.1%	70.55	27.10	16260	1000gm	3000	960	3960	12300	1:3.10	VII
2	Emamectin benzoate 5 SG @ 0.0015%	74.32	30.87	18522	150 gm	4050	960	5010	13512	1:2.70	VIII
3	Lambda cyhalothrin 5 EC @ 0.006 %	68.96	25.51	15306	600 ml	1080	960	2040	13266	1:6.50	II
4	Spinosad 45 SC @ 0.01%	81.05	37.60	22560	111 ml	4435	960	5395	17165	1:3.18	VI
5	Indoxacarb 14.5 SC @ 0.01%	76.29	32.84	19704	345 ml	1800	960	2760	16944	1:6.14	III
6	Chlorpyriphos 20 EC @ 0.05%	64.13	20.68	12408	1250 ml	810	960	1770	10638	1;6.01	IV
7	Cypermethrin 25 EC @ 0.006%	72.96	29.51	17706	120 ml	396	960	1356	16350	1:12.05	I
8	Azadirachtin 1500 ppm @ 3 ml l^{-1}	56.65	13.20	7920	1500 ml	375	960	1335	6585	1:4.93	V
9	Untreated Control	43.45	-		-	-	-	-			
	SE(m)±	6.19			-	-		-			
	CD at 5%	18.55			-	-		-			

1. Labour charges @ Rs. 75 day^{-1}, 2. Spray pump charge @ Rs. 25 day^{-1}, 3. Average Sale price of brinjal @ Rs. 600 q^{-1}

that application of spinosad gave highest monetary returns of Rs.17165 ha^{-1} and was followed by application of indoxacarb (Rs.16944 ha^{-1}), cypermethrin (Rs. 16350 ha^{-1}) and emamectin benzoate (Rs. 13512 ha^{-1}).

Calculations of incremental cost benefit ratio (ICBR) revealed cost effectiveness of cypermethrin with highest ICBR of 1:12.05 and can be stated as most viable treatment. Application of lambda-cyhalothrin and indoxacarb with ICBR of 1:6.50 and 1:6.14, respectively were next in descending order of economy. Rest of the promising treatments can be arranged as chlorpyriphos (1:6.01), azadirachtin (1:4.93), spinosad (1: 3.18), cartap hydrochloride (1: 3.10) and emamectin benzoate (1:2.70).

Although, application of spinosad was most promising, in terms of lower shoot and fruit damage translating into higher yield and monetary returns, the higher cost of application deprived it a place at top. Promising treatments with higher ICBR were cypermethrin, indoxacarb, which can be used against *Leucinodes orbonalis* Guen. Similar results are also reported by Borad *et al.* (2002), Kalawate and Dethe (2012) and Duara *et al.* (2003).

Thus, the overall results revealed that application of spinosad 45SC @ 0.01 per cent was found most effective treatment in minimizing shoot and fruit damage of brinjal shoot and fruit borer in brinjal crops with maximum yield and higher monetary returns. It was followed by indoxacarb 14.5SC @ 0.01per cent, emamectin benzoate 5SG @ 0.0015per cent, cartap hydrochloride 50SP @ 0.1per cent, respectively in recording less per cent shoot and fruit infestation of brinjal shoot and fruit borer and were significantly superior over control.

LITERATURE CITED

Adiroubane, D. and K. Raghuraman, 2008. Plant products and microbial formulation in the management of brinjal shoot and fruit borer, *Leucinodes orbonalis* (Guenee.), J. Bio pesticides, 1 (2):124 -129.

Anonymous 2010. http://www.iasri.res.in/agridata/12data/chapter8/db2012tb8_9.pdf

Borad, P. K., H. M. Patel, A. J. Chavda, and J. R. Patel, 2002. Bioefficacy of endosulfan and cypermethrin mixture against insect pests of brinjal (*Solanum melongena*), Ind. J. Agric. Sci, 72(11): 685-688.

Duara, D.; S. C. Deka ; A. A. Baruah and N. Barman. 2003. Bio- efficacy of synthetic parathyroid against brinjal shoot and fruit borer, *L. orbonalis* Guen. Pestol, 28(2): 28-30

Gomez, K. H. and A. A. Gomez, 1984. Statistical procedure for Agricultural Research, John Wiley & Sons, Inc. New York, USA (2nd edn.) : 680.

Harish D. K., A. K. Agasimani, S. J. Imamsaheb and S. S. Patil, 2011. Growth and yield parameters in brinjal as influenced by organic nutrient management and plant protection conditions. Res.J.Agric.Sci., 2(2): 221-225.

Jayakrishnan, S. and G. Madhuban, 2009. Application of Indoxacarb for management of shoot and fruit borer of egg plant (*Solanum melongena*) and its decontamination, J. Environ. Sci. and Health, Part B. 23(3):292-301.

Jena, B.C., B. Shrihari and R. Mohapatra, 2006. Pesticidal management practices to control brinjal shoot and fruit borer, Ind. J. Entomol. 68(2):193-196.

Kalawate, Aparna and M. D. Dethe, 2012. Bioefficacy study of biorational insecticide on brinjal, J. Bio pesticides, 5(1): 75-80.

Natekar, M. G., S. Rai and N. P. Agnihotri, 1987, Bioefficacy of synthetic pyrethroids and their residues in brinjal fruit, Pestol, 11:18-22.

Patel, B.V.; M. Bheemanna; A.C. Hosamani; G. B. Tulsiram and S.G. Hanchinal, 2004. Fenpropathrin (Meothrin) 30 EC: An ideal insecticide in brinjal, Pestology. 28(12) : 53-57.

Patra Sandip, M.L.Chatterjee, S. Mondal, A. Samanta, 2009. Field Evaluation of Some New Insecticides against Brinjal shoot and fruit borer, *Leucinodes orbonalis* (Guen.), Pesticide Res. J.,21(1):58-60

Tayde A. R. and S.Sobita, 2010. Efficacy of Spinosad and *Neem* Products Against Shoot and Fruit Borer (*Leucinodes orbonalis* Guen.) of Brinjal (*Solanum melongena* L.), Trends in Biosciences 3(2):208-209.

Tripathi, M. K., B. Senapati and R. K. Patra, 1996. Seasonal incidence and population fluctuation of *L. orbonalis* Guen.at Bhubaneshwar, Pest Mag. and Econ. Zool.4 (1):15-18.

❖ ❖ ❖

PKV Res. J. Vol. 36 (2), July 2012

Determinants of Income and Employment Generation Activities of Self Help Groups Women Entrepreneurs in Vidarbha Region

Y. B. Shambharkar[1], D. M. Mankar[2] and Amrapali Bhasme[3]

ABSTRACT

The study on "Analysis of entrepreneurship in women member of self help groups" was undertaken in Akola district in Vidarbha region of Maharashtra state with a sample size of 150 respondents from 15 villages in Akola district. Ex- post facto type research design was used for present investigation. The findings revealed that the trained women entrepreneurs' had generated average income of Rs. 22,933 from cloth shop, followed by Rs. 22,567/- and Rs. 22533/- from beauty parlour and kirana shop, respectively. After taking the training from the MAVIM institute, little more than half (52.66%) of women entrepreneurs had high level of income generation above Rs.10577/- followed by 30.66 per cent of them were in low level of income generation category (Up to Rs. 6179) and 16.67 per cent fall in medium level of income generation ranging from Rs. 6179 to Rs. 10,577. The 39.33 per cent of the trained women entrepreneurs of SHG showed continuously increasing trend. Increasing trend of income generation was due to good reputation with customers, adequate popularity, more demand for the product or service and further expansion of the units. In case of employment generation , enterprises like food items, papad making, farming, kirnana shop, beauty parlour were generated employment as 98,87,83,60, respectively. More than half (56.00%) of trained women entrepreneurs generated employment upto 56 days in a year through their enterprise.

Women are the best change agents to touch the core of poverty and are very important segment in development at local to global level. The status of women is barometer of democratism of any state, an indicator of how human rights are respected in it. Hence it is necessary to bring positive change in women. Time immemorial women are described as the better half of men. But in reality, the woman in developing countries does not tally with this description. It is well known fact that women have played and continue to play a key role in conservation of basic life support systems such as land, water, flora and fauna. Women have to play a dual role, as a housewife and as income earners. Women have the burden of preparing food for the family, besides fulfilling their fundamental role of nurturing and caring for the children and tending to elderly members of the household. Even then they suffer from being economically and socially invisible. There is continued inequality and vulnerability of women in all fields like socio-economic, political, education, health care, nutrition.

The development of any nation depends primarily on the important role played by the entrepreneurs. Thus, in all economic development activities more attention is being given to entrepreneurship development. Capacity building of women is a must for development of entrepreneurship among women. Therefore, entrepreneurship development training programmesare organized by many institutions. Appropriate feedback is of immense help in planning and conducting trainings. In this backdrop, this study will bring out the hard facts about rate of success of trainings and extent of income and employment generation by the women entrepreneurs

The specialists in economic development have considered entrepreneurship development as a possible approach to empowerment. A women as an entrepreneur is economically more powerful than as a mere work, because ownership not only confers control over assets but also gives her the freedom to take decision. This will also uplift her social status in the society.

The existence of women in the state of economic, political, social and knowledge disempowerment is known to be a major hindrance to economic development. Self help groups provides appropriate platform for economical development. There is need of empowerment of rural women in gender equality, drudgery reduction, facilitating self confidence, increasing their income, provision for increased employment, awareness about their rights and to avoid misbehavior from male dominated society

1. Assistant Prof., 2. Professor & Head and 3. PG student, Department of Extension Education, Dr. PDKV, Akola

There are number of SHGs of women in villages or cities. And also there are number of organizations engaged in imparting trainings to the SHGs. Hence to know the impact of training in establishing an enterprise or actual functioning of the SHGs, it is necessary to analyze the entrepreneurship in women member of self Help Groups to know their actual development through establishment of enterprises in terms of income and employment generation activities with the objective to study the income and employment generation activities.

MATERIAL AND METHODS

The present study was conducted in Patur, Akola and Murtizapur tahsil of Akola district in Vidarbha region of Maharashtra state. From each selected tahsil, list of women SHGs villages that were obtained trainings from MAVIM, Akola and established more enterprises were obtained from MAVIM head office, Akola. From Patur 07, Akola 05 and Murtizapur 03 villages were selected purposively on the basis of more number of enterprises established. Thus, total 15 villages were selected for data collection.From each selected village, the SHGs Women who had taken entrepreneurship training from MAVIM, Akola during the period 2007-2010 was listed. In those three years, the total number of SHGs women in selected villages trained was 1008. Later, list of SHGs trainees who had established an enterprise were enumerated with the help of MAVIM personnel, Akola. The respondents were selected purposively from the list to constitute sample size of 150 respondents.

RESULTS AND DISCUSSION

Income and employment generation

The results with regards to income and employment possessed by trained women entrepreneurs of self help groups generated from enterprises have been furnished as below

Income generation

The bird eye view of the Table 1 showed that, average income of Rs.22933 /- was generated from cloth shop followed byRs. 22567/- and Rs. 22533.00/- were generated from beauty parlor and Kiranashop respectively. These enterprises were situated in a place where they had good business and accessible to more number of customers and these enterprises provided service which was having more demand and good returns. Larger unit size, good reputation with the customers and adequate skill were the reasons for high income generation.

The respondents had generated income from enterprises such as stationary, tailoring, food items,garments and papad making were Rs.12033/-, Rs.11833/-,Rs. 11533/-, Rs.9166/- and Rs.8500/-, respectively. The products and services of above enterprises are mainly seasonal demand and they are medium range units. Apart from that more competition from the already established branded products and large units were the other reasons for medium income generation.

Table 1. Distribution of respondents according to their enterprise wise income generated by women entrepreneurs of Self Help Group

S. N.	Enterprise	Income generation in 3 years			Total income	Average income
		2007-08	2008-09	2009-10	earned in three years	in a year
1	Kirana shop	22600/-	20000/-	25000/-	67600/-	22533/-
2	Tailoring	10000/-	12000/-	13500/-	35500/-	11833/-
3	Beauty parlor	20000/-	22700/-	25000/-	67700/-	22567/-
4	Cloth shop	22000/-	23000/-	23800/-	68800/-	22933 /-
5	Papad making	8500/-	7000/-	10000/-	25500/-	8500/-
6	Bangles sale	3500/-	4200/-	5500/-	13200/-	4400/-
7	Food items	11200/-	12400/-	11000/-	34600/-	11533/-
8	Stationery	10300/-	12700/-	13100/-	36100/-	12033 /-
9	Masala preparation	4300/-	5000/-	4800/-	14100/-	4700/-
10	Garments	8000/-	8500/-	11000/-	27500/-	9167/-
11	Farming	5000/-	5700/-	7000/-	17700/-	5900/-
12	Dairy	4500/-	4000/-	6000/-	14500/-	4833 /-

The results also indicated that the farming enterprise (Rs. 5900/-), Dairy (Rs.4833/-), Masala preparation (Rs.4700/-) and Bangle sale (Rs.4400/-) were found to be comparatively low income generating enterprises. Comparatively less price for the produce in the area was the reason for low income generation.

It is revealed from Table 2 that little more than half (52.66%) of women entrepreneurs the respondents of self-help group were belonged to high level of income generation category which ranged above Rs.10,577/-, followed by 30.66 per cent of respondents in low level of income generation category (i.e. up to Rs.6179/-) and 16.67 per cent fall in medium category of income generation ranging from Rs.6,179- Rs.10,577/-).

Therefore, it is concluded from Table 2 that, maximum number of the trained women entrepreneurs (52.67%) belonged to the high level of income generation group. The present findings are similar to the findings of Venkata Naidu (2004) who reported that majority of the women respondents recorded their annual net income more than Rs.15000/- . Contrast findings were observed by Sushma (2007) who reported that 46.92 per cent of the EDP trainees belonged to medium income generation category.

The data presented in Table3 indicates that, 39.33 per cent of the trained women entrepreneurs of SHG showed continuously increasing trend. Increasing trend of income generation was due to good reputation with the customers, adequate popularity, more demand for the product or service and further expansion of the units.

The proportion of the respondents (38.00%) showed stability in their income generation, which is because of not expanding the units further, entrepreneurs are contented with the extent of income generation through their enterprise and also they don’t want to take more risk by establishing large units.

Decreasing trend of income generation was noticed amongst 22.67 per cent of the women entrepreneurs. Loss in the initial stage, continuously shifting of units from place to place and other personal problems viz., mainly health problems, seasonal farm activities etc., were the reasons for decreasing trend in income generation.

