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RESEARCH JOURNAL

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Cytoplasmic Male Sterility Development in Safflower

S. N. Deshmukh[1], M. M. Wakode[2] and R.D. Ratnaparakhi[3]

ABSTRACT

In safflower, besides the high degree of heterosis the hybrids did not gained the commercial success due to lack of availability of effective male sterility system in public domain. The attempt was made to develop the cytoplasmic male sterility system at Oilseeds Research Unit, Dr. PDKV, Akola and succeeded in development of two CMS lines in safflower with 100 per cent male sterility maintenance. The restorer development programme was simultaneously undertaken resulted in eight restorer lines, out of which three restorers restored the fertility more than 85 per cent in the hybrid combinations. The hybrid combinations produced utilizing the newly developed CMS lines restored 100 per cent fertility. Two hybrids AKSH-3 and AKSH-6, recorded the useful heterosis of 40.8 and 32.2 per cent, respectively.

High degree of heterosis has been reported for seed yield in safflower (*Carthamustinctorius*). However, commercial success of hybrid has not been seen in GMS hybrid (DSH 129, MKH 11, NARI-NH-1 and NARI-H-15) and CMS hybrids (MRSA-521). Hill (1989) reported the first cytoplasmic-genic male sterility (CGMS) system in safflower. In USA, hybrid developed using CGMS system recorded 25-35 per cent yield advantage over the best varieties (Hill, 2001). The CGMS system in safflower developed by Hill is not available to the public. Therefore, the work on development of cytoplasmic genetic male sterility system through conventional breeding was initiated in 1993 at Directorate of Oilseeds Research, Hyderabad and developed another CGMS system from the cross between *Carthamusoxyacantha* and cultivated species i.e. *Carthamustinctorius* (Anjani, 2008). At the same time, during the course of CMS development at NARI, Phaltan they came across thermosensitive genetic male sterility (TGMS) in safflower for the first time. TGMS lines exhibited complete male sterility during winter and restoration of fertility under summer conditions (Singh *et al*., 2008)

MATERIAL AND METHODS

In Dr. PanjabraoDeshmukhKrishiVidyapeeth at Crop Research Unit (Oilseeds), CMS development programme was initiated in the year 2004 and came out with two CMS lines in safflower, i.e. AKS-CMS 2A/B with orange petals and AKS-CMS 3A/B with whitepetals. Since, at that point of time, do not having wild species of safflower, resort another shortcut method and succeed (Table 1).

Table 1. CMS development programme

S.N.	Year	Activity
1.	2004-05	Selfing of known CMS F_1 hybrid by putting news paper bags on the capitulum
2.	2005-06	Previous year's selfed seed of CMS F_1 hybrid was grown in block. After identification of male sterile plants in F_{2-} bulk of known CMS F_1 hybrid, it was crossed individually to the male fertile plants of germplasm or GMS lines and in all 150 pairwise crosses were made (MA toME) as under:MA- Sterile plant x GMU 2351 (MA_1 X MA_1 to MA_{44} X MA_{44})MB- sterile plants x MMS (Non spiny) (MB_1 x MB_1 to MB_{22} x MB_{22})MC- sterile plants x MS (o) 9 (MC_1 x MC_1 to MC_{29} x MC_{29})MD- sterile plants x MMS (Spiny) (MD_1x MD_1 to MD_{25} to MD_{25})ME- sterile plants x ASD 07-03 (ME_1 x ME_1 to ME_{30} x ME_{30})
3.	2006-07	150 pairwise crosses were grown and after identification of male sterile plants, back crossing performed in all MA to ME series plants and 282 pairwise crosses were effected. At the same time, many pairs fail to restore sterility were rejected.
4.	2007-08	282 pairwise crosses were grown and

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again after identification of male sterile plants back crosses were performed in MB, MC and MD series and 105 paired crosses were effected. At the same time MA and ME series were rejected completely alongwith pairs failed to restore sterility.

5. 2008-09 105 pairwise crosses were grown and again after identification of male sterile plants back crosses were performed only in three series i.e. MB, MC and MD and 79 paired crosses were effected and few pairs, which failed to restore sterility were rejected.

6. 2009-10 79 pairwise crosses were grown and below mentioned 15 progenies were selected, maintained and evaluated for male sterility percentage by sibbing with their sterility maintainer counterpart.

Male sterile line	No. of Male sterile plants	No. of Male fertile plants	% sterility
MB 13-3-1	10	15	40.00
MB13-3-8	13	4	76.4
MC6-15-9	5	1	83.3
MC 12-6-6	12	8	60.0
MC 12-17-10	36	9	80.0
MC 25-3-6	25	14	64.1
MC 25-3-11	24	11	68.6
MC 25-7-11	23	13	63.9
MC 25-12-2	24	7	77.4
MC 25-12-4	28	9	75.7
MD 4-4	35	19	64.8
MD 4-6	25	9	73.5
MD 22-6	20	10	66.7
MD 25-10	23	6	79.3
MD 53-5	16	9	64.0

Further, in this 15 pairs, 132 pairwise crosses were made.

7. 2010-11 132 pairwise crosses were grown and on the basis of good opening of sterile flowers, petal colour, spiny/non-spiny nature, agronomic acceptability and above 90 per cent sterility, 65 pairs were selected.

8. 2011-12 65 pairwise crosses were grown in the field and on the basis of good opening of sterile flowers, agronomic acceptability and 100 per cent male sterility maintenance, one pair each in MD 4-4-1 (11 plants) and MD 4-4-5 (16 plants) were selected. In the same season 12 pairwise crosses (8-MD-4-4-1 and 4 - MD-4-4-5) were attempted. (Table 2).