Employment generation

It is revealed from Table 4 that, enterprises like food items, papad making, farming, kirana shop, beauty parlor were generated employment as 98, 87 , 83,60, and 60 mean mandays, respectively. The proportion of mean mandayswere in dairy (51), garments (48), tailoring (42), bangle sale (41), cloth shop (40), stationary (36), masala preparation (35) generated employment.

The data presented in Table 5 that, maximum number of women entrepreneur respondents (56.00%) had generated employment upto 56 days through their enterprise followed by 25.34 per cent and 18.66 per cent in medium range of 57-77 days and high range of 78-98 days of employment generation.

Table 2.Distribution of the respondents according to their overall income generation of selected enterprises.

S. N.	Income generation (In Rs) range	Respondents (n=150)	
		Frequency	Percentage
1	Low (upto Rs.6,179/-)	46	30.66
2	Medium (Rs.6,179- Rs.10,577/-)	25	16.67
3	High (above Rs.10577/-)	79	52.67
	Total	**150**	**100**

Table 3. Trend of income generation by trained women entrepreneurs through the enterprise

Category	Frequency	Percentage
Increasing trend	59	39.33
Stable trend	57	38.00
Decreasing trend	34	22.67
Total	**150**	**100**

Table 4. Distribution of respondents according to enterprise-wise employment generation

S. N.	Enterprise	Income generation in 3 years			Total income earned in three years	Average income in a year
		2007-08	2008-09	2009-10		
1	Kirana shop	220	260	278	480	60
2	Tailoring	120	110	120	350	42
3	Beauty parlor	150	160	170	480	60
4	Cloth shop	100	120	100	320	40
5	Papad making	250	250	200	700	87
6	Bangles sale	100	120	110	330	41
7	Food items	260	240	278	778	98
8	Stationery	100	90	95	285	36
9	Masala preparations	95	87	95	277	35
10	Garments	140	120	124	384	48
11	Farming	220	210	235	665	83
12	Dairy	135	135	140	410	51

Table 5. Distribution of the respondents according to their overall employment generation in selected enterprises

S. N.	Employment generation $year^{-1}$ (Days)	Respondents (n=150)	
		Frequency	Percentage
1	Up to 56	84	56.00
2	57-77	28	18.66
3	78-98	38	25.34
	Total	**150**	**100**

The present findings are similar to the findings of Gangaiah*et al.* (2006) who reported that cloth business and tailoring generated 240 man days of employment, whereas agriculture could generate 218 man days of employment.Sushma (2007) revealed that majority (51.53%) of the trained women entrepreneurs generated medium range (139.14-227.02 mandays) of employment through their enterprises.

CONCLUSION

From the study it was observed that majority of the entrepreneurs of SHGs (77.33%) were observed in medium level of income generation ranging from Rs.6,179/- to Rs.10,578/-, whereas as in case of employment generation maximum number (56.00%) of the SHGs women entrepreneurs were generated employment yearly at mean mandays of upto 56 days. This tends to imply that there is again scope to increase the income and employment generation by expanding the size of the units. For expansion of the size,number of unitsand number of enterprises in the area for accommodation of large number of women in the programmes,MAVIM (*Mahila Arthik Vikas Mahamandal*) personnel should encourage and help them to get credit from financial resources. This calls for further encouragement of women trainees who have established their enterprise by the MAVIM institute training who are involved in entrepreneurship.

LITERATURE CITED

Gangaiah, G. B. Nagaraja and C. Vasudevulu Naidu, 2006. Impact of self help groups on income and employment, a case study of Kurukshetra, 18-23.

Sushma K.C., 2007. An Analysis of Entrepreneurship Development in Women through EDP Trainings M.Sc. Thesis (Unpub.), Dept. of Agricultural Extension, University of Agricultural Sciences, Dharwad (Karnataka).

Venkata Naidu, G., 2004. Employment and income generation from TRYSEM in Anantapur district of Andhra Pradesh, Monthly Commentary : 22-26.

❖ ❖ ❖

Testing of Modified Green Chickpea Pod Stripping Cum Shelling Machine

M. R. Rajput[1], B. L. Mandhyan[2] and P. A. Borkar[3]

ABSTRACT

A study was conducted in the year 2008 with an objective of preparing test procedure and testing of machine. Development of green chickpea pod stripping cum shelling machine is important because green chickpea is widely appreciated as health food. It is a protein rich supplement to cereal-based diets, especially to the poor in developing countries, where people are vegetarians or cannot afford animal protein. It can be marketed after shelling at higher profit to urban areas. Export of this produce may fetch foreign exchange. Thus the profit of farmers and rural entrepreneurs will increase. Also it will develop suitable agrobased industries in rural areas besides generating employment. The machine was developed at AICRP on Post Harvest Technology, College of Agricultural Engineering, Jabalpur. This machine mainly consists of three units viz. stripping, shelling, and cleaning unit. The capacity, stripping and shelling efficiency was observed to be 24 kg/h, 93.66 % and 89.44 per cent, respectively.

Chickpea is called Bengal gram or Gram *(Cicer aritinum* L.) in South Asia and it is a major pulse crop in India, widely grown for centuries and accounts for nearly 40 percent of the total pulse production. India is a major chickpea growing country of the world, accounting for 61.65 percent of the total world area and 68.13 percent of the total world production. Chickpea is widely appreciated as health food. It is a protein rich supplement to cereal-based diets, especially to the poor in developing countries, where people are vegetarians or can not afford animal protein. Chickpea has a very important role in human diet in our country. Green chickpea (*Cicer aritinum* L.) can be marketed after shelling, at higher profit to urban areas. Thus the profit of farmers and rural entrepreneurs will increase manifold. Export of this produce may fetch foreign exchange as its export potential exists in countries like USA, U.K., Canada, Saudi Arab, UAE, Srilanka, Malaysia, etc. (Anonymous, 2002).

Sustainable agricultural development needs designing and development of on farm processing machines for value addition. This will necessary for employment of agricultural labour and creation of agrobased industries in rural areas. Keeping in view the facts placed above, a machine has been developed at AICRP on Post Harvest Technology, College of Agricultural Engineering, Jabalpur which have functions like detaching the green chickpea pods from the plants, shelling the pods and separating the green seeds from the green husk of pods. However, there is no standard procedure of Bureau of Indian Standards for testing of this machine; hence a project was under taken to prepare a test procedure and testing the performance of the machine.

MATERIAL AND METHODS

Theoretical Consideration

The green chickpea stripping cum shelling machine mainly consists of three units which are stripping, shelling and cleaning units. The performance of these three units is affected by a number of crop and machine parameters.

Theoretical Capacity of Stripper

The theoretical capacity of stripper was calculated on the following observations while testing the machine.

1. One fourth circumference of stripper comes in contact with plant at the time of stripping
2. Three fourth length of plant is in contact with stripper

Calculations:

Diameter of the stripper = 260 mm

Therefore, circumference = $\pi \times 260 = 817$ mm

Considering time for which the plant is held before stripping unit is 15 seconds

The part of plant which can be stripped off in one second

$$= \frac{(1/4 \times 817)}{15} = 0.0136 \text{ m}$$

1. Senior Research Assistant, and 3. Research Engineer, AICRP on PHT, Dr. PDKV, Akola – 444104 (M.S.)
2. Ex. Head, Deptt. of Post Harvest Process and Food Engineering, JNKVV, Jabalpur – 482004 (M.P.)

Considering, the rpm of the stripper to be 110.

The length of the plant that would be stripped of in one hour

$= 0.0136 \times 1.83 \times 3600 = 89.597$ m (110/60 = 1.83 rps)

It was observed that, average length of the plant of variety JG315 = 0.478m

Therefore, part of the plant in contact with stripper = $3/4 \times 0.478 = 0.359$ m

Average weight of one plant = 0.125 kg

Thus, weight of plant that would be stripped off in one hour

$$= \frac{89.597 \times 0.125}{0.359} = 31.20 \text{ kg/h}$$

Hence, theoretical capacity = 31.20 kg/h

Details and Operations of Machine

The green chickpea stripping cum shelling machine consists of stripping unit, shelling unit and cleaning unit. The machine occupies a floor area of 0.645 m × 1.455 m and its height is 1.765 m. Preliminary trials were conducted on a sample size of 500 g green chickpea plants for various speeds of shelling rollers (& obviously stripping roller)

A bunch of green chickpea plants is held in front of the stripping unit in such a way that leaves and pods are projected into the stripping loops and on rotation of the stripping cylinder, the pods are detached from the plants. The detached pods along with shreddings fall in the shelling unit, which consists of three rollers of 12 gauge m.s. sheet, upper two enclosed with rubber with corrugated metal sheet and third (lower) with only corrugated rubber sheet.

The upper two rollers operate at different speeds. One is fast (190 to 585 rpm) and other is slow (53 to 185 rpm) in reverse direction. The third roller operates at medium speed (81 to 265 rpm) having direction same as the fast roller (Table 1). As the pod falls on the rollers the slow roller offers compression and consequently holds the pod. Fast roller develops shearing force on pod. The third roller operates at medium speed and is used to improve the shelling. Because of this third roller, the double shelling action is given for getting better shelling efficiency. After shelling the husk and the green seeds drop in the cleaning unit in front of the blower, where the husk is blown off and the green seeds drop as the final product.

Fig. 1: Modified green chickpea pod stripping cum shelling machine

Procurement of Chickpea for testing

Freshly harvested Chickpea (JG315) plants were procured from the local market. The moisture content of green seed was observed to be 72.66 percent (wb).

Testing of stripping unit

In BIS No.: 3327-1965 the procedure for testing a foot operated paddy thresher is mentioned. This procedure was modified and adopted for testing the stripping unit of the machine. The details are given as follows.

Stripping efficiency was calculated by using the following expression.

Stripping efficiency (in percent)

$$= \frac{\text{(1-Weight of pods left on plants after stripping)}}{\text{Weight of plant fed}} \times \frac{\text{(1-Weight of shreddings)}}{\text{Weight of plant fed}} \times 100$$

(Mandhyan *et al.*, 2001)

Shelling unit

The shelling unit was tested as per the Indian standard specification for paddy dehusker no. IS: 8824 – 1977. This procedure was modified and adopted for testing the stripping unit of the machine. The details are given as follows.

Length of travel

The knowledge of length of travel is required to decide the clearance between the rollers. On the basis of dimensions of the pod, the length of travel of pod is calculated. Length of travel is an important factor affecting the breakage. It gives the idea about relation between clearance and breakage.

The complete path of travel of pod is calculated by the expression.

$$L = [0.5D\,(d-b) + 0.25(d^2-b^2)]^{0.5} \qquad \text{(Phirke, 2004)}$$

Where, D = roller diameter

b = clearance between the rollers

d = initial size of the pod

L = length of section of path

Length of travel or path for 8 mm, 9 mm and 10 mm clearance is 35.50 mm, 26.88 mm and 13.54 mm, respectively. From these calculated results it is observed that as the clearance increased the length of travel decreased.

Calculation of shelling efficiency

Shelling efficiency was calculated by following expression

$$\eta\chi\ \text{hulling} = E\ \text{hulling} \times E\ \text{wk}$$

$$E\ \text{hulling} = \frac{(n_1 - n_2)}{n_1}$$

Where n_1 = amount of pods before hulling, kg

n_2 = amount of unshelled pod after hulling, kg

The coefficient of wholeness (E wk)

$$E\ \text{wk} = \frac{k_2 - k_1}{(k_2 - k_1) + (d_2 - d_1) + (m_2 - m_1)} \qquad \text{(Chakraverty, 1995)}$$

Where,

$(k_2 - k_1)$ = yield of whole green seeds

$(d_2 - d_1)$ = yield of broken green seeds

$(m_2 - m_1)$ = yield of mealy waste in the product

RESULTS AND DISCUSSION

Preliminary trials were conducted to fix the range of annular gap between the top two rollers for shelling JG315 variety of green chickpea and three gaps identified were 8 mm, 9 mm and 10 mm. In second stage shelling the gap between top and bottom roller was kept 7 mm, 8 mm and 9 mm against the gap between top two rollers.

The results are presented with the help of graphs and tables. Their interpretation is also discussed in the following paragraphs.

Effect of speed of stripper on stripping efficiency and capacity of machine

The effect of speed on capacity is as shown in Fig. 2. It was observed that as the peripheral speed increased in the experiment zone, capacity increased from 18.46 kg/h at 1.306 m/s to 24 kg/h at 2.246 m/s. The actual capacity is somewhat low as compared to the theoretical capacity of 31.20 kg/h. This may be due to the reason that theoretical capacity was calculated on single plant basis and at no load condition offering zero resistance to the movement of plant inside the stripping unit.

It can be observed from the Fig. 2 that as the peripheral speed increased, there is increase in stripping efficiency but after some time it decreased. This is because with the pods the shreddings are increased and that results in reduction of stripping efficiency.

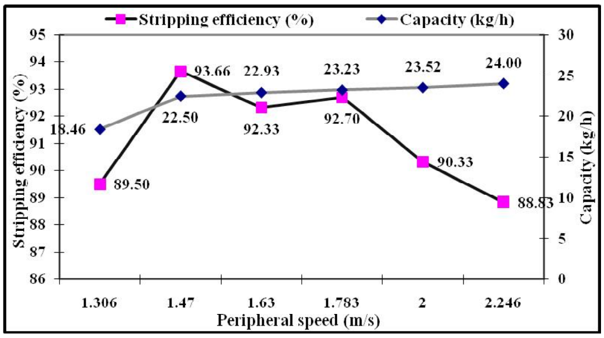


Fig. 2. Effect of speed of stripper on stripping efficiency and capacity

Effect of gap between the rollers, speed of rollers and speed ratio on shelling efficiency

The tests results of the green chickpea pod stripping cum shelling machine are shown in Table 1. A close look reveals that best operating parameters for shelling are top gap – 10 mm gap between rollers, bottom gap – 9 mm, 415 rpm of fast roller, 190 rpm of medium roller and 108 rpm of slow roller with the speed ratio 4: 1.5: 1 (Fast : Medium : Slow) where the shelling efficiency of 89.44 percent was obtained (Fig. 3).

Table 1 revealed that the best result of (3: 1.5: 1 speed ratio for) shelling efficiency 81.88 percent was

Table 1: The test results of the modified green chickpea pod stripping cum shelling machine

S.N.	Results										
	TopGap (mm)	Bottom Gap (mm)	Feed Rate (kg.)	RPM Stripper	Stripping efficiency (%)	RPM slow Shelling Roller	RPM Fast Shelling Roller	RPM Medium Shelling Roller	Coefficient of Hulling	Coefficient of Wholeness	Shelling Efficiency (%)
1	9	8	1	93	87.30	105 (1)	345 (3)	123 (1.5)	0.89	0.72	64.08
2	9	8	1	105	89.88	117 (1)	380 (3)	170(1.5)	0.93	0.74	68.82
3	9	8	1	126	89.63	140 (1)	460 (3)	210(1.5)	0.93	0.62	57.66
4	9	8	1	147	90.33	170 (1)	540 (3)	255(1.5)	0.94	0.61	57.34
5	10	9	1	105	85.97	126 (1)	395 (3)	170(1.5)	0.89	0.92	81.88
6	10	9	1	126	85.19	138 (1)	475 (3)	220(1.5)	0.89	0.86	76.54
7	10	9	1	147	89.55	160 (1)	525 (3)	235(1.5)	0.90	0.80	72.00
8	10	9	1	165	88.83	185 (1)	585 (3)	265(1.5)	0.90	0.74	66.60
9	8	7	0.5	48	83.32	53 (1)	190 (3)	81(1.5)	0.84	0.77	64.68
10	8	7	0.5	66	84.45	77 (1)	252 (3)	123(1.5)	0.97	0.67	64.99
11	8	7	0.5	93	83.61	96 (1)	310 (3)	129(1.5)	0.95	0.61	57.95
12	8	7	0.5	108	84.56	114 (1)	350 (3)	170(1.5)	0.95	0.68	64.60
13	10	9	1	117	88.65	108 (1)	415 (4)	190(1.5)	0.86	1.04	89.44
14	9	8	1	108	89.71	102 (1)	395 (4)	180(1.5)	0.87	0.99	86.13
15	8	7	1	108	93.66	99 (1)	370 (4)	170(1.5)	0.93	0.56	52.08
16	10	9	1	92	90.79	69 (1)	270 (4)	126(1.5)	0.80	0.74	59.20
17	10	9	1	96	89.50	78 (1)	320 (4)	150(1.5)	0.91	0.94	85.54
18	10	9	1	120	92.33	105 (1)	405 (4)	190(1.5)	0.90	0.89	80.10
19	10	9	1	131	92.70	125 (1)	425 (4)	210(1.5)	0.87	0.92	80.04

Note – Figures in parentheses shows speed ratio of the rollers obtained for the operating parameters top gap - 10 mm clearance, bottom gap – 9 mm, 395 rpm of fast roller, 170 rpm of medium roller and 126 rpm for slow roller. It was the second best shelling recovery in all the tests which have been taken during testing.

Shelling is a function of compression, shear and abrasion. Here, the compressive forces are controlled by the gap and shear forces by varying speed ratios. In this machine the trend revealed that shelling efficiency is lower when gap is more also when the gap is less. The reason is that when gap is less, crushed green seeds are obtained in larger quantity because of higher compression and in case of more gap unshelled pods are obtained in large quantity because of less shearing action.

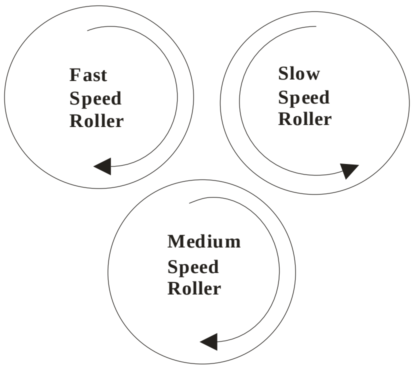


Fig.3 Principle of shelling unit

CONCLUSIONS

1. The capacity of the machine was 24 kg h^{-1}
2. The stripping and shelling efficiency were 93.66 and 89.44 per cent, respectively.

LITERATURE CITED

Anonymous, 2002. Post Harvest Profile of Chickpea at http:// agmarket.nic.in / bengal. gram / profile / pdf

Chakraverty, A., 1995. Post Harvest Technology of Cereals, Pulses and Oilseeds, Third Edition, New Delhi, Oxford and IBH Publishing Co. Pvt. Ltd. : 175-176.

Indian Standard Specification For Paddy Thresher, Pedal Operated IS : 3327-1965

Indian Standard Specification For Rubber Roll For Paddy Dehusker. IS : 8427-1977

Mandhyan, B.L., Ganguly, S., Mishra, R.P. 2001. Design and development and testing of Fresh Bengal gram stripping cum shelling machine, IE(I) J. AG , 82 : 30-33.

Phirke, P.S., 2004. Processing and Conveying Equipment Design, First Edition, New Delhi, Jain Brothers : 177-178

Heterosis in Sunflower

Sunflower (*Helianthus annuus* L.) is a rich source of good quality edible oil. It was earlier used as an ornamental plant in India, emerged as a most important edible oil crop after soybean, rapeseed and groundnut, popularly known as 'Surajmukhi'. Sunflower was introduced for commercial cultivation in India in 1969 from former USSR. Sunflower contains 38 to 42 per cent oil. Being a cross pollinated crop it is natural that it should exhibit heterosis for yield and yield contributing traits. Sunflower hybrids exhibit varied magnitude and direction of heterosis for different characters (Gangappa *et al*., 1997). Present investigation was carried out, with the objective to estimate heterosis, heterobeltiosis and standard heterosis for yield and yield contributing traits of economic importance from hybrids developed from genetically diverse lines and testers. Gill *et al*., (1998) reported that high heterosis can be utilized for earliness, seed yield and head diameter in sunflower.

The experimental material included in the present study comprised of 4 CMS lines (females) viz., CMS17A, 89A, 148A and 852A and 10 testers (males) viz., PKV 101R, 103R, 104R, 105R, 106R, 107R, 108R, 109R, 110R and 273R and their 40 F_1's along with the commercial check SH 3322. The experiment was conducted during *Rabi* 2010-2011 in randomized block design with three replications. All operations were undertaken according to the recommendations. The observations were recorded on 9 characters viz., days to maturity, plant height, head diameter, seed filling percentage, 100 seed weight, volume weight, hull content , oil content and seed yield per plant. Analysis of variance was carried out as per standard method (Panse and Sukhatme, 1954 and Singh and Chaudhary, 1977).

The analysis of variance revealed highly significant differences among the crosses for most of the traits. Heterosis was estimated in 40 hybrids for nine different characters and was expressed as percent increase or decrease over mid parents, better parent and standard check. The parents depicted highly significant variation for most characters under study except 100 seed weight, volume weight, oil content and seed yield kg/ha. For days to maturity CMS 89 x PKV 107R exhibited the significant negative heterosis (-5.95**), heterobeltiosis (-5.24**) and cross CMS 852 x PKV 110R (-4.23**) revealed significant standard heterosis for maturity. The cross CMS 852 x PKV 105R revealed the highest per cent of H1 (-0.32) and H2 (5.68**) for plant height and cross CMS 17 x PKV 104R (-11.81**) showed highest standard heterosis for plant height. Head diameter is an important yield contributing character, and cross CMS 17 x PKV 105R recorded highest values of H1 (120.53**) and H2(111.61**) and cross CMS 17 x PKV 101R recorded high H3 (45.69**) significantly superior over check followed by 22 other hybrids. The cross CMS 852 x PKV 107R showed significant average heterosis, heterobeltiosis and also positive but non significant standard heterosis for seed filling percentage 14.61**, 13.20** and 0.86 respectively. For seed yield per plant the cross CMS 17 x PKV 110R depicted highest average (428.46**) and better parent heterosis (306.64**) while the cross CMS 852 x PKV 107R showed highest standard heterosis (88.13**) followed by nine other hybrids. Naik *et al*. (1988), Madrap and Makne (1993), Ahire *et al*. (1994), Nehru *et al*. (2000), Dudhe (2004), Tavade *et al*. (2009) observed highest significant heterosis for yield and yield contributing characters as discussed above which are in agreement with present findings. For hundred seed weight CMS 89 x PKV 109R reveals the highest test weight for mid parent (150.03**), better parent (122.40**) and standard heterosis (52.24**). Gangappa *et al*. (1997) also reported highest heterosis for the character. For oil content the cross CMS 148 x PKV 107 R showed highest average heterosis (6.42**) and better parent heterosis (5.49**).

The results revealed extent of all three types of heterosis within the available genetic variability. The hybrid CMS 17 x PKV 110R exhibited high percent of mid parent should be evaluated for a more valid conclusion.

Table 1: Percentage of H1, H2 and H3

S.N.	Hybrids	Days to maturity			Plant height (cm)			Head diameter (cm)		
		H1	H2	H3	H1	H2	H3	H1	H2	H3
1	CMS 17 X PKV 101 R	-0.34	1.90 **	19.76 **	34.21 **	2.55 **	3.62 **	58.32 **	9.53 **	45.69 **
2	CMS 17 X PKV 103 R	-3.00 **	-1.47	36.27 **	42.96 **	9.24 **	4.70 **	70.51 **	59.31 **	-6.39 **
3	CMS 17 X PKV 104 R	2.76**	8.25 **	14.50 **	15.41 **	-11.81**	3.92 **	24.04 **	-5.77 **	-7.41 **
4	CMS 17 X PKV 105 R	-0.88	2.69 **	20.66 **	36.17 **	4.05 **	1.78 **	120.53 **	111.61 **	17.52 **
5	CMS 17 X PKV 106 R	0.16	4.75 **	31.86 **	42.37 **	8.79 **	1.96 **	119.43 **	87.20 **	35.29 **
6	CMS 17 X PKV 107 R	0.31	1.60	38.47 **	40.89 **	7.66 **	5.24 **	78.14 **	37.32 **	29.37 **
7	CMS 17 X PKV 108 R	-1.31 *	-1.00	18.66 **	19.41 **	-8.75 **	4.54 **	58.44 **	25.54 **	9.59 **
8	CMS 17 X PKV 109 R	-5.27 **	-3.99 **	18.70 **	35.54 **	3.57 **	-0.66	76.93 **	45.64 **	15.02 **
9	CMS 17 X PKV 110 R	-1.09 *	2.72 **	22.31 **	29.77 **	-0.84 **	1.35 **	92.19 **	59.45 **	23.44 **
10	CMS 17 X PKV 273 R	-0.16	3.37 **	19.97 **	32.58 **	1.31 **	2.58 **	68.41 **	38.66 **	9.43 **
11	CMS 89 X PKV 101 R	-0.05	1.65 **	18.91 **	30.63 **	3.51 **	3.37 **	10.06 **	-21.26 **	4.73**
12	CMS 89 X PKV 103 R	-4.65 **	-2.63 **	32.86 **	36.78 **	8.38 **	2.38 **	94.09 **	91.69 **	12.63 **
13	CMS 89 X PKV 104 R	-1.70 **	2.98 **	25.34 **	26.64 **	-1.70 **	-1.14**	45.24 **	14.97 **	12.97 **
14	CMS 89 X PKV 105 R	-4.19 **	-1.28 *	24.54 **	37.76 **	9.16 **	-2.15 **	93.92 **	90.93 **	9.41 **
15	CMS 89 X PKV 106 R	-0.5	3.50 **	26.46 **	33.92 **	6.12 **	0.74	102.65 **	81.66 **	31.29 **
16	CMS 89 X PKV 107 R	-5.95 **	-5.24 **	30.58 **	30.71 **	3.37 **	-1.84 **	38.18 **	11.12 **	4.68**
17	CMS 89 X PKV 108 R	-3.99 **	-3.78 **	31.08 **	32.64 **	2.65 **	1.17**	49.60 **	23.91 **	8.16 **
18	CMS 89 X PKV 109 R	-3.89 **	-3.11 **	13.27 **	26.74 **	0.43 **	0.25	99.24 **	71.90 **	35.76 **
19	CMS 89 X PKV 110 R	-3.17 **	0	11.88 **	16.46 **	-7.72 **	-1.33 *	81.40 **	57.84 **	22.19 **
20	CMS 89 X PKV 273 R	-4.64 **	-1.80 **	7.84 **	16.85 **	-7.41 **	-2.56 **	78.02 **	53.64 **	21.26 **
21	CMS 148 X PKV 101R	0.69	1.42 **	16.22 **	27.60 **	1.21 **	1.65 **	-6.80 **	-23.56 **	1.66**
22	CMS 148 X PKV 103R	-0.11	4.57 **	29.71 **	33.47 **	5.87 **	4.81 **	50.88 **	27.49 **	8.58 **
23	CMS 148 X PKV 104R	1.58 **	3.83 **	27.54 **	28.93 **	0.08	-0.33**	1.33**	-5.42 **	-7.07 **
24	CMS 148 X PKV 105R	-0.12	0.45**	19.64 **	32.27 **	4.91**	-0.44**	37.05 **	13.21 **	-3.59**
25	CMS 148 X PKV 106R	2.90**	4.43 **	30.21 **	37.82 **	9.32 **	1.64 **	23.80 **	14.43 **	-2.55**
26	CMS 148 X PKV 107R	-1.50 **	0.14	29.09 **	29.28 **	2.24 **	0.38	0.17	-4.63**	-10.16 **
27	CMS 148 X PKV 108R	-0.87	1.78**	31.48 **	33.12 **	3.02 **	2.02**	4.34**	3.07**	-10.03 **
28	CMS 148 X PKV 109R	-2.24 **	-0.66	14.21 **	27.72 **	1.31 **	-0.43	14.06 **	9.92 **	-6.39 **
29	CMS 148 X PKV 110R	3.25 **	4.07**	10.81 **	15.29 **	-8.56 **	2.69**	-1.79**	-6.26 **	-20.17 **
30	CMS 148 X PKV 273R	0.29	0.79	17.92 **	27.70 **	1.29 **	0.02	1.81**	-1.92**	-16.48 **
31	CMS 852 X PKV 101R	-0.61	-0.35	6.17 **	11.82 **	-4.13 **	0.79	-0.89**	-25.79 **	-1.3**
32	CMS 852 X PKV 103R	-0.95	3.19**	27.20 **	28.57 **	7.89 **	4.38**	41.83 **	33.90 **	-11.41 **
33	CMS 852 X PKV 104R	2.14**	4.88 **	25.54 **	32.09 **	2.53 **	0.68	26.06 **	5.47 **	3.64**
34	CMS 852 X PKV 105R	1.79 **	2.83 **	-0.32	5.68 **	-9.40 **	1.92**	21.93 **	12.14 **	-25.81 **
35	CMS 852 X PKV 106R	2.39 **	4.39 **	18.82**	20.80**	3.57 **	1.61 *	10.34 **	5.68**	-23.62 **
36	CMS 852 X PKV 107R	-3.61 **	-2.45 **	29.01 **	34.43 **	6.32 **	-1.33 *	22.64 **	4.39**	-1.66**
37	CMS 852 X PKV 108R	-0.21	1.99 **	24.21 **	30.91 **	1.31 **	3.16 **	-11.84 **	-22.51 **	-32.35 **
38	CMS 852 X PKV 109R	4.73**	5.94 **	18.13 **	26.65 **	8.58 **	7.15 **	27.91 **	17.54 **	-7.17 **
39	CMS 852 X PKV 110R	-4.15 **	-2.94 **	13.96 **	13.96 **	-2.30 **	-4.23 **	40.89 **	30.65 **	1.14**
40	CMS 852 X PKV 273R	0.50	1.47 **	16.30**	34.21 **	2.55 **	0.69	15.99 **	6.62 **	-15.85 **
	Range	-5.95 to 4.73	-5.24 to 8.25	-0.32 to 38.47	5.68 to 42.96	-11.81to 9.32	-4.23 to 7.15	-11.84 to 120.53	-25.79 to 111.61	-32.35 to 45.69
	SE (M)±	0.375	0.433	0.173	0.199	0.199	0.433	0.193	0.222	0.222
	CD (5%)	1.0567	1.2202	0.4878	0.5633	0.5633	1.2202	0.5435	0.6276	0.6276
	CD (1%)	1.4014	1.6182	0.6469	0.7470	0.7470	1.6182	0.7209	0.8324	0.8324

* Significant at 5% level of significance **Significant at 1% level of significance , H1- Average heterosis,H2-Heterobeltiosis,H3-Standard heterosis over SH 3322

Cont….