9. 2012-13 Progenies of last year eight and four pairwise crosses were raised and astonishingly it was observed that all plants male sterility was maintained perfectly (Table-2). Therefore, separate harvest of each sterile and it's sterility maintainer part was done and the bulks were maintained as follows.1. AKS CMS 2 A and AKS CMS 2 B (MD 4-4-1)2. AKS CMS 3 A and AKS CMS 3 B (MD 4-4-5)

RESULTS AND DISCUSSION

During 2011-12 and 2012-13 the CMS line AKS CMS 2A and AKS CMS 3A maintained 100 percent male sterility. The details of sterility maintenance and salient features of these two lines are depicted in Table 2.

Table 2. Male sterility per cent maintained in A lines

A line	2011-12			2012-13			Salient features
	Total plants	Male sterile	Male fertile	Total plants	Male sterile	Male fertile	
AKS CMS 2A	11	11	0	200	200	0	Petal colour yellow turn to orange, spiny nature and good flower opening
AKS CMS 3 A	16	16	0	180	180	0	Petal colour white, spiny nature and good flower opening

Table 3. Performance of CMS based safflower hybrid in PHT

Particulars	CMS hybrids						Check variety	SE±	CD	CV
	AKSH 1	AKSH 2	AKSH 3	AKSH 4	AKSH 5	AKSH 6	PKV Pink		(at 5%)	(%)
A line	AKS CMS 2 A (Common for all hybrid)									
R line	AKS 11-1R	AKS 9-1R	AKS/ S 41	AKS 9-2R	AKS 11-2R	PKV pink				
Seed Yield (kg ha^{-1})	1086	1593	1979*	1611	1359	1859*	1406	135.6	395.7	12.4
% increase or decrease over check (-)	22.8	13.3	40.8	14.6	(-)3.3	32.2				

* Indicate significant superiority over check. Source: RRC. 2013

Fig. 1: Petal colour and opening of male sterile flowers

Simultaneously, eight fertility restorer lines (R lines) which are able to restore the fertility of various CMS lines were developed, viz., AKS 8 R (Yellow), AKS 9-1 R (Orange), AKS 9-2 R (Yellow), AKS 10-1 R (Orange), AKS 10-2 R (Yellow), AKS 11-1R (orange), AKS 11-2R (Yellow) and AKS 48 R (Yellow). These lines were evaluated by producing the hybrid combinations and it was found that the restorer lines AKS 11-2 R, AKS 8 R and AKS 9-1 R restored 92 per cent, 88.23 per cent and 85 per cent fertility of CMS line AKS CMS 2A line respectively.

Six experimental safflower hybrids were developed by utilizing newly developed cytoplasmic male sterile lineAKS CMS 2A during the year 2011-12 and were evaluated in Preliminary Hybrid Trial (PHT) during 2012-13 along with high yielding check variety viz., PKV Pink, under the dryland conditions in Vertisols. The results of PHT trial revealed that, the difference due to genotypes hybrids^{-1} for seed yield were statistically significant and safflower CMS hybrid AKSH-3 (1979 kg ha^{-1}) and AKSH 6 (1859 kg ha^{-1}) exhibited statistical significance over high yielding check variety PKV Pink (1406 kg ha^{-1}). The percentage of usefulheterosis of AKSH-3 and AKSH-6 over PKV Pink was 40.8 per cent and 32.2 per cent respectively (Table 3).

The seed of two newly developed safflower CMS lines is available with Senior Research Scientist, Oilseeds Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola and will be made available to the safflower breeder from any public institute on demand.

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Induced Mutation Using Gamma Radiation in Black Gram

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ABSTRACT

Seeds of black gram (*Vigna mungo* (L.) Hepper) was exposed to the gamma rays irradiation with doses 15Gy, 25Gy and 35Gy on three genotypes *viz.*, T-9, TPU-4 and AKU-18. The M_1 generation was observed for different parameters besides population screened for chlorophyll mutants. In M_2 generation all the harvested seed from each treatment were raised, which were carefully screened for economic viable mutants. Two hundred and twenty selected viable mutant plants from M_2 generation were harvested separately for confirmation of mutants and variability study in M_3 generation. The mutants were grouped as early mutant (earliness), bold seeded mutant, pod mutants, tall mutant, more branching mutant and dwarf mutant. Among the 220 mutant lines selected in M_3 generation from M_2 generation plants for their confirmation were grown. Out of these only 23 mutant lines showed true to type breeding behavior for early maturity, more number of seeds per pod, tallness, dwarfness, more branching, and bold seed mutants and remaining lines showed segregation.

Black gram is considered to have been domesticated in India from its wild ancestral *Vigna mungo* var. *silvestris* Lukoki *et. al.* (1980), the centre of origin of black gram according to Vavilov (1926). It has originated from Indian contingent. According to Dana (1980), *Vigna mungo* (L.) Hepper has 2n=22 chromosomes. It is warm season crop grown in *Kharif, Rabi* and *Spring/summer* seasons in the country. It is widely cultivated in the country as sole, mix or intercrop with cotton, sorghum, maize, pigeonpea, *bajra*, groundnut and sesame.

Induced mutations were used to generate genetic variability and have been successfully utilized to improve yield and yield components of various pulse crops like *Vigna unguiculata* (Mensah & Akomeah,1992), *Cajanus cajan* (Srivastava & Singh 1996) and *Vigna mungo* (Kundu & Singh, 1981). This shows that mutagenesis is a tool to be employed for crop improvement. There is considerable evidence that mutation is induced in polygenic traits and that is a genetic gain under selection. In M_2 generation macro mutation may be observed particularly following radiation treatment. The macro mutants are usually undesirable due to accompanying genetic instability. Micro mutations that alter quantitatively inherited characters are most useful to the breeders since they are least deleterious although they are more difficult to detect. The micro mutations increase variability in yield, protein content, plant height, flowering, pod production, seed weight or other yield related traits that are quantitatively inherited. Though mutation breeding attempts may be made to broaden the variation spectrum to facilitate selection of lines with improved nutritional qualities, especially with respect to protein associated with high yield (Tah, 2006). Gamma irradiation as a mutagen can induce useful as well as harmful mutation in plant (Gupta, 1996). Therefore the study was undertaken with the objective to induce mutation in three black gram genotypes using gamma radiation to determine the mutation frequency, observe the mutant traits and purify them for possible uses.