S.N.	Hybrids	Seed filling (%)			100 seed weight(g)			Volume weight (g 100^{-1} ml)		
		H1	H2	H3	H1	H2	H3	H1	H2	H3
1	CMS 17 X PKV 101 R	-5.73 **	-10.73**	-7.79 **	72.22 **	69.37 **	24.90 **	14.65 **	6.03 **	1.13**
2	CMS 17 X PKV 103 R	-11.34 **	-13.51 **	-16.05 **	78.73 **	48.39 **	9.43 *	8.30 **	-2.16*	-1.73**
3	CMS 17 X PKV 104 R	-26.76 **	-31.24 **	-27.66 **	29.22 **	29.16 **	-4.75**	3.15 **	-4.36 **	-9.27 **
4	CMS 17 X PKV 105 R	-1.6*	-3.96 **	-6.86 **	29.95 **	24.75 **	-8.01**	7.72 **	4.75 **	-15.11 **
5	CMS 17 X PKV 106 R	-7.86**	-10.53 **	-17.40 **	57.79 **	55.11 **	14.38 **	24.37 **	12.95 **	12.12 **
6	CMS 17 X PKV 107 R	-8.57 **	-10.17 **	-17.06 **	61.60 **	45.10 **	34.46 **	-2.95 **	-18.7 **	-2.33 *
7	CMS 17 X PKV 108 R	-4.82 **	-6.28 **	-10.74 **	31.39 **	26.68 **	-6.58**	3.10 **	-0.19	-13.60 **
8	CMS 17 X PKV 109 R	-17.76 **	-19.44 **	-22.47 **	82.06 **	56.85 **	15.67 **	25.98 **	15.95 **	11.75 **
9	CMS 17 X PKV 110 R	4.32 **	3.32 **	-4.61 **	53.85 **	49.68 **	10.38 **	-2.94 *	-5.32 **	-19.32 **
10	CMS 17 X PKV 273 R	3.39 **	-0.36**	-8.00 **	34.30 **	21.91 **	10.24 **	-7.12 **	-7.39 **	-24.51 **
11	CMS 89 X PKV 101 R	-8.80 **	-14.92 **	-12.11 **	31.36 **	28.73 **	-8.21**	-3.32 **	-7.38 **	-3.55 **
12	CMS 89 X PKV 103 R	-13.12 **	-16.53 **	-18.98 **	60.97 **	37.76 **	-5.7**	-5.75 **	-7.42 **	-3.58 **
13	CMS 89 X PKV 104 R	-1.51*	-8.89**	-4.15 **	60.86 **	55.16 **	14.31 **	-7.47 **	-11.59 **	-7.93 **
14	CMS 89 X PKV 105 R	7.75 **	3.56 **	0.42	32.80 **	32.21 **	-9.50 **	1.79**	-11.69 **	-8.03 **
15	CMS 89 X PKV 106 R	-3.40 **	-4.72 **	-14.79**	65.42 **	62.19 **	15.54 **	-1.46**	-3.77 **	0.22
16	CMS 89 X PKV 107 R	-5.11 **	-5.29 **	-15.29 **	38.19 **	20.13 **	11.33 **	-20.56 **	-25.87 **	-10.88 **
17	CMS 89 X PKV 108 R	-19.92 **	-22.36 **	-26.06 **	32.51 **	32.51 **	-9.29 **	-3.94 **	-12.04 **	-8.40 **
18	CMS 89 X PKV 109 R	-21.89 **	-24.66 **	-27.49 **	150.03 **	122.4**	52.24 **	-15.16 **	-18.32 **	-14.94 **
19	CMS 89 X PKV 110 R	-20.70 **	-21.19 **	-28.63 **	31.66 **	30.45 **	-9.02 **	-13.09 **	-20.99 **	-17.72 **
20	CMS 89 X PKV 273 R	-20.78 **	-22.46 **	-30.65 **	-6.32**	-17.70**	-25.58 **	-8.94 **	-18.83 **	-15.47 **
21	CMS 148 X PKV 101R	-13.23 **	-22.11 **	-19.54 **	39.35 **	24.61 **	12.69 **	-1.39**	-8.52 **	-12.75 **
22	CMS 148 X PKV 103R	-12.13 **	-18.88 **	-21.27 **	36.71 **	5.18**	-4.88**	7.06 **	-2.99 **	-2.55 **
23	CMS 148 X PKV 104R	-14.17 **	-23.57 **	-19.59 **	-9.05**	-17.48**	-25.37 **	2.33 **	-4.84 **	-9.72 **
24	CMS 148 X PKV 105R	-7.76 **	-14.81 **	-17.39 **	14.79 **	0.45*	-9.16 **	25.85 **	21.98 **	-0.48
25	CMS 148 X PKV 106R	-26.44 **	-28.49 **	-37.80 **	12.80 **	0.83**	-8.82**	6.23 **	-3.23 **	-3.94 **
26	CMS 148 X PKV 107R	-14.60 **	-17.93 **	-26.88 **	-18.64 **	-19.62**	-25.51 **	-2.41 **	-18.10 **	-1.53**
27	CMS 148 X PKV 108R	7.62 **	0.23	-4.55 **	-8.54**	-19.65**	-27.34 **	-2.19**	-5.00 **	-17.77 **
28	CMS 148 X PKV 109R	-24.28 **	-29.83 **	-32.47 **	3.92**	-17.40**	-25.31 **	8.68 **	0.34	-3.29 **
29	CMS 148 X PKV 110R	-21.48 **	-25.13 **	-32.20 **	10.97 **	-1.73**	-11.13 **	4.18 **	1.97**	-13.11 **
30	CMS 148 X PKV 273R	-17.83 **	-19.50 **	-31.07 **	-6.9**	-6.9**	-15.81 **	12.82 **	12.77 **	-8.00 **
31	CMS 852 X PKV 101R	-4.59 **	-12.16 **	-9.27 **	17.93 **	3.68**	-2.51**	-4.44 **	-6.71 **	-11.02 **
32	CMS 852 X PKV 103R	-8.50 **	-13.29 **	-15.84 **	-6.08**	-28.72**	-32.97 **	0.19	-4.59 **	-4.16 **
33	CMS 852 X PKV 104R	-9.84 **	-17.68 **	-13.40 **	13.43 **	1.15**	-4.88**	-1.31**	-3.39 **	-8.35 **
34	CMS 852 X PKV 105R	-32.69 **	-36.18 **	-38.12 **	13.83 **	-2.02**	-7.87**	8.49 **	-0.04	-9.17 **
35	CMS 852 X PKV 106R	-0.3	-0.34	-13.32 **	11.17 **	-2.31**	-8.14**	-0.93*	-5.12 **	-5.82 **
36	CMS 852 X PKV 107R	14.61 **	13.20 **	0.86	21.15 **	20.27 **	13.09 **	-17.85 **	-27.89 **	-13.30 **
37	CMS 852 X PKV 108R	5.07 **	0.47	-4.32**	-11.65 **	-23.67**	-28.22 **	0.21	-2.16**	-11.11 **
38	CMS 852 X PKV 109R	6.87 **	1.68*	-2.14 **	27.81 **	0.14	-5.83**	3.80 **	0.83	-2.82 **
39	CMS 852 X PKV 110R	11.45 **	9.20 **	-1.11	-5.14**	-17.39**	-22.32 **	2.24 *	-0.94*	-10.00 **
40	CMS 852 X PKV 273R	4.33 **	3.57 **	-10.00 **	2.39**	0.4	-5.56**	16.03 **	10.06 **	0
	Range	-32.69 to 14.61	-36.18 to 13.20	-38.12 to 0.86	-18.64 to 150.03	-28.72 to 122.40	-32.97 to 52.24	-20.56 to 25.98	-27.89 to 21.98	-24.51 to 12.12
	SE (M)±	0.514	0.594	0.594	0.315	0.156	0.516	0.273	0.316	0.316
	CD (5%)	1.449	1.673	1.673	0.3817	0.4408	0.4408	0.7705	0.8897	0.8897
	CD (1%)	1.921	2.219	2.219	0.5063	0.5846	0.5846	1.0218	1.1799	1.11799

* Significant at 5% level of significance **Significant at 1% level of significance , H1- Average heterosis, H2-Heterobeltiosis, H3-Standard heterosis over SH 3322

Cont….

S.N.	Hybrids	Hull content (%)			Oil content (%)			Seed yield plant^{-1} (g)		
		H1	H2	H3	H1	H2	H3	H1	H2	H3
1	CMS 17 X PKV 101 R	14.89**	7.32**	6.38**	0.36**	-0.37*	-11.37 **	70.90 **	16.54 **	4.35 **
2	CMS 17 X PKV 103 R	18.36**	13.37**	6.54**	3.50 **	1.84 **	-7.76 **	229.01 **	207.95 **	15.08 **
3	CMS 17 X PKV 104 R	15.23**	10.12**	3.98**	-5.81 **	-6.46 **	-18.00 **	-23.97 **	-48.35 **	-53.09 **
4	CMS 17 X PKV 105 R	8.8**	-1.29	4.28**	3.29 **	-0.86**	-5.49 **	111.88 **	95.38 **	-36.34 **
5	CMS 17 X PKV 106 R	-3.6**	-8.79 **	-12.04 **	0.94 *	-2.29 **	-8.48 **	218.56 **	173.29 **	-10.95 **
6	CMS 17 X PKV 107 R	-0.12	-5.48**	-8.89 **	4.77 **	-0.19	-3.36 **	217.17 **	214.43 **	4.25 **
7	CMS 17 X PKV 108 R	-7.42 **	-15.61 **	-11.76 **	-2.17 **	-3.13 **	-13.37 **	184.59 **	136.04 **	-23.09 **
8	CMS 17 X PKV 109 R	1.87**	-5.98**	-4.36**	-4.48 **	-7.03 **	-13.90 **	220.54 **	182.19 **	-8.05 **
9	CMS 17 X PKV 110 R	-13.00**	-19.31 **	-18.79 **	4.09 **	-0.53**	-4.29 **	428.46 **	306.64 **	32.50 **
10	CMS 17 X PKV 273 R	-2.06**	-11.98 **	-5.01**	-2.53 **	-3.95 **	-13.27 **	105.38 **	61.85 **	-8.45 **
11	CMS 89 X PKV 101 R	-5.67**	-7.51 **	-8.31 **	-5.60 **	-7.46 **	-14.30 **	-19.16 **	-46.47 **	-52.07 **
12	CMS 89 X PKV 103 R	-2.57**	-3.23**	-7.82 **	-1.30 **	-2.38 **	-9.60 **	168.30 **	138.41 **	-10.91 **
13	CMS 89 X PKV 104 R	-15.23 **	-15.59 **	-19.60 **	-9.91 **	-12.90 **	-19.34 **	101.84 **	33.19 **	20.97 **
14	CMS 89 X PKV 105 R	-20.35 **	-24.27 **	-19.99 **	2.76 **	1.29 **	-3.44 **	188.11 **	180.50 **	-18.54 **
15	CMS 89 X PKV 106 R	-9.65 **	-10.20 **	-13.41 **	2.83 **	2.25 **	-4.23 **	273.04 **	236.31 **	-2.33**
16	CMS 89 X PKV 107 R	0.53	-0.07	-3.67**	4.29 **	2.02 **	-1.23 **	231.69 **	211.11 **	3.15**
17	CMS 89 X PKV 108 R	-15.11 **	-18.89 **	-15.19 **	0.56**	-1.17 **	-8.48 **	177.66 **	141.45 **	-29.88 **
18	CMS 89 X PKV 109 R	-7.42 *	-10.36 **	-8.82 *	0.36**	0.36*	-7.06 **	328.25 **	296.88 **	15.26 **
19	CMS 89 X PKV 110 R	-16.99 **	-19.22 **	-18.69 **	0.64**	-1.25 **	-4.98 **	156.27 **	105.62 **	-40.28 **
20	CMS 89 X PKV 273 R	-13.76 **	-18.82 **	-12.39 **	-2.24 **	-3.46 **	-10.59 **	15.76 **	-12.40 **	-50.45 **
21	CMS 148 X PKV 101R	-18.94 **	-19.34 **	-19.25 **	-0.63**	-3.59 **	-8.79 **	7.21 **	-8.09 **	-17.70 **
22	CMS 148 X PKV 103R	-1.04**	-4.07**	-3.97**	0.73**	-1.42 **	-6.74 **	60.25 **	26.92 **	-18.79 **
23	CMS 148 X PKV 104R	14.55	11.3**	11.42 **	-0.59**	-4.88 **	-10.01 **	-1.82**	-16.33 **	-24.01 **
24	CMS 148 X PKV 105R	-5.08**	-7.57 **	-2.35**	5.89 **	5.49 **	0.56**	32.55 **	-5.23**	-39.36 **
25	CMS 148 X PKV 106R	-17.33 **	-18.85 **	-18.76 **	2.72 **	2.21 **	-3.31 **	0.37	-31.52 **	-56.19 **
26	CMS 148 X PKV 107R	-10.01 **	-11.68 **	-11.58 **	6.42 **	5.20 **	1.86 **	7.84 *	-18.14 **	-47.62 **
27	CMS 148 X PKV 108R	-3.06**	-5.13**	-0.79	1.05 **	-1.71 **	-7.02 **	-17.73 **	-45.06 **	-64.85 **
28	CMS 148 X PKV 109R	-15.87 **	-16.54 **	-15.11 **	0.59**	-0.47	-5.84 **	6.41**	-26.18 **	-52.77 **
29	CMS 148 X PKV 110R	-23.57 **	-23.77 **	-23.28 **	5.71 **	4.83 **	0.86 **	18.88 **	-24.24 **	-51.53 **
30	CMS 148 X PKV 273R	-21.77 **	-24.60 **	-18.63 **	-6.00 **	-8.14 **	-13.09 **	-14.28 **	-19.25 **	-48.33 **
31	CMS 852 X PKV 101R	-22.23 **	-23.20 **	-21.93 **	-2.94 **	-3.62 **	-13.04 **	43.45 **	11.73 **	0.04
32	CMS 852 X PKV 103R	-6.73 **	-10.26 **	-8.77 **	0.88 **	0.68**	-8.81 **	9.41 **	-4.36**	-52.24 **
33	CMS 852 X PKV 104R	-3.97**	-7.38 **	-5.86**	-2.54 **	-4.58 **	-13.91 **	26.69 **	-1.83**	-10.84 **
34	CMS 852 X PKV 105R	-14.30 **	-15.92 **	-11.17 **	-1.90 **	-4.53 **	-8.99 **	13.90 **	-11.68 **	-55.89 **
35	CMS 852 X PKV 106R	-11.40 **	-13.67 **	-12.25 **	0.29	-1.55 **	-7.79 **	43.15 **	5**	-47.57 **
36	CMS 852 X PKV 107R	-14.75 **	-16.95 **	-15.58 **	6.03 **	2.42 **	-0.84 **	352.81 **	276.73 **	88.13 **
37	CMS 852 X PKV 108R	-22.19 **	-23.28 **	-19.77 **	-8.12 **	-8.52 **	-17.47 **	3.34**	-26.12 **	-63.11 **
38	CMS 852 X PKV 109R	-4.85**	-4.88**	-3.25**	0.31*	-0.98 **	-8.30 **	110.86 **	57.77 **	-21.22 **
39	CMS 852 X PKV 110R	-6.41 **	-6.87**	-5.33**	6.32 **	3.01 **	-0.89 **	203.33 **	105.00 **	2.37**
40	CMS 852 X PKV 273R	-10.90 **	-13.48 **	-6.63**	-2.48 **	-2.52 **	-11.97 **	14.47 **	7.77 **	-39.04 **
	Range	-23.57 to 18.36	-24.60 to 13.37	-23.28 to11.42	-8.12 to 6.42	-12.90 to 5.49	-19.34 to 1.86	-23.97 to 428.46	-48.35 to 306.64	-64.85 to 88.13
	SE (M)±	0.460	0.531	0.531	0.096	0.111	0.111	0.287	0.332	0.332
	CD (5%)	1.2958	1.4963	1.4963	0.271	0.3129	0.3129	0.8095	0.9347	0.9347
	CD (1%)	1.7185	1.9844	1.9844	0.3594	0.415	0.415	1.0735	1.2396	1.2396

*Significant at 5% level of significance **Significant at 1% level of significance , H1- Average heterosis, H2-Heterobeltiosis, H3-Standard heterosis over SH 3322

LITERATURE CITED

Ahire, N.R; B.B. Pawar, A.D. Dumbre, 1994. Heterosis and inbreeding depression in sunflower. J. Mah. Agric. Univ., 19 (2): 183-187.

Dudhe, M.Y., 2004. Diallel analysis of Restorer lines in sunflower (*Helianthus annuus* L.) M.Sc. Thesis (Unpub.), Dr. PDKV, Akola.

Gangappa, E; K.M. Channakrishnaian, S. Remash, M.S. Harini, 1997. Exploitation of heterosis in sunflower (*Helianthus annuus* L.), Crop Res. (Hissar), 13 (2):339-348.

Gill, H.S; S.R. Khurana, T.P. Yadava and R.K. Sheron, 1998. Expression of heterosis for different characters in sunflower over environments.

Madrap, I. A. and V.G. Makne 1993. Heterosis in relation to combining ability effects and phenotypic stability in sunflower, Indian J. Agric. Sci., 63 (8): 484-488.

Naik, N.M; B.B Pawar and A.D. Dumbre 1988. Heterosis in sunflower, J.Maharashtra Agric. Univ., 3 (1): 39-42.

Nehru, S.D; D. Eshwarppa, S. Rangaah and R.S. Kulkarni 2000. Studies on Heterosis for seed yield and oil content to develop hybrids with high oil yield in sunflower, Mysore J. Agric. Sci. 34:1-5.

Panse, V.G. and P.V. Sukhatme, 1954. Statistical method for Agriculture workers, New Delhi, ICAR Publication.

Singh, P.K. and B.D. Chaudhary, 1977. Biometrical methods in quantative genetic Analysis Ludhiana, Kalyani Publishers.

Tavade , S. N., S. S. Lande and S. P. Patil, 2009. Combining ability studies in some restorers lines of sunflower (*Helianthus annuus* L.), Karnataka J. Agric. Sci., 22(1) : 32-35.

Dept. of Botany,
Dr. P.D.K.V., Akola

R. I. Ali
S. N. Deshmukh
A. V. Nagmote
S. D. Tayade

❖ ❖ ❖

Correlations Between Yield and Yield Contributing Characters in Safflower

Safflower (*Carthamus tinctorius* L.) is one of the most important *Rabi* oilseed crops belonging to family Asteraceae. There are twenty five species in the genus, out of which only *Carthamus tinctorius* L. 2n=24 is cultivated and used for oil production. India has legitimate pride of being the largest producer of safflower in the world. In India, Maharashtra and Karnataka are the two most important safflower growing states accounting 73 per cent and 22 per cent of total area under safflower, respectively. Safflower is grown as a rainfed crop and is considered to be drought tolerant hence it gives better option to the farmers in dry land for crop rotation in respect of weed and disease control. Higher genotypic correlations than the phenotypic one indicated inherent relationship between the characters. Yield is an important character in any crop, therefore, the knowledge of genetic correlation for yield and its components becomes very important in any crop improvement program when the breeder is confronted in problem of combining high yield potentials with desirable agronomic traits. Correlation is a measure of degree to which characters are associated with yield or among themselves, which helpful for the plant breeder to develop appropriate line of action for crop improvement.

The present study was conducted during *Rabi* 2009-10 at the field of Oilseed research unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The material for present study consisted of 240 families of safflower segregating for genetic male sterility and five checks AKS-207, Bhima, A-1, PBNS-12 and Phule kusuma, which were evaluated in augmented block design in five blocks during 2009-10. Each block consists of 48 progenies with 5 checks. The spacing between plant to plant was 20 cm and row to row was 45 cm was followed. The data were recorded on three randomly selected fertile plants for days to 50 per cent flowering, days to maturity, plant height (cm), number of primary branches plant^{-1}, number of capitula per plant, number of seed capitulum^{-1}, oil content (%) and seed yield plant^{-1} (g).

In the present study, for most of the characters values of genotypic correlations were of higher magnitude than phenotypic correlations. This indicated

Table 1. Genotypic and phenotypic correlations among eight quantitative yield contributing characters for the progeny selection of safflower

Character		Days to 50% flowering	Days to maturity	Plant height (cm)	Primary branches plant^{-1}	No. of capitula plant^{-1}	No. of seeds capitulum^{-1}	Oil content (%)	Seed yield plant^{-1}(g)
Days to 50% flowering	G	1.000	0.422**	-0.182**	-0.426**	-0.317**	0.198**	0.117	-0.422**
	P	1.000	0.352**	0.091	-0.045	-0.146*	0.185**	0.147*	-0.112
Days to maturity	G		1.000	0.094	-0.262**	-0.065	0.136	0.351**	0.272**
	P		1.000	0.098	0.066	0.052	0.099	0.056	0.181**
Plant height (cm)	G			1.000	0.313	0.375**	0.223**	0.053	0.314**
	P			1.000	0.245	0.222**	0.205**	0.028	0.241**
Primary branches plant^{-1}	G				1.000	0.882**	-0.154*	-0.364**	-0.307*
	P				1.000	0.799**	0.033	0.088	0.483*
No. of capitula plant^{-1}	G					1.000	-0.059	0.906**	0.019
	P					1.000	0.058	0.125	0.624**
No. of seeds capitulum^{-1}	G						1.000	0.110	0.176*
	P						1.000	0.039	0.183**
Oil content (%)	G							1.000	0.881**
	P							1.000	0.173*
Seed yield plant^{-1}(g)	G								1.000
	P								1.000

The correlation coefficient was tested at 5% (*) and 1% (**) level of significance.

that there was a strong inherent association between characters. The seed yield plant^{-1} exhibited highly significant and strong positive genotypic and phenotypic correlation with days to maturity (0.272**, 0.181**, respectively), plant height (0.314**, 0.241**, respectively), number of seeds capitulum^{-1} (0.176*, 0.183**, respectively). Similar results were reported by Patil *et al*. (1994), Pandya *et al*. (1996), Reddy (2002), Mummaneni *et al.* (2003), Rathod (2005) and Goyal (2006). Seed yield plant^{-1} showed negative genotypic correlation with days to 50 per cent flowering (-0.422**). Similar findings were reported by Naole (2004), Rathod (2005), Goyal (2006) and Nandkhile *et al.* (2008). Seed yield plant^{-1} showed positive and significant phenotypic correlation with primary branches plant^{-1} (0.483*) and number of capitula plant^{-1} (0.624**). Plant height exhibited strong genotypic and phenotypic correlation with number of capitula plant^{-1} (0.375**, 0.222**, respectively) and number of seed capitulum^{-1} (0.223**, 0.205**, respectively). Number of primary branches also showed strong positive significant genotypic and phenotypic correlation with number of capitula plant^{-1} (0.882**, 0.799**, respectively). The seed yield plant^{-1} also showed significant positive correlation with oil content (0.881**, 0.173*, respectively) which is in conformity with the findings of Reddy (2002), Kukde (2009), Mahajan *et al.* (2009) (Table 1).

The most striking results were the association between number of primary branches plant^{-1} with number of seed capitulum^{-1} and seed yield plant^{-1} were negatively correlated. It indicated that increase in number of primary branches would result in reduction in number of seed capitulum^{-1} and seed yield plant^{-1} hinting the undesirable linkage between them. To break this linkage through breeding programme recurrent selection techniques should be effective by producing random mating population. The present investigation clearly showed that the traits, *viz.*, days to maturity, plant height (cm) and number of seed capitulum^{-1} had strong association with seed yield plant^{-1}. This indicated that direct selection for these traits will definitely enhance seed yield in safflower.

LITERATURE CITED

Goyal, V.S., 2006. Evaluation of third cycle of recurrent selection for seed yield and its components in safflower (*Carthamus tinctorius* L.), M.Sc. Thesis (Unpub.), Dr. PDKV, Akola.

Kukde, D.S., 2009. Evaluation of second cycle population from recurrent selection for yield and yield components in safflower (*Carthamus tinctorius* L.) M.Sc. Thesis (Unpub.), Dr. PDKV, Akola (M.S.).

Mahajan, P. V., S. N. Deshmukh and R. D. Ratnaparkhi, 2009. Evaluation of progenies selected from random mated population of safflower (*Carthamus tinctorius* L.) using GMS lines, J. Oilsseds Res., 26:156-158.

Mummaneni, B.N., 2003. Recurrent selection for yield in safflower using genetic male sterility, M.Sc. Thesis (Unpub.), Dr.PDKV, Akola.

Nandkhile S.G., S.S. Lande and S.N. Deshmukh, 2008. Correlation studies for yield and yield contributing characters in safflower (*Carthamus tinctorius* L.), PKV Res. J. Vol 32(2) : 200-202.

Naole, V.P. ,2004. Recurrent half-sib selection for yield in random-mating population of safflower (*Carthamus tinctorius* L.) M.Sc. Thesis (Unpub.), Dr. PDKV, Akola.

Pandya, N.K., S.C. Gupta and A.K. Nagda, 1996. Path analysis of some yield contributing traits in safflower, Crop Res. (Hisar), 11(3) : 313-318.

Patil, V.D., M. V. S. Reddy and Y.S. Nerkar, 1994. Efficiency of early generation selection for yield and related characters in safflower (*Carthamus tinctorius* L.), Theor. Appl. Genet. 89 (2/3): 293-296.

Rathod P. M., 2005. Evaluation of half –sib families developed from random mating population of safflower (*Carthamus tinctorius* L.) M.Sc. Thesis (Unpub), Dr. PDKV, Akola.

Reddy, S.H.N., 2002. Studies on recurrent selection in a safflower population segregating for genetic male sterility M.sc. Thesis (Unpub.), Dr. PDKV, Akola.

Dept. of Botany,
Dr. P.D.K.V., Akola

A. V. Nagmote
S. N. Deshmukh
R. I. Ali
N. S. Bhagat

❖ ❖ ❖

Targeted Yield Approach for Fertilizer Requirements of Rabi Onion

Onion (*Allium cepa* L) is one of the oldest important vegetables of India. In India, onion is grown on an area of about 4.55 lakh hectares with an annual production of 60.34 lakh tonnes of onion bulbs. Maharashtra is a leading onion growing state with an area of 84.48 thousand hectares and a production of 16.61 lakh tonnes of onion bulbs annually (Anonymous, 2006).

India ranks second in vegetable production in the world, but its average yields are very low. To facilitate the desired increase in productivity, the plant needs adequate quantities of essential nutrients in readily available forms. No vegetable grower could do so without heavy and balanced fertilizer use because vegetables are short duration and heavy feeder crops. Imbalanced fertilization is the main cause of low yields of onion.