MATERIAL AND METHODS

The experimental material for the present study comprised of three black gram varieties *viz.*, T-9, TPU-4 and AKU-18. Eighty gram seeds of each variety were irradiated with 15Gy, 25Gy, 35Gy gamma rays at the BARC (Bhabha Atomic Research Centre) Trombay, Mumbai on 27th Feb, 2010.

Table 1: Description of treatments

Treatment codes	Genotype	Description of Treatment
V1T0	T-9	Control (0Gy)
V1T1	T-9	Irradiation with 15Gy
V1T2	T-9	Irradiation with 25Gy
V1T3	T-9	Irradiation with 35Gy
V2 T0	TPU-4	Control (0Gy)
V2 T1	TPU-4	Irradiation with 15Gy
V2 T2	TPU-4	Irradiation with 25Gy
V2 T3	TPU-4	Irradiation with 35Gy
V3 T0	AKU-18	Control (0Gy)
V3 T1	AKU-18	Irradiation with 15Gy
V3 T2	AKU-18	Irradiation with 25Gy
V3 T3	AKU-18	Irradiation with 35Gy

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M_1 generation

The treated seeds along with one control for each genotype were sown to raise M_1 generation in augmented trail during *Summer* 2010 at the research field of Department of Agril. Botany, Dr.PDKV, Akola. The M_1 generation was observed for different parameters besides population screened for chlorophyll mutants. Seeds from each plant of M_1 generation were harvested separately.

M_2 generation

The M_2 generation was raised in *Kharif* 2010 plant to row progenies were raised from all the harvested seeds from each treatment. The treated populations were carefully screened for desirable economic viable mutants. Two hundred and twenty selected mutant plants and treatment wise randomly selected plants were harvested for confirmation of mutants and variability study in M_3 generation.

M_3 generation

In *Kharif* 2011, seeds of all the harvested plants from each treatment from M_2 generation was sown to raise M_3 generation in replicated trial using Randomized Blocks Design with three replications by spacing of 45 x 10 cm. The sowing was undertaken on the well leveled piece of land at the field of Pulses Research Unit, Dr. PDKV, Akola with net plot size 3.00 x 1.80 m^2.

RESULTS AND DISCUSSION

In M_3 generation, 220 mutant lines of selected M_2 plant for their confirmation were grown out of these 220 mutant lines, only 23 mutant lines showed true to type breeding behavior in M_3 generation and remaining lines showed segregation for the selected characters. The characters of 23 mutant lines which were confirmed in M_3 generation were having early maturity, more number of seeds per pod, tall, dwarf, more branching and large

Table 2: Confirmation of induced macro mutations in M_3 generation

Mutants line No.	Parental variety	Dose in which mutant isolated	Desirable character possessed by mutants
1	AKU-18	15 Gy	Early maturity (68days) than control (71days)
2	T-9	15Gy	Early maturity (65 days) than control(70days)
3	AKU-18	25 Gy	Early maturity(69days) than control(71days)
4	AKU-18	35 Gy	Early maturity(61 days) than control(71days)
5	T-9	25 Gy	Early maturity (52 days)than control(70days)
6	TPU-4	35 Gy	Early maturity(68 days) than control(71days)
7	T-9	35Gy	More number of seeds per pod(8) than control(5)
8	TPU-4	25 Gy	More number of seeds per pod(10) than control(7)
9	AKU-18	25 Gy	More number of seeds per pod(9) than control(6)
10	AKU-18	35 Gy	Tall (50cm)than control(45cm)
11	T-9	35 Gy	Dwarf(15cm) than control(44cm)
12	TPU-4	15 Gy	Dwarf (16cm) than control(46)
13	TPU-4	35 Gy	More branching(11) than control(6)
14	T-9	25 Gy	More branching (9) than control (5.)
15	AKU-18	15 Gy	More branching (12) than control (5)
16	TPU-4	25 Gy	More branching (9) than control(6)
17	TPU-4	15 Gy	More branching(13) than control(6)
18	TPU-4	15 Gy	Long pod (7cm) than control(5cm)
19	T-9	15 Gy	Long pod (6cm) than control(4cm)
20	AKU-18	35 Gy	Bold seeds(5.3 g /100 seed) than control(4.2g/100)
21	T-9	25 Gy	Bold seeds(5.2g/100 seed) than control(3.8g/100 seed)
22	AKU-18	25 Gy	More pods(33) than control(29)
23	AKU-18	25 Gy	More pods(35) than control(29)

seeded mutants. Similar results were obtained by Kharkwal (1981) in M_3 generation in chickpea irradiated with gamma rays and Khan and Tyagi (2010) in M_3 generation in soybean cultivar Pusa-16 and PK-1042 were treated with 15, 30 and 45 Gy of gamma rays.

Six mutants showed early maturity, the character response equivalent to all the given doses (Table 2). The higher doses of gamma rays showed good report for more number of seeds per pod. The gamma ray dose 35 Gy showed good response for the height mutants. The lower dose 15 Gy found more effective than the other doses for long pod character. The dose 25 Gy found effective for bold seed and more pods per plant. The usefulness of mutagen depends both on its mutagenic effectiveness and efficiency, efficient mutagenesis being the production of maximum desirable changes accompanied by the least possible undesirable changes. The mutagenic effectiveness and efficiency generally decreased with the increasing dose of gamma rays with few exceptions Kumar *et al.* (2007).