For judicious use of chemical fertilizers, soil fertility evaluation is the most important attribute, which enhances crop production. Ramamoorthy *et al.* (1967) and Velayutham (1979), established a theoretical basis for making scientific fertilizer recommendations based on soil test crop response. The present study was planned to develop fertilizer prescription equations for balanced use of fertilizers and targeting onion yields and to evaluate the applicability/validity of these equations.

A standard main experiment was conducted on *Rabi* onion using the fertility gradient approach (*Ramamoorthy et al.*, 1967) during 2004-05. Pre-plant soil samples were collected from each plot before the superimposition of the treatments and were analysed for available N (Subbiah and Asija, 1956), available P (Olsen *et al.*, 1954) and available K (Hanway and Heidel, 1952). The plant samples were analysed for Total N, P and K content (Jackson, 1967). The total uptake of nutrients was computed using onion bulb and straw (tops) yield.

The data on onion bulb yield, nutrient uptake, pre-plant soil available nutrients and fertilizer doses applied was used to calculate the basic parameters, viz, nutrient requirement (kg t^{-1}), contribution of nutrients from soil (CS) and fertilizers (CF) as described by Ramamoorthy *et al.*, (1967). The per cent contribution from added FYM was estimated. All these parameters were used for formulating fertilizer adjustment / prescription equations.

In order to test the validity of these yield targeting equations, field experiments were conducted at two locations (Akola and Buldhana). Surface soil samples were collected from the experimental site of these locations and analyzed for available N, available P and available K (Table 1) by using standard methods as mentioned earlier.

Table 1. Initial soil characteristics

S.N.	Particulars	Location I	Location II
		Akola	**Buldhana**
1	pH	8.28	8.35
2	EC (dSm^{-1})	0.42	0.40
3	Organic carbon content (%)	0.43	0.41
4	Available N (kg ha^{-1})	194.56	189.33
5	Available P (kg ha^{-1})	16.92	15.32
6	Available K (kg ha^{-1})	287.36	281.64
7	Textural class	clay	clay

To test the validity of derived yield targeting equations, the field experiments were laid out in randomized block design at both the locations with eleven treatments (Table 2) replicated thrice. Three yield targets (40, 50 and 60 t ha^{-1}) were fixed, with fertilizer alone and in combination with 20 t of FYM ha^{-1}. Additional treatments i.e. treatment No.1 to 5 were also included for comparison.

For production of one tonne of onion 0.85 kg N, 0.35 kg P and 1.25 kg K were required. While the percent contribution from soil in respect of N, P and K was 6.34, 39.80 and 8.86, respectively. The contribution from fertilizer was 15.20, 7.54 and 27.53 per cent in respect of N, P and K, respectively. While the per cent contribution from fertilizer in presence of FYM was 17.75, 8.08 and 38.42 in respect of N, P and K, respectively. Whereas per cent contribution of N, P and K from FYM was 5.52, 4.02 and 7.80, respectively.

Sole use of chemical fertilizers (without FYM)

$$FN = 5.59\,T - 0.42\,SN$$

$$FP_2O_5 = 4.38\,T - 4.93\,SP$$

$$FK_2O = 3.25\,T - 0.23\,SK$$

Conjoint use of chemical fertilizers and FYM

$$FN = 4.79\,T - 0.36\,SN - 1.49\,FYM$$

$$FP_2O_5 = 4.64\,T - 5.28\,SP - 1.87\,FYM$$

$$FK_2O = 4.54\,T - 0.32\,SK - 1.69\,FYM$$

Table 2. Yield targeting in Onion (Mean of two trials)

S.N.	Treatment	Nutrient applied (kg ha^{-1})			Yield of onion bulb (t ha^{-1})	Cost of fertilizer (Rs. ha^{-1})	Monetary returns (Rs. ha^{-1})	Increase in returns over control (Rs ha^{-1})	Returns / rupees spent on fertilizers (Rs. ha^{-1})	Per cent deviation
		N	P_2O_5	K_2O						
1	Control	-	-	-	23.66	-	70980	-	-	-
2	20 t ha^{-1} FYM	-	-	-	31.36	15000.00	94080	23100	1.54	-
3	Recommended dose of fertilizers	100	50	50	31.98	2724.95	95925	24945	9.15	-
4	RDF as per soil test without FYM	115	74	48.5	34.22	3540.69	102660	31680	8.97	-
5	RDF as per soil test with 20 t ha^{-1} FYM	69	40	34	34.18	2037.46	102525	31545	15.49	-
6	40 t ha^{-1} target without FYM	143	96	65	41.72	4560.26	125160	54180	11.92	+ 4.30
7	40 t ha^{-1} target with 20 t ha^{-1} FYM	93	64	57	40.56	3138.90	121665	50685	16.26	+ 1.40
8	50 t ha^{-1} target without FYM	199	140	102	50.99	6633.92	152970	81990	12.39	+ 1.98
9	50 t ha^{-1} target with 20 t ha^{-1} FYM	141	110	97	52.58	5231.24	157740	86760	16.61	+ 5.16
10	60 t ha^{-1} target without FYM	255	183	148	59.82	8755.89	179460	108480	12.40	- 0.30
11	60 t ha^{-1} target with 20 t ha^{-1} FYM	189	156	130	61.88	7263.15	185625	114645	15.81	+ 3.13
	SE (m) ±				0.94					
	CD at 5 %				2.66					
	Test of significance between yield targeted and actually obtained (treatment No. 6 to 11)				N.S					

Rates: Urea- Rs.380/100 kg^{-1}, SSP- Rs.470/100 kg^{-1}, MOP- Rs.520/100 kg^{-1}. Selling rates of onion: Rs. 3000 t^{-1}.

Where, FN, FP_2O_5, FK_2O and SN, SP, SK indicate fertilizer N, P_2O_5, K_2O and soil available N, P, K respectively in kg ha^{-1}, while T indicates the yield target in t ha^{-1} and FYM is farm yard manure in Mg ha^{-1}.

The data on onion yield, soil and fertilizer nutrients from 80 treated plots have been utilized for fitting multiple regression equations based on quadratic function.The data derived from the equation and the R^2 value, the assorted treatments for 0-15 cm depth 0.83 indicating 83 percent variation in onion yield obtained by using soil test values, fertilizer dose and FYM. This also suggests a scope for explaining the factors other than the soil test values, fertilizer doses, FYM, which affect the onion yield. The R^2 value of 0.83 indicated good fit for these multiple regression equations. Bangar (1990) reported that the R^2 values for multiple regression equations above 0.66 indicated good fit, 0.65 to 0.45 as moderate fit and below 0.45 as poor fit.

Similarly, R^2 values of 0.99, 0.86 and 0. 79 were also reported by Kadam (1999) for onion, Konde (2002) for soybean and Raut (2004) for sorghum. Data presented in Table 2 revealed that the yield differences due to different treatments were found to be significant at both the locations. Further it could be noted that the yield targeted and yield obtained under field condition with the fertilizers applied to the desired targets on the basis of fertilizer prescription equations and soil test values agreed with each other within ± 10 per cent error. The statistical test of significance between yield targeted and yield actually obtained also indicates the possibility to achieve yield target of onion bulb upto 60 t ha^{-1} by the application of fertilizer nutrients using derived fertilizer adjustment equations during this investigation.

The economic analysis of the fertilizer applied for targeted production and actually achieved revealed that, the highest monetary returns amounting Rs. 1,85,625.00 ha^{-1} was obtained under 60 t ha^{-1} yield target of onion. The returns per rupee invested on fertilizer was highest (Rs. 16.61) in the targeted yield treatment of 50 t ha^{-1} through fertilizer + FYM, which was higher as compared to recommended dose of fertilizer indicating the usefulness of yield targeting approach in crop production for higher benefit. These results are in close conformity with the results of Kadu *et.al.,* (2001).The results of follow-up trials conducted confirm the validity of the derived fertilizer prescription equations as the anticipated onion yield targets of 40, 50 and 60 t ha^{-1} were achieved with highest monetary returns.

LITERATURE CITED

Anonymous., 2006. Annual Report, Director of Economics and Statistics, New Delhi.

Bangar, A. R., 1990. Quantitative evaluation of efficacy of soil test and fertilizer responses to sorghum cv.-CSH 8R through some soil fertility appraisal techniques under varying moisture regimes of dryland Vertisols. *Ph. D. Thesis* (Unpub.) MPKV., Rahuri.

Hanway, J. J and H. Heidel., 1952. Lowa State College Agric. Bull. 57, 1.

Jackson, M.L., 1967. Soil chemical analysis, Prentice - Hall of India (Ltd.), New Delhi.

Kadam, B.S., 1999. Nitrogen, Phosphorus and Potassium requirements of rabi onion based on targeted yield concept. Ph. D. Thesis (Unpub.), MPKV, Rahuri.

Kadu, P. P., A.G. Durgude, A.S. Patil and J.D. Patil., 2001. Nutrient requirement of *rabi* Onion based on soil testing, J. Maharashtra. Agric. Univ., 26(1): 10-11.

Konde, N.M., 2002. Fertilizer requirement of soybean wheat cropping system by conjoint use of manure and chemical fertilizers based on targeted yield approach, Ph. D. Thesis (Unpub.).MPKV, Rahuri.

Olsen, S.R., C.V. Cole, F.S. Watanabe and L. Dean., 1954. U.S.D.A. Circ. 939, U.S. Govt. Printing Office, Washington DC.

Ramamoorthy, B., R.L. Narsimhan and R.S. Dinesh., 1967. Fertilizer application for specific yield targets of Sonora-64, Indian Farming, 27(5): 43-44.

Raut, P.D., 2004. Soil test crop response correlation studies on sorghum under rainfed condition. Ph.D. Thesis (Unpub.).Dr. PDKV, Akola.

Subbiah, B.V. and G.L. Asija., 1956. A rapid procedure for determination of available nitrogen in soil, Current Sci. 25 : 256 - 260.

Velayutham, M., 1979. Fertilizer recommendations based on targeted yield concept. Problems and Prospects. Fertil. News, 24(9):12-20.

Department of Soil Science and Agril. Chemistry, Dr. PDKV, Akola

Mohammad Sajid
M. N. Patil
B. M. Yadgirwar
J. R. Katore
N. S. Ukey

Effect of Pre-cooling of Fruits on Physiological Loss in Weight of Different Mango Cultivars During Ambient Storage Condition

Mango (*Mangifera indica* L.) is grown almost in 87 countries around the world and hence this fruit occupies a unique place among the different fruit crops grown in India. Mango belongs to family Anacardiaceae genus *Mangifera* and it is reported that there are 41 species of mango. (Kalra *et al*.,1995).

The pre-cooling at 12 and 16^{0}C temperature resulted equally in improving the quality of ripened fruits and delayed ripening with the extension of shelf life by about 4 and 2 days, respectively than control. Besides these, the pre-cooling treatments was completely inhibited the incidence of stem end rot and anthracnose till 13th day of storage with or without fungicidal treatment (Kapse, 1993).

An experiment on ‘Effect of pre-cooling of fruits on physiological loss in weight of different mango cultivars during ambient storage condition’ was carried out at Department of Post harvest Technology in collaboration with laboratory of ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari, during the year 2007. There are total 13 treatments and experiment was laid out in Completely Randomized Design.

Fruits were weighed on the first day of treatment and their weight were recorded. Subsequently at 5 days interval, their weights were recorded and the loss in weight was expressed as percentage over the initial weight.

$$PLW\% = \frac{\text{Original weight-Final weight}}{\text{Original weight}} \times 100$$

A) Physiological loss in weight

Kesar : Data presented in Table 1 indicated that minimum (21.59 %) weight loss was recorded in treatment T_7 (Pre-cooling of fruits at 8^{o}C for 8 hours) during storage period which was statistically at par with other treatments except, T_1 (Control), T_2, T_5 and T_8 but, on 20th day of storage, treatment T_7 showed significant reduction in weight loss and was at par with treatments T_4, T_{10} and T_{13} as compared to control (T_1). On 20th day of storage, treatment T_1 (Control), T_2, T_5 and T_8 were discarded due to early ripening of fruits.

Alphonso : Minimum (17.15 %) weight loss was recorded in treatment T_7 (Pre-cooling of fruits at 8^{o}C for 8 hours) during storage period which was statistically at par with other treatments except, T_1 (Control), T_2, T_5 and T_8 - on 10th and 15th day. Whereas on 20th day of storage, treatment T_7 noted significant reduction in weight loss and was at par with treatments T_4, T_{10} and T_{13} as compared to control (T_1). On 20th day of storage treatments T_1 (Control), T_2, T_5 and T_8 were discarded due to early ripening of fruits.

Rajapuri : The difference in weight loss of Rajapuri mango fruits under various treatment were observed non significant on 5th day of storage. Whereas on 10th and 15th day of storage, significant differences were observed in per cent weight loss. Significantly minimum (15.83 %) weight loss was recorded in treatment T_4 (Pre-cooling of fruits at 6^{o}C for 8 hours) during storage period which was statistically at par with other treatments except, T_1 (Control), T_2, T_5,T_8 and T_{11} but, on 20th day of storage, treatment T_4 exhibited significant reduction in weight loss and was at par with treatments T_7, T_{10} and T_{13}, while treatments T_1 (Control), T_2, T_5 and T_8 and T_{11} treated fruits were discarded due to early ripening of fruits. At all the stages of storage, treated fruits showed significant reduction in weight loss as compared to control.

B) Number of days taken for ripening

Table 2: Effect of pre-cooling treatments on days for ripening of mango cv. Kesar, Alphonso and Rajapuri during storage at ambient temperature

Treatments	Ripening (days)		
	Kesar	Alphonso	Rajapuri
T_1	9.71	10.10	12.60
T_2	10.33	10.55	13.10
T_3	10.96	11.21	13.89
T_4	11.32	11.95	14.20
T_5	10.46	10.75	13.21
T_6	11.18	11.71	13.76
T_7	11.50	12.00	14.15
T_8	10.65	10.95	13.32
T_9	11.07	11.53	13.55
T_{10}	11.42	12.05	14.10
T_{11}	10.81	11.10	13.40
T_{12}	11.00	11.34	13.50
T_{13}	11.25	11.80	14.05
S.E. (m) ±	0.28	0.37	0.29
CD at 5%	0.87	1.13	0.89

Table 1: Effect of pre-cooling of fruits on changes in per cent physiological loss in weight of mango cultivars during storage at ambient temperature

Treatments	Physiological loss in weight (%)														
	Kesar					Alphonso					Rajapuri				
	0 day	5th day	10th day	15th day	20th day	0 day	5th day	10th day	15th day	20th day	0 day	5th day	10th day	15th day	20th day
T_1	0.0	4.98	9.29	21.31	0.00	0.0	6.57	9.87	13.99	18.17	0.0	4.37	9.00	12.47	16.67
T_2	0.0	4.26	8.21	20.70	0.00	0.0	6.08	9.86	13.98	18.18	0.0	4.33	8.95	12.46	16.66
T_3	0.0	5.07	7.75	17.57	22.75	0.0	6.20	9.55	13.51	18.20	0.0	4.31	8.47	12.01	15.95
T_4	0.0	5.15	6.97	17.27	21.80	0.0	6.32	9.30	13.37	17.25	0.0	4.29	8.33	11.44	15.81
T_5	0.0	4.36	8.16	20.11	0.00	0.0	5.78	9.83	13.81	18.00	0.0	4.40	8.91	12.44	16.64
T_6	0.0	5.13	7.30	17.48	22.55	0.0	5.97	9.47	13.46	17.63	0.0	4.46	8.48	12.17	16.09
T_7	0.0	5.23	6.79	16.71	21.59	0.0	5.26	9.20	13.34	17.15	0.0	4.52	8.35	11.45	15.83
T_8	0.0	4.53	8.16	18.07	23.45	0.0	5.53	9.79	13.77	17.79	0.0	4.41	8.88	12.43	16.63
T_9	0.0	4.23	7.65	17.50	22.59	0.0	5.79	9.49	13.47	17.65	0.0	4.48	8.49	12.25	16.11
T_{10}	0.0	4.51	6.81	17.17	21.72	0.0	5.63	9.22	13.35	17.22	0.0	4.56	8.37	11.60	15.85
T_{11}	0.0	4.25	7.89	17.58	22.80	0.0	5.84	9.78	13.75	17.85	0.0	4.39	8.83	12.35	16.60
T_{12}	0.0	4.70	7.69	17.55	22.70	0.0	5.66	9.50	13.48	17.71	0.0	4.43	8.73	12.29	16.26
T_{13}	0.0	4.62	7.25	17.28	22.37	0.0	5.69	9.35	13.39	17.42	0.0	4.49	8.45	11.91	15.88
S.E (m) ±		0.23	0.32	0.28	0.29		0.28	0.14	0.13	0.12		0.09	0.14	0.23	0.15
CD at 5%	NS	NS	0.97	0.85	0.87		NS	0.44	0.40	0.38		NS	0.42	0.71	0.46

T_1 Control
T_2 Pre-cooling of mango at 6 °C for 2 hours
T_3 Pre-cooling of mango at 6 °C for 5 hours
T_4 Pre-cooling of mango at 6 °C for 8 hours
T_5 Pre-cooling of mango at 8 °C for 2 hours
T_6 Pre-cooling of mango at 8 °C for 5 hours
T_7 Pre-cooling of mango at 8 °C for 8 hours
T_8 re-cooling of mango at 10°C for 2 hours
T_9 Pre-cooling of mango at 10°C for 5 hours
T_{10} Pre-cooling of mango at 10 °C for 8 hours
T_{11} Pre-cooling of mango at 12 °C for 2 hours
T_{12} Pre-cooling of mango at 12 °C for 5 hours
T_{13} Pre-cooling of mango at 12 °C for 8 hours

Kesar

From the Table 2, it is observed that delayed ripening of Kesar fruits (11.50 days) was observed in treatment T_7 (pre-cooling of fruits at 8°C for 8 hours) as compared to other treatment under study being at par with other treatments. However, early ripening was noted in control treatment (9.71 days).

Alphonso

Similar trend was observed in Alphonso mango fruits (Table 2) but fruits were ripened earlier than Rajapuri in most of the treatments. Significantly higher days taken for ripening (12.00) were found in treatments T_7, while untreated fruits (control) required minimum days (10.10) for ripening.

Rajapuri

Higher numbers of days (14.20) were found to be required for fruit ripening in treatment T_4 which was at par with treatments T_7, T_{10} and T_{13}, while untreated fruits T_1 (control) required minimum days (*i.e.* 12.60) for ripening.

The results showed that the physiological loss in weight significantly increased as storage period was increased from 5th to 20th days after harvest. The minimum physiological loss in weight was recorded in mango fruits cv. Kesar and Alphonso when pre-cooled at 8°C temperature for 8 hours (T_7), while in cultivar Rajapuri minimum physiological loss in weight was recorded in fruits when pre-cooled at 6°C temperature for 8 hours (T_4). Similar observations were also recorded by Mann and Singh (1976), Chauhan *et al.* (1987), Roy and Pal (1991), Kapse (1993) and Puttaraju and Reddy (1997) who reported that precooling in shortest possible time after harvest had the minimum PLW in mango, while Unde *et al.* (2004) reported that pre-cooling of grapes reduced PLW.

LITERATURE CITED

Chauhan, H. S.; J. Kumar, ; R. K. Sharma, and R. Singh, 1987. Effect of some chemicals and cooling on shelf life of mango. *Haryana J. Hort. Sci.*, 16 (3-4): 218-222.

Kalra S.K.; D. K. Tandon and B. P. Singh, 1995. Mango, In: Salunkhe, D.K.and Kadam, S. S. (edn.) Hand book of fruit science and technology, production, composition, storage and processing. Marcel Dekker, New york :123.

Kapse, B. M., 1993. An integrated Approach to post-harvest handling of mango. (*Mangifera indica* L.) cultivar Kesar, Ph.D. Thesis (Unpub), G.A.U., S. K., Nagar.

Mann, S. S. and R. N. Singh, 1976.The cold storage life of Dashehari mangos.Scientia-Horticultural. 5: 3, 249-253.

Puttaraju, T. B. and T. V. Reddy, 1997. Effect of pre-cooling on the quality of mango (cv. Mallika). J. Food Sci. Technol., 34 (1): 24-25.

Unde, P. A., H. G.More, V. N. Gawande, and A. V. Munde, 2004. Effect of pre-cooling on field heat removal and shelf life of grapes, J. Maharashtra Agric. Univ., 28 (3): 341-342.

Department of Horticulture,
NAU, Navsari, Gujrat

U. B. Deshmukh
S. G. Salunkhe
A. S. Khandagale
R. D. Chaudhari

❖ ❖ ❖

Ovipositional Preference of Zygogramma Beetle on Different Hosts

The neotropical weed, *Parthenium hysterophorus* Linnaeus (Asteraceae) is one of the top ten notorious weeds in India. Being a prolific seed producer, it produces up to 25,000 seeds (achenes) per plant (Navie *et al*. 1996) and 25,000 seeds/m^2 in abandoned fields in India (Joshi, 1991). It is an extremely aggressive colonizer occupying 200,000 hectares in India in terrain and mountainous areas. It is believed to have entered India in the early 50's. This weed causes many problems to human health, agriculture, livestock production and biodiversity (Evans, 1997).

Parthenium has been considered as one of the greatest source of dermatitis, asthma, nasal-dermal and nasal-bronchial types of diseases resulting from *Parthenin* (Nabum and Mandal, 2008). This weed contains allelochemicals which suppress the growth of local vegetation. The sesquiterpene lactones contained in *Parthenium* cause severe dermatitis. Pollens of *Parthenium* cause asthama and allergic bronchitis. *Parthenium* is resistant to the widely used herbicides such as paraquat. *Parthenin*, a glucoside is said to produce depressant effect on nervous system (Chandra and Vartak, 1970). Various methods such as mechanical and chemical have been tried against this weed. Chemical methods for controlling *P. hysterophorus* are costly and impracticable. These methods are hazardous to grazing stock (Desai and Bhoi, 1981). Therefore, biological control of this weed is gaining importance today.

Among the various bio-control agents, faba bean aphid and membracid bug were used to control this weed, but faba bean aphid (*Aphis fabae*) was not found effective being polyphagous and the membracid bug (*Lepotenthrus taurus*) attacks the *Parthenium*, but also feeds on cotton, hence could not be utilized. *Z. bicolorata*, a chrysomelid beetle was found specific to *Parthenium* (Jayanth and Nagarkatti, 1987). So the present investigation has been undertaken with the objectives to study the ovipositional preference of *Z. bicolorata* on different hosts.

The present investigations on the ovipositional preference of *Zygogramma bicolorata* Pallister adults on different hosts were carried out under concealed laboratory conditions at lnsectary of Entomology Section, College of Agriculture, Nagpur during the year 2010-2011. *Z. bicolorata* was used as test insect. The culture of this chrysomelid beetle was procured from the nearby field of Insectory premises of Entomology Section, College of Agriculture, Nagpur. The treatments constituting the different host plants viz., *Parthenium hysterophorus* L., *Carthamus tinctorius* (safflower), *Helianthus annuus* (sunflower), *Chrysanthemum indicum* (chrysanthemum), *Tagetes erecta* (marigold), *Guizotia abyssinica* (niger), *Xanthium strumarium* (gokharu) were raised in pot and tested for feeding and preference.

Z. bicolorata was reared in 11 x 14 cm transparent jars fitted with fine wire mesh on different hosts. Fresh leaves of different host plants were offered to the pair of freshly emerged adult beetles at morning time 9.00 a.m. every day. Pair of freshly emerged adult beetles was kept in each container and as such five containers were maintained at room temperature of 26 $\pm$ 2 ^{0}C. In each container fresh leaves were offered as ovipositional host treatment. The observations were recorded on the basis of eggs laid by *Z. bicolorata* adult female per day per host after 24 hours at morning time 9.00 a.m. every day.

On the basis of average eggs laid day^{-1} female^{-1} beetle of *Z. bicolorata*, the result showed that the most preferred ovipositional host was *Parthenium* leaves which recorded 21.4235 eggs day^{-1} female^{-1} an average. The average number of eggs laid per day per female on other host plants leaves viz., *Carthamus tinctorius* (Safflower), *Helianthus annuus* (Sunflower), *Chrysanthemum indicum* (*Chrysanthemum*), *Tagetes erecta* (Marigold), *Guizotia abyssinica* (Niger) and *Xanthium strumarium* (Gokharu) were 0.7588, 0.9705, 0.6588, 0.741, 0.670 and 2.694 eggs day^{-1} female^{-1}, respectively.

Longevity of eggs laid on *Parthenium* leaves was more and lasted up to the 35th day of the adult emergence, whereas on *Carthamus tinctorius* (Safflower), *Helianthus annuus* (Sunflower), *Chrysanthemum indicum* (Chrysanthemum), *Tagetes erecta* (Marigold), *Guizotia abyssinica* (Niger) and *Xanthium strumarium* (Gokharu) leaves, longevity of eggs laying was less and egg laying ceased after 10-12 days due to lack of feeding as well as ovipositional probing preference.

Table 1: Ovipositional preference of *Zygogramma bicolorata* Pallister on different host plants

Tr. No.	Treatment / Host Plant	Average no. of eggs laid day^{-1} $Female^{-1}$
T_1	*Parthenium hysterophorus* L. leaves	21.42
T_2	*Carthamus tinctorius* (safflower) leaves	0.75
T_3	*Helianthus annuus* (sunflower) leaves	0.97
T_4	*Chrysanthemum indicum* (chrysanthemum) leaves	0.65
T_5	*Tagetes erecta* (marigold) leaves	0.74
T_6	*Guizotia abyssinica* (niger) leaves	0.97
T_7	*Xanthium strumarium* (gokharu) leaves	2.69
	'F' test	Sig.
	S.E (m) $\pm$	0.024
	C. D. at 5%	0.069

From these observations it could be concluded that the *Parthenium* leaves was the most preferred ovipositional host than others for *Z. bicolorata*. The other host plants treatments were showed the negligible or non preferred ovipositional host for *Z. bicolorata*. Schwarzlaender *et. al.* (1996) reported that adult fecundity test examine the ability of a plant to support egg production. They differ from adult feeding or oviposition tests that test acceptability of host. Adult fecundity tests are relevant only for plant species that adult accept for feeding.

Withers (1999) studied towards an integrated approach to predicting risk to non-target species, reported larval development of *Z. bicolorata* on all plants species and to assess suitability for oviposition only on those species that supports larval development.

LITREATURE CITED

Chandra, G. S. and V. D. Vartak, 1970. Harmful effects of *P. hysterophorus* L., PANS, 16:212.

Desai, S. N. and P. G. Bhoi, 1981. Comparative response of *Parthenin* and styosanthes in the control of the *Parthenium*, J. Maharashtra Agric.Univ., 6(2): 266-267.

Evans, H.C. 1997. *Parthenium hysterophorus* : a review of its weed status and possibilities for biological control. Biocontrol news and information, 18: 89-98 N.

Jayanth, K. P. and S. Nagarkatti, 1987. Investigation on the host-specificify and damage potential of *Z. bicolorata* introduced into India for the biological control of *Parthenium hysterophorus* L. Entomon, 12 (2): 141-145.

Joshi, S. 1991. Interference effects of *Cassia uniflora* Mill. on *Parthenium hysterophorus* L. Plant and Soil. 132: 213-218

Nabum Yadi and S. K. Mandal, 2008. Biology of Mexican beetle (*Zygogramma bicolorata* Pallister) a bio-contorl agent for managing *Parthenium hysterophorus* L. Environment and ecology. 2008; 26 (2A) : 767-770.

Navie, S.C., R. E. McFayen., F. P. Penetta and S.W. Adkins, 1996. The biology of Autralian weeds 27. *Parthenium hysterophours* L. Plant protection quarterly, 11; 76-88.

Schwarzlaender M. H., L. Hinz and R. Wittenberg, 1996. Oogenesis requirements and weed biocontrol : an essentioal part in host range evaluation of insect agents or just wasted time : 79-85, In : Proceedings of the 9th international symposium on biological control of weeds. January 19-26; 1996.

Withers, T. M. 1999. Towards an integrated approach to predicting risk to non-target species : 34-40, In: Host specificity testing in Australasia: Towards Improved Assay for Biological Control. T. M. Withers, L. Barton Browne and J. Stanley.