Different types of mutants isolated from various treatments of gamma rays on their morphological changes have been isolated under present investigation. They are explained as follows:

I. Mutations affecting leaf morphology

1**. Wrinkled leaf mutant**

This type of mutant showed dark green wrinkled leaf as compared control leaf. This type of mutant was observed in TPU-4 with 15 Gy gamma rays dose Fig.(a). Chontira *et al.* (2005) reported the same type of mutant.

2. **Greenish yellow leaf mutant**

This type of mutant showed greenish yellow leaf with normal pod bearing and it was found only in T-9 with 35 Gy dose of gamma rays Fig. (b). Chontira *et al.* (2005) were reported similar type of mutant.

3. **Small leaf mutant**

The leaves of this mutant were quite small in size than the normal control leaves. This type of mutant was found in AKU-18 with 15 Gy dose of gamma rays Fig. (c). Such small leaves mutant was also recorded by Kumar *et al.* (2007).

4. **Quadra foliate mutant**

This type of mutant showed four leaflets in one leaf, this was found only in TPU-4 with gamma rays dose of 25 Gy Fig. (d). Similar mutant was recorded by Grover and Virk (1984) in green gram.

5. **Broad leaf mutant**

The leaves of this type of mutant were quite wider than the normal leaf. T-9 with 35 Gy dose of gamma rays showed such type of mutants Fig. (e). This type mutant was also recorded by Singh and Yadav (1991) in green gram.

II. Mutations affecting Plant type

1. **Dwarf mutant**

The height of plant was 20 cm as compared to control (46.40 cm). Such type of mutant was found in TPU-4 with 15 Gy dose of gamma rays which showed short internodes with few branches and poor bearing of pods Fig. (f). Similar type mutant was also reported by Kumar *et al.* (2007) in blackgram.

2. **Tall mutant**

AKU-18 with gamma rays dose of 35 Gy isolated as the tall mutant. This type of mutant achieved height 102 cm than control 45.26 cm Fig. (g). Similar type of mutant was also reported by Kumar *et al.* (2007) in blackgram.

3. **Vine type mutant**

The plant was weak, slender, and delicate and showed creeping habit. The leaves showed normal shape, height was 95 cm. This type of mutant was observed in AKU-18 with gamma rays dose of 35 Gy Fig. (h). Grover and Virk (1984) found similar type of mutant in green gram.

III. Mutations affecting pod type

1. **Bold pod mutant**

This type of mutant showed bold pod with increase in hundred grain weight (5.00g 100seed^{-1}) over control (3.30g 100 seed^{-1}). The gamma rays dose of 25 Gy on AKU-18 showed such type of mutant Fig. (i). Similar type of mutant was also reported by Kumar *et al.* (2007) in blackgram.

2. **Short pod mutant**

Such type of mutant was found in AKU-18 with 35 Gy dose of gamma rays. This type of mutant showed short pod size (3.20cm) as compared to control (4.50cm) plant pod Fig. (i). Similar type of mutant was also reported by Kumar *et al.* (2007) in blackgram.

3. **Long pod mutant**

This type of mutant showed longer size of pod (6.00) than the normal pod of control (5.53cm), TPU-4 with 35 Gy dose of gamma rays showed this type of mutant Fig. (i). Similar type of mutant was also reported by Kumar *et al.* (2007) in blackgram.

4. **Hairy pod mutant**

AKU-18 with gamma rays dose of 15 Gy experiential this type of mutant, which showed hairs on the pods and bear low number of pods Fig. (i). Similar type mutant was also reported by Kumar *et al.* (2007) in blackgram.

IV. Mutations affecting seed, podding and branching

1. **Bold seeds mutant**

This type of mutant showed bold seed (3.80 g 100^{-1} seed) than the control (3.38g 100^{-1} seed) Fig. (j).The treatment T-9 with 35 Gy dose of gamma rays showed this type of mutant.

2. **High podding mutant**

This type of mutant bears more number of pods as compare to its control. This type of mutants was found in AKU-18 with gamma rays dose of 15 Gy Fig. (k). Similar type of mutant was also reported by Kumar *et al.* (2007) in blackgram.

3. **Profuse/ more branching mutant**

This type of mutant was also found in TPU-4 with 25 Gy dose of gamma rays. This type of mutant showed more number of branches as compared to its control Fig. (l). Similar type of mutant was also reported by Kumar *et al.* (2007) in blackgram.

The characters of 23 mutant lines which were confirmed in M_3 generation were early maturity, more number of seeds per pod, tall, dwarf, more branching, and bold seeded mutants. The result have been discussed from the point of view for their practical usefulness in relation to blackgram breeding programme and certain information have been obtained which may help in the future for further improvement in blackgram yield and other yield contributing characters.

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Heterosis for Yield and its Components in Castor

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ABSTRACT

Heterosis studies in castor (*Ricinus communis* L.) were undertaken in a set of 10 parents involving three female and seven male parents.during *Kharif* 2010-11. The heterosis analysis revealed that the cross 48-1 X SKI-1 exhibited highest average heterosis (156.29%), heterobeltiosis (109.43%) and standard heterosis over the check varieties AKC-1(35.28%) and 48-1(109.42%) for seed yield plant^{-1}.

Castor is a non-edible oilseed crop cultivated around the world because of commercial importance of its oil. There are varied industrial applications of castor oil and its derivatives. Papova (1926) reported 42 to 58 per cent oil in castor seed whereas Li wang (2007) reported 35 to 55 per cent oil in castor seed. The oil is mainly used as lubricant because of its property to remain liquid at very low temperatures (-32°C), high density and viscosity (18 times higher than that of any other vegetable oil). Castor oil and its derivatives have wide range of uses in the manufacture of lubricants, plastics, adhesives, waxes, polishes, coating applications, inks, paints.