College of Agriculture,
Nagpur

A. P. Malkapure
R. O. Deotale
A. T. Kakde

❖ ❖ ❖

Screening for Resistance in Rangpur Lime and Rough Lemon Seedling against Rootrot

Phytophthora diseases of citrus are one of the most damaging manifestations of the disease complex caused by the species of *Phytophthora*. Root rot may result in partial or total loss of the fibrous feeder roots. The damage may be severe and resulting in to early death of young plants in nurseries and field plantings, or it may be less severe or occur at later growth stage and cause the decline and loss of older trees. The simplest means of reducing losses due to this disease is the use of resistant/ tolerant rootstocks. Root rot has become a serious problem in the nurseries and young irrigated orchards, where it caused chiefly by

Table 1: Screening of rootstock seedlings of Rangpur lime and Rough lemon against *Phytophthora* under artificial inoculated conditions

Rootstock Seedlings	Pooled Mean of Three Years		
	Per cent seedling mortality	Feeder root rating	Per cent leaf fall
Rangpur Lime			
Rangpur lime (Brazil)	16.49(23.89)*	2.49	16.15(23.65)*
Rangpur lime (Pooklingminz)	14.33(22.04)	2.69	13.61(21.60)
Rangpur lime (Abohar)	13.80(21.87)	2.18	15.50(23.15)
Rangpur lime (Poona)	24.58(29.63)	2.83	21.70(27.73)
Rangpur lime (Knors)	16.20(23.62)	2.36	12.41(20.55)
Rangpur lime (Kirumakki)	17.91(25.00)	2.70	16.53(23.93)
Rangpur lime (USA)	21.83(27.81)	2.20	13.65(23.25)
Rangpur lime (Poona Srirampur)	16.35(23.79)	1.92	12.22(20.60)
Rangpur lime (Brazilian)	15.68(23.27)	2.79	17.30(24.57)
Rangpur lime (Srirampur)	13.58(21.66)	1.89	20.41(26.84)
Rangpur lime (8748)	16.50(23.93)	2.48	13.27(21.32)
Rangpur lime (8744)	17.25(24.52)	2.27	19.88(26.43)
Rangpur lime (Phillipine red lime)	14.67(22.43)	2.04	15.23(22.91)
Rangpur lime (Tirupati)	20.00(26.53)	2.28	17.72(24.87)
Rangpur lime (Akola)	10.62(18.96)	1.80	11.53(19.78)
Rough Lemon			
Rough lemon (Chethalli)	21.56(27.63)	2.73	14.01(21.90)
Rough lemon (Assam)	18.75(25.61)	2.53	18.21(25.18)
Rough lemon (Limmonaria Assam)	21.52(27.53)	2.50	17.84(24.95)
Rough lemon (Jatti Khatti)	19.50(26.19)	2.60	17.84(24.95)
Rough lemon (South Africa)	19.37(26.08)	2.37	15.66(23.26)
Rough lemon (58-III-IV)	40.00(39.20)	2.65	20.05(26.56)
Rough lemon (Florida)	20.00(26.51)	2.20	16.21(23.71)
Rough lemon (14-19-13)	20.45(26.83)	2.31	14.72(22.51)
Rough lemon (Australia)	28.57(30.75)	2.33	16.83(24.16)
Rough lemon (Tharsa)	29.57(32.72)	2.23	17.36(24.59)
Rough lemon (Akola)	12.21(20.37)	1.85	14.57(22.40)
‘F’ test	Sig.	Sig.	Sig.
S.E. (m) ±	0.84	0.061	0.59
C.D. at 5%	2.36	0.17	1.68

* Figures in parenthesis are arc sin values

Table 2: Effect of *Phytophthora* on growth parameters of rootstock seedlings under artificial inoculation conditions

Rootstock seedlings	Pooled mean of three years per seedling				
	Seedling height (cm)	Seedling girth (cm)	Tap root length (cm)	Fresh root weight (g)	Root volume (cc)
Rangpur lime					
Rangpur lime (Brazil)	22.40	1.36	11.80	1.39	2.05
Rangpur lime (Pookling minz)	21.27	1.18	10.04	1.17	1.46
Rangpur lime (Abohar)	21.71	1.14	11.83	1.14	1.42
Rangpur lime (Poona)	16.87	1.29	10.30	1.07	1.06
Rangpur lime (Knors)	19.80	1.21	10.43	1.24	1.53
Rangpur lime (Kirumakki)	17.73	1.03	10.11	0.93	1.12
Rangpur lime (USA)	19.69	1.17	11.08	1.12	1.30
Rangpur lime (Poona Srirampur)	22.81	1.26	11.38	1.37	1.70
Rangpur lime (Brazilian)	21.97	1.13	11.95	1.16	1.46
Rangpur lime (Srirampur)	26.37	1.28	13.53	1.93	2.17
Rangpur lime (8748)	18.70	1.11	9.89	1.16	1.18
Rangpur lime (8744)	21.74	1.38	16.05	2.26	2.93
Rangpur lime (Phillipine red lime)	21.43	1.04	11.44	1.03	1.27
Rangpur lime (Tirupati)	20.61	1.16	14.91	1.76	1.79
Rangpur lime(Akola)	29.81	1.80	21.36	3.14	3.33
Rough lemon					
Rough lemon (Chethalli)	24.30	1.22	11.87	1.83	1.51
Rough lemon (Assam)	24.86	1.37	13.83	1.27	1.15
Rough lemon (Limmonaria Assam)	21.90	1.24	10.64	1.16	1.31
Rough lemon (Jatti Khatti)	24.37	1.11	10.45	1.39	1.31
Rough lemon (South Africa)	22.26	1.32	12.67	1.69	1.63
Rough lemon (58-III-IV)	16.30	1.02	8.45	1.14	1.10
Rough lemon (Florida)	26.85	1.37	14.27	1.73	1.81
Rough lemon (14-19-13)	24.82	1.16	10.44	1.33	1.63
Rough lemon (Australia)	25.75	1.15	11.52	1.21	1.56
Rough lemon (Tharsa)	23.87	1.28	11.02	1.20	1.59
Rough lemon (Akola)	32.52	1.96	19.27	2.30	2.11
‘F’ test	Sig.	Sig.	Sig.	Sig.	Sig.
S.E. (m) ±	2.48	0.13	1.41	0.28	0.36
C.D. at 5%	6.98	0.37	3.97	0.81	1.02

Phytophthora parasitica and *P. citrophthora*. Rangpur lime (*Citrus limonia*), Rough lemon (*Citrus jambheri*) and many other species are used as rootstocks. To know the relative resistance in various available strains, fourteen of Rangpur lime and ten of Rough lemons were screened for three years in artificial epiphytotic condition.

Seeds of different strains were sown in sterilized soil + sand mixture in pots during October/ November. After 10 months growth, these seedlings were transplanted during July in artificially inoculated nursery beds at 25 x 25cm row-to-row and plant-to-plant spacing in Randomized Block Design with four replications.

Cultures of *Phytophthora* isolated from root adhering soil were multiplied on large scale and was collected in sterilized water. Ten liters of sporangial suspension was added to the bed @ $2.5m^2$ bed area fortnightly starting from July to October. Observations on seedling mortality and leaf fall were recorded periodically. Growth parameters were also recorded after 5 month of uprooted seedlings. Disease scale, 1-5 given by Grimm and Hutchinson, 1973 was used for feeder root rating.

Phytophthora diseases revealed the great variation among the different rootstock strains (Table 1a). Rangpur lime (Akola) was found resistant to *Phytophthora* root rot with lowest seedling mortality (10.62%) and leaf fall (11.53%) and found significantly superior over other strains followed by Rough lemon (Akola). The other strains had recorded mortality above 13.58 %. Rangpur lime (Akola) and Rough lemon (Akola) both showed less feeder root rating. Less feeder root rating of Rangpur lime than Rough lemon against *Phytophthora* root rot were also reported by Prasad *et.al* (1997).

Data on growth parameters (Table 1 (b)) were also indicated that both these rootstocks have comparatively better health compared to other strains. These results are similar to the findings Sawant *et.al* (1984). Kale and Peshney (1997) reported Rough lemon (Akola) as a resistant to *Phytophthora* root rot and leaf fall. However, under present studies, Rangpur lime (Akola) was found resistant to *Phytophthora* root rot and leaf fall caused by *Phytophthora parasitica*. This might be due to the strainal variation exists in both pathogen and host.

Based on the data, it can be concluded that Rangpur lime (Akola) was found resistant to *Phytophthora* root rot in Vidarbha region than Rough lemon (Akola). Hence, preference may be given to the Rangpur lime (Akola) for propagation of citrus budlings.

LITERATURE CITED

Grimm, G. R. and D. J. Hutchinson, 1973. A procedure for evaluating resistance of citrus seedlings to *Phytophthora parasitica* (*P. nicotianee* var. *parasitica*), Plant Dis. Reptr., 57 (8): 669-672

Kale, K.B. and N.L Peshney, 1997. Evaluation of seedling resistance in Rangpur lime and Rough lemon strains to *Phytophthora* diseases, Proc. of National Symposium on Citriculture : 62-64

Prasad, M.B.N.V and S.D. Sawant, 1997. Citrus rootstock hybrids resistant to *Phytophthora* and Citrus nematodes and also tolerant to salinity and drought. *Proc. of National Symposium on Citriculture :* 59-61

Sawant P.M.; P.S. Lande and K.G. Choudhari, 1984. Reaction of citrus rootstocks to *Phytophthora* diseases, Indian J. Mycol. and Pl. Pathol., 14 (2): 111-118

AICRP on Tropical Fruits (Citrus),
Dr. PDKV, Akola

Ekta D. Bagde
G. K. Giri
Madhuri Sadafale
A. K. Sadawarte

❖ ❖ ❖

SUGGESTIONS FOR AUTHORS

General : The PKV Research Journal is published twice a year to promote the cause of research and disseminate the knowledge in the field of agricultural sciences. Subject matter should fall in the categories of (i) Original research articles (ii) Research notes and (iii) Review papers.

Manuscript : It should be typed on full scape good quality, double spaced, on one side of the page only, with sufficient margin, 5 cm on the left side and 2.5 cm on each of the remaining sides. The author(s) may submit paper in duplicate. He may not type his name, designation and acknowledgement on the first copy. All sheets in the copy should be of one side only and should not ordinarily exceed 10 in numbers including tables. Writing style should be simple, concise and precise. Presentation of article should have the components in the following sequence : TITLE, NAME (S) OF AUTHOR(S), FOOT NOTE, ABSTRACT, INTRODUCTION (without heading), MATERIAL AND METHODS, RESULTS AND DISCUSSION, ACKNOWLEDGEMENT if any and LITERATURE CITED. Format of Research note may be as per the pattern of PKV Res. J. Vol. 17 No. 2 of 1992. All calculations, tables, figures, names, quotations, citations, etc. should be carefully verified before submission.

The metric system of measurements should be followed and standard abbreviations be used.

The paper need necessarily to be accompanied by an undertaking that it is not published earlier in any journal. The author(s) are advised to adhere to the format of this journal strictly. In the event of not following the format, the paper(s) may not be attended to.

Title : The title of the article should be short and precise and should be followed in the next line, by name(s) of author(s). Foot note on the first page should include the department(s) contributing the article, designation and present address of author(s).

Abstract : Concise summation of findings not exceeding 200 words should be written at the beginning of the papers. The abstract should start with the objective. It should be intelligible without reference to the original paper. It should be written in such a way that will facilitate abstracting of the paper in the world of abstracts.

Table : Type each table on a separate sheet. They should be numbered in arabic numerals with title of the table in the same line. Table should be placed at the end of the manuscript, but its place in the text should be indicated.

Figures : Identify graphs, line drawings and photographs with consecutive arabic numbers as Fig. 1, Fig. 2. Place figures after tables. Photographs must be clear, glossy prints, original graphs and drawing must be in Indian ink or equivalent on plain white drawing paper. Lettering should be large and bold enough to permit reduction. Each figure number should placed on the back of each figure in pencil for identification.

Nomenclature : The latin binomial or trinomial and authority must be should for all plants, insects and pathogens at first listing either in the title or when first mentioned in the text. Crop varieties (not experimental lines and strains) should be identified by a single quotation mark at first listing only. Generic and specific names should be in italic e.g. *Lycopersium esculentum* Mil Morgtobe.

Reference : They should be double space throughout and arranged alphabetically according to author's names and should be placed under the heading "**LITERATURE CITED**" at the end of the article. Each reference should contain the name of author with initials, the year of publication, title of article, the abbreviated title of publication, volume and page e.g.

Sarode, S.V. and U.S. Kulkarni, 1998. Sustanability of *Helicoverpa armigera* (Hubner) on weed partheninum hysterophorous, Indian J. Entomol., 60 (4) : 421-422

Kawarkhe, V.J., R.N. Jane and Manisha Deshmukh, 2003.Effect of nitrogen and specing levels on growth and flower yield of China Aster, PKV Res. J., 27 (2) : 163-165.

In the text, the reference should be indicated by author's name followed by year of publication. When more than one paper by the same author appears in a single year they should be distinguished as a, b, c,......

Please refer to annexure of PKV Res. J. Volume 11(2), 1987 for abbreviation of journals to be given under **LITERATURE CITED**.

Correspondence : Manuscripts should be sent in duplicate directly to Editor-in-Chief, PKV Research Journal, Director of Research, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola - 444 104 (Maharashtra). Manuscripts are examined by the Editorial Board and referred to competent referees.

The Editorial Board takes no responsibility for the facts of the opinions expressed in the journal which rests with the authors.

Published by Dr. S.V. Sarode, Director of Research, Dr. PDKV, Akola for and on behalf of Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India in 2013 and Printed by him at Tanvi Graphics, Ranpise Nagar, Akola

DR. PANJABRAO DESHMUKH KRISHI VIDYAPEETH, AKOLA

RESEARCH JOURNAL

1. PKV Research Journal is published twice a year in January and July by Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola.
2. The contribution of paper is open only to active members and subscribers.
3. Annual membership of Journal subscription (with effect from 1-1-2006)
   i) Active member — Rs. 200/- per annum
   ii) Students — Rs. 100/- per annum
   iii) Libraries/Institutes — Rs. 200/- per annum
   iv) Other subscribers — Rs. 500/- per annum (for overseas)
   v) Life members/Donors — Rs. 1000/- (Rs. 3000/- for overseas)
   vi) Patrons — Rs. 5000/-
   vii) Sustaining Associates — Rs. 10,000/-
4. A limited space will be provided for the advertisement pertaining to various branches of Agriculture and Veterinary Science.
5. **Correspondence :** All correspondence regarding subscription and business matter may please be addressed to the Secretary, PKV Research Journal, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Krishi Nagar, Akola - 444 104 Maharashtra State (India).

This publication is included in the abstracting and indexing coverage of Biosciences Information Service of Biological Abstracts and Field Crop Abstracts.