Besides India, Brazil and China are the most important castor growing countries in the world. India contributes more than one third of the world production of castor oil (5.5 lakh tones) and meets about 80 per cent world castor oil demands. Hence, castor plays an important role in Indian economy by earning valuable foreign exchange.

The phenomenon of heterosis has proved to be the most important genetic tool in enhancing the yield of cross pollinated species in general and particularly in castor. With the availability of cent per cent pistillate lines in castor, exploitation of hybrid vigour on commercial scale has become feasible and economical (Gopani *et al*., 1968). The spectacular advancement in production and productivity of castor has been witnessed in India especially in Gujarat which was mainly due to release of hybrids and their adaptation by farmers.

MATERIAL AND METHODS

A set of 10 parents (three females viz., AKC-1, 48-1, DCS-9 and seven males viz., EC97706, Aquation No. 315-3, SKI-1, Salem 91, EC168554, RC1284, EC284470) along with their 21 F_1's including two checks i.e. AKC-1 and 48-1 was evaluated in randomized complete block design with 3 replications at the field of AICRP for Dryland Agriculture Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *Kharif* 2010-11.

The data were recorded for days to 50 per cent flowering, days to maturity of primary spikes, number of nodes up to primary spikes, plant height, effective length of primary spikes, effective length of secondary spikes, effective length of tertiary spikes, number of secondary spikes, number of tertiary spikes, total number of spikes, number of capsules on primary spikes, number of capsules on secondary spikes, number of capsules on tertiary spikes, total number of capsules, 100 seed weight, seed yield and oil content. Analysis of variance was carried out as per standard method (Panse and Sukhatme, 1954). The average heterosis, heterobeltiosis and useful heterosis were calculated to know the extent of heterosis.

RESULTS AND DISCUSSION

The analysis of variance for various characters under study has been presented in Table 1. The variation among genotypes was highly significant for all characters except for number of secondary spikes indicating the presence of substantial amount of genetic variability for these characters. Further partitioning of genotypic variance into components viz., parents, crosses and parents vs crosses revealed that the parents differed among themselves significantly for all the characters except number of secondary spikes. Similarly, the crosses also showed highly significant differences for all the characters except number of secondary spikes. The mean sum of squares due to parents vs crosses were significant for all the characters indicating the significant differences between parents and crosses except for the characters viz., plant height, number of secondary spikes, number of tertiary spikes, total number of spikes, number of capsules on primary spikes, number of capsules on secondary spikes and number of capsules on tertiary spikes and total number of capsules.

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Among the parents, the parent AKC-1 showed highest mean performance for maximum five characters viz., effective length of secondary spikes (15.67cm), effective length of tertiary spikes (11.67cm), number of tertiary spikes (3.33), total number of spikes (7.33) and oil content (49.33%). It also took lowest number of days to 50 per cent flowering (48.33days). Similarly, another parent Salem 91 recorded highest mean performance for maximum five characters viz., effective length of primary spikes (30.67cm), number of capsules on primary spikes (46.33), number of capsules on secondary spikes (18.67), total number of capsules plant^{-1} (75.33) and seed yield per plant (48.19 g). It was also found to be earliest in maturity (93.33days) among the parents. For the characters, number of nodes (13) and plant height (33.67cm), the parent EC168554 was found to be promising whereas the parent RC 1284 recorded highest number of capsules on tertiary spikes (12.33). The maximum 100 seed weight (30.68g) was displayed by the parent 48-1.

Among the crosses, the cross AKC-1 x EC 284470 recorded lowest number of days to 50 per cent flowering (54.33days) and 48-1 x EC 97706 (94.67days) was observed to be earliest in maturity. Lowest number of nodes and plant height was found in the crosses AKC-1 x Aquation No. 315-3 (14.67) and DCS-9 x EC 284470 (23.67cm) respectively. The cross 48-1 x Aquation No. 315-3 recorded maximum effective length of primary spike (32.67cm) and number of capsules (48.67) which resulted into maximum number of capsules plant^{-1} (72.33) indicating the importance of effective length of primary spikes in the breeding programme. The maximum effective length of secondary and tertiary spikes was found in the crosses AKC-1 x Salem 91 (17.33cm) and DCS-9 x Salem 91 (10cm) respectively. The cross 48-1 x EC 168554 recorded highest effective number of tertiary spikes (3.33cm), total number of spikes per plant (7.33) and total number of capsules on tertiary spikes (12). The cross 48-1 x SKI 1 produced highest number of capsules on secondary spikes (12) as well as seed yield per plant (57.09g). For the characters, 100 seed weight and oil content, the crosses 48-1 x EC 284470 (31.6g) and DCS-9 x Aquation No. 315-3 (49.25 %), respectively were found to be promising.

Commercial exploitation of heterosis in castor is regarded as one of the major breakthrough in the field of castor improvement. Castor is highly cross pollinated crop and with the availability of 100 per cent pistillate lines, heterosis has been successfully exploited in castor and in India first castor hybrid GCH 3 (TSP-10 R x J 1) was released for general cultivation in Gujarat as early as 1968 (Gopani *et al*., 1968).

In the present study, the existence of overall heterosis was evident and good number of crosses showed significant heterosis over the mid parent, better parent and standard checks AKC-1 and 48-1 for various traits in desired direction.

The crosses expressing maximum average heterosis for several characters are presented in Table 2.The highest average heterosis in desirable direction was recorded in the cross 48-1 X SKI-1 for the characters viz., days to 50 per cent flowering of primary spikes (-10.38%), number of tertiary spikes (166.67%), number of capsules on secondary spikes (122.22%), and seed yield per plant (156.29%). The cross 48-1 X Aquation No.315-3 exhibited maximum average heterosis for the traits viz., effective length of primary spikes (122.75%), number of capsules on primary spikes (274.36%) and total number of capsules per plant (180.00%). The cross 48-1 X EC168554 depicted maximum average heterosis for the characters viz., effective length of secondary spikes (96.08%), total number of spikes (57.14%), number of capsules on tertiary spikes (148.28%). The cross 48-1 X EC97706 showed highest average heterosis for the traits viz., days to maturity of primary spikes (-20.78) and effective length of tertiary spikes (107.41%). The occurrence of heterosis as observed in present study has also been reported by several workers for plant height (Chaudhari, 2007), for number of nodes upto primary spikes (Dangaria *et al*., 1987 and Thakker *et al*., 2005), for length of primary spikes (Dangaria *et al.*, 1987 and Joshi *et al*., 2001), for number of capsules on the primary spikes (Thakker *et al*., 2005), and for total number of spikes (Joshi *et al*., 2001). Relatively moderate to low heterosis for days to 50 per cent flowering and maturity observed in present investigation was also reported by Mehta *et al*. (1991)

However, the measure of heterosis over mid parental value has relatively limited importance and is of more academic interest. On other hand, the heterosis measured over the better parent and/or standard check is of much practical importance. In the present investigation, therefore, the heterosis has also been measured over the better parent and the standard checks AKC-1 and 48-1.

Table 1: Analysis of variances for various characters

Source of variation	DF	Mean sum of squares								
		Days to 50% flowering of primary spikes	Days to maturity of primary spikes	Number of nodes up to primary spikes	Plant height (cm)	Effective length of primary spikes	Effective length of secondary spikes	Effective length of tertiary spikes	Number of secondary spikes	Number of tertiary spikes
	1	2	3	4	5	6	7	8	9	
Replication	2	5.49*	0.65	0.14	17.75	0.80	6.65	1.49	0.04	0.52*
Genotypes	30	51.48**	424.50**	24.35**	1280.37**	144.30**	25.92**	10.85**	0.56	1.36**
Parents	9	73.20**	423.64**	43.29**	1512.80**	216.40**	30.83**	16.05**	0.60	1.54**
Crosses	20	43.47**	443.05**	16.35**	1238.95**	115.61**	19.95**	7.08**	0.50	1.35**
Parents Vs Crosses	1	16.28**	61.50**	13.89**	17.10	69.01**	101.07**	39.47**	1.24	0.12
Error	60	1.63	1.79	1.47	18.81	7.63	2.50	0.87	0.54	0.12

Source of variation	DF	Mean sum of squares							
		Total number of spikes	Number of capsules on primary spikes	Number of capsules on secondary spikes	Number of capsules on tertiary spikes	Total number of capsule plant^{-1}	100 seed weight (g)	Seed yield plant^{-1} (g)	Oil content (%)
		10	11	12	13	14	15	16	17
Replication	2	0.72	26.62	2.33	5.51*	37.46	6.61**	0.05*	0.09**
Genotypes	30	2.70**	316.38**	40.28**	15.90**	645.55**	56.94**	472.80**	6.07**
Parents	9	3.17**	448.30**	59.33**	28.38**	1088.80**	52.82**	434.16**	7.65**
Crosses	20	2.60**	272.84**	33.50**	11.01**	477.78**	57.00**	507.89**	4.99**
Parents Vs Crosses	1	0.59	0.014	4.51	1.37	11.69	92.86**	118.58**	13.35**
Error	60	0.75	21.21	3.60	1.31	28.96	1.24	0.014	0.0065

Note: * Significant at 5% level of significance. ** Significant at 1% level of significance

Table 2: The crosses showing highest average heterosis and Heterobeltiosis and useful heterosis

S.N.	Name of crosses	Average heterosis	Heterobeltiosis	Useful heterosis over AKC-1U	seful heterosis over 48-1
1	48-1 X SKI-1	Days to 50% flowering of primary spikes (-10.38%)	Effective length of tertiary spikes (81.25%)	Seed yield per plant (35.28%)	Number of capsules on secondary spikes (160.76%)
		Number of tertiary spikes (166.67%)	Number of tertiary spikes (166.67%)	-	Seed yield per plant (109.42%)
		Number of capsules on secondary spikes (122.22%)	Number of capsules on secondary spikes (93.55%)	-	-
		Seed yield per plant (156.29%)	Seed yield per plant (109.43%)	-	-
2	48-1 X EC168554	Effective length of secondary spikes (96.08%)	Effective length of secondary spikes (78.57%)	-	Number of tertiary spikes (233.33%)
		Total number of spikes (57.14%)	Total number of spikes (46.67%)	-	Total number of spikes (69.36%)
		Number of capsules on tertiary spikes (148.28%)	Number of capsules on tertiary spikes (125.00%)	-	Number of capsules on tertiary spikes (125.14%)
3	48-1 X Aquation No. 315-3	Effective length of primary spikes (122.75%)	Effective length of primary spikes (68.98%)	-	Effective length of primary spikes (69.01%)
		Number of capsules on primary spikes (274.36%)	Number of capsules on primary spikes (274.36%)	-	Number of capsules on primary spikes (294.65%)
		Total number of capsule (180%)	Total number of capsule (174.68%)	-	Total number of capsule (185.56%)
4	48-1 X EC 97706	Days to maturity of primary spikes (-20.78%)	-	-	-
		Effective length of tertiary spikes (107.41%)	-	-	-
5	AKC-1 X Salem 91	Number of nodes up to primary spikes (-23.66%)	Number of nodes up to primary spikes (-25.39%)	-	Length of secondary spikes (85.78%)
6	AKC-1 X EC 284470	Plant height (-56.12%)	Plant height (-47.93%)	-	-
7	DCS-9 X Aquation No. 315-3	100 seed weight (15.94%)	-	-	Oil content (3.00%)
8	DCS-9 X EC 97706	Oil content (4.88%)	-	-	-
9	DCS-9 X EC 168554	-	Days to 50% flowering of primary spikes (-1.69%)	-	-
10		-	100 seed weight (7.53%)	-	-
11	AKC-1 X SKI-1	-	Days to maturity of primary spikes (-16.76%)	-	-
12	48-1 X Salem 91	-	Oil content (1.69%)	-	-
13	48-1 X EC 284470	-	-	Days to maturity of primary spikes (-18.08%)	Days to maturity of primary spikes(-23.43%)
14		-	-	100 seed weight (34.33%)	100 seed weight (3.00%)
15	AKC-1 X Aquation No. 315-3	-	-	Number of nodes up to primary spikes (-31.25%)	Number of nodes up to primary spikes (-41.36%)
16	DCS-9 X EC 284470	-	-	Plant height (-76.17%)	Plant height (-60.99%)
17	AKC-1 X RC 1284	-	-	-	Days to 50% flowering of primary spikes (-21.50%)
18	DCS-9 X Salem 91	-	-	-	Effective length of tertiary spikes (87.62%)

Many crosses exhibited maximum heterosis over the better parent (Table 2) in desirable direction for yield and its component traits. The cross 48-1 X SKI-1 showed heterobeltiosis for maximum number of characters viz., effective length of tertiary spikes (81.25%), number of tertiary spikes (166.67%), number of capsules on secondary spikes (93.55%) and seed yield per plant (109.43%). The cross 48-1 X Aquation No.315-3 showed maximum heterobeltiosis for the traits viz., effective length of primary spikes (68.98%), number of capsules on primary spikes (274.36%) and total number of capsules per plant (174.68%). The cross 48-1 X EC168554 exhibited highest heterosis over better parent for the characters viz., effective length of secondary spikes (78.57%), total number of spikes (46.67%), number of capsules on tertiary spikes (125.00%). The cross DCS-9 X EC168554 exhibited highest heterosis over better parent for the characters days to 50 per cent flowering of primary spikes (-1.69%) and 100 seed weight (-7.53%).

It was observed that cross showing high heterobeltiosis for seed yield per plant in general also manifested heterotic effects for its contributing characters like length of tertiary spikes, number of tertiary spikes and number of capsules on secondary spikes. This study thus, substantiates the findings of Mehta *et al.* (1991).

The yield superiority of the cross over best cultivated varieties is important and essential from commercial cultivation point of view. The varieties 48-1and AKC-1 have been used as checks in order to obtain the information on the superiority of the crosses over AKC-1 and 48-1. The crosses showing maximum useful heterosis over the check varieties 48-1 and AKC-1 for different characters in desired direction are given in Table 2. The highest useful heterosis over the check AKC-1 in desirable direction was recorded by the cross 48-1 X EC 284470 for days to maturity of primary spikes (-18.08%) and for 100 seed weight (34.33%). The cross AKC-1 X Aquation No. 315-3 showed highest useful heterosis over the check AKC-1 for number of nodes up to primary spikes (-31.25%). The cross DCS-9 X EC 284470 showed maximum useful heterosis over the check AKC-1 for plant height (-76.17%) in desired direction. The cross 48-1 X SKI-1 exhibited maximum useful heterosis over the check AKC-1 for seed yield plant^{-1}.(35.28%).

The highest useful heterosis over the check variety 48-1 in desirable direction was recorded by the cross 48-1 X Aquation No.315-3 for the characters viz., effective length of primary spikes (69.01%), number of capsules on primary spikes (294.65%) and total number of capsules per plant (185.56%). The cross 48-1 X EC 168554 showed highest useful heterosis over the check 48-1 for the traits viz., number of tertiary spikes (233.33 %), total number of spikes (69.36%), number of capsules on tertiary spikes (125.14%). The cross 48-1 X SKI-1 showed maximum useful heterosis over the check 48-1 for the characters viz., number of capsules on secondary spikes (160.76%) and seed yield plant^{-1} (109.42 %).

Overall results of heterosis analysis revealed that the cross 48-1 X SKI-1 exhibited highest average heterosis (156.29%), heterobeltiosis (109.43%) and standard heterosis over the check AKC-1(35.28%) and the check 48-1(109.42%) for seed yield plant^{-1}. It also depicted high mean performance for number of capsules on secondary spikes (12) as well as seed yield plant^{-1} (57.09g). Thus, this cross 48-1 X SKI-1 was found to be promising for exploitation of heterosis.

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Genetic Variability and Correlation Studies in Leafy Amaranth

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ABSTRACT

Twenty genotypes belonging to *Amaranthus tricolor* were evaluated at Department of Horticulture, Dr. PDKV in the year 2012 to work out the variability and correlation coefficient. The characters like leaf area, width of leaf, length of leaf and stem diameter exhibited almost equal magnitudes of GCV and PCV, thereby indicated that there was less influence of environment on these characters and entire variation was due to genotypic effect only. Out of thirteen characters ten characters plant height, stem diameter, length of leaf, width of leaf, leaf area, petiole length, weight of leaf, weight of stem, leaf/stem ration and yield (q ha^{-1}) recorded, high heritability along with high genetic advance. Thereby, indicated the direct selection of those characters may be useful in improvement of the crop. Association analysis revealed that, out of thirteen characters only two characters *viz.* plant height and petiole length exhibited positive and significant association with the yield(q ha^{-1}). The result indicated that, the plants with highest petiole length and plant height are the most important characters contributing to the yield in Amaranth crop.

Among the vegetable crops Amaranth is unique because of their fast growing nature with extremely high yield potential, less susceptibility to soil born diseases, easy for cultivation, suitable for both home garden and commercial cultivation. Being tropical and warm season crop. Amaranth leaves and succulent stems contain high levels of vitamins including β-carotene (precursor of vitamin A), vitamin B6, vitamin C, and dietary minerals such as calcium (350-400mg $100g^{-1}$), iron (38mg $100g^{-1}$), magnesium, phosphorus, potassium, zinc, copper and manganese and minerals (Makus and Davis, 1984; Susan and Anne, 1988). Amaranth is short-duration crop gives quick response to manures and fertilizers, availability of diverse types suited to specific agro-climatic situations make it a favorite crop of farmers to fit in any cropping systems. Both leafy and grain types play an important role to combat malnutrition of poor people (Gopalakrishnan, 2007).

Crop improvement in Amaranth gained momentum only during the recent decade in different countries and is required through utilization of available genetic variability, which is a pre-requisite in any hybridization program. The extent of variability in crop, determines the limits of selection for improvement. The characters of economic importance are generally quantitative in nature and exhibit considerable degree of interaction with the environment. Thus, it becomes necessary to compute variability present in the material and its partitioning into genotypic, phenotypic, and environmental effects (Shukla *et al.,* 2006). Genetic variability is important to select characters, which are heritable. Unless and until there is large amount of variability present in the population, the breeder has little scope in breeding for high yielding varieties. Similarly, knowledge on the association of component traits with the yield may greatly help in making more precise and accurate selection. An estimate of genotypic and phenotypic correlations will be useful in planning and evaluating breeding programmes.

MATERIAL AND METHODS

Twenty genotypes belonging to *Amaranthus tricolor* from germplasm maintained at NBPGR, Regional Station, Shimla, and Himachal Pradesh were obtained and raised at Department of Horticulture field Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola in Randomized Block Design with 3 replications in the year 2012. Observations were recorded on randomly selected 10 plants for yield and yield contributing traits. Analysis of variance was carried out in order to partition the total variation showed by different characters under study into its components viz. blocks, treatments and error. Analysis was carried out as per the standard method suggested by Panse and Sukhatme (1967).

RESULTS AND DISCUSSION

Analysis of variance revealed that, mean sum of squares were significant for all most all the characters studied. Data pertaining to range, mean, GCV, PCV, Heritability and Genetic Advance presented in Table 1.

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As regards the genotypic and phenotypic coefficients of variation, higher GCV and PCV values were recorded for the characters leaf area (43.41, 43.58), width of leaf (33.08, 35.21), leaf:stem ratio (26.52, 43.62), weight of leaf (26.49, 32.62), weight stem (24.31, 39.47), petiole length (23.99, 28.34), length of leaf (22.73, 23.60), plant height (20.97, 22.59) and stem diameter (20.62, 21.80) which are in confirmation with the results reported by Simtha and Krishnakumary (2011), Suryawanshi (2003), Rana *et.al.*, (2005), Mohanalakshmi (1998), Rani and Veeraragavathatham (2001). Moderate genotypic and phenotypic coefficient of variation was observed for character yield ha^{-1} (18.77, 28.80), number of leaf (12.37, 18.21) and chlorophyll index (11.22, 15.35), while low magnitude of GCV and PCV was observed for the character days to harvesting (7.84, 10.77).

The characters like leaf area, width of leaf, length of leaf and stem diameter exhibited almost equal magnitudes of GCV and PCV, indicated that there was a less influence of environment on these characters and entire variation was due to genotypic effect only. Other character expression was due to favorable environment and not due to genetic effects since, the magnitude of PCV is more than the magnitude of GCV.

Heritability worked out in broad sense would suggest how far the variation is heritable and selection is effective. Though heritability estimates are the true indicators of genetic potentiality of the genotypes as tool for selection (Johnson *et.al*, 1955), change in the heritability due to fluctuation of environmental factors detected from the total dependence of such estimates. However, heritability estimates when considered in conjunction with the predicted genetic gain from a reliable tool in selection. Thereby indicate the EGA of a character in response to selection pressure imparted on them.

In present investigation, highest heritability in broad sense to the extent of 99.23 per cent was recorded for the characters leaf area followed by stem diameter (89.48%), width of leaf (88.27%), plant height (86.21%), petiole length (71.66%), weight of leaf (65.94%), while moderate heritability in broad sense were recorded for the characters chlorophyll index (53.43%), days to harvesting (52.92%), number of leaves (45.98%), yield per hectare (42.51%), weight of stem (37.94%), leaf:stem ratio (36.97%). Similar findings were reported by Rani and Veeraragavathatham (2001) for plant height, leaf weight and stem weight.

As regards the genetic advance as percent over mean moderate values were recorded by the characters number of leaves (17.24%), chlorophyll index (16.89%) and days to harvesting (11.74%), while rest of the characters recorded higher magnitudes of genetic advance (GA) as percent over mean. Considering the importance of both heritability and genetic advance together, out of thirteen characters ten characters viz. plant heights, stem diameter, length of leaf, width of leaf, leaf area, and petiole length, weight of leaf, weight of stem, leaf:stem ration and yield (q ha^{-1}) recorded high heritability along with

Table 1: Estimates of genetic parameters viz. range, mean, GCV, PCV, heritability and EGA

S.N.	Characters	Range	Mean	GCV (%)	PCV (%)	Heritability (h^2) (%)	EGA as % over mean
1	Plant height (cm)	8.51 - 22.55	14.57	20.97	22.59	86.21	40.11
2	No. of leaf	6.60 - 11.73	9.51	12.35	18.21	45.98	17.24
3	Stem Diameter (cm)	0.41 - 0.89	0.62	20.62	21.80	89.48	40.17
4	Length of leaf (cm)	3.29 - 6.61	4.46	22.73	23.60	92.74	45.09
5	Width of leaf (cm)	1.33 - 3.74	2.22	33.08	35.21	88.27	64.02
6	Leaf Area (cm^2)	5.56 - 25.16	11.69	43.41	43.58	99.23	89.07
7	Petiole length (cm)	1.29 - 3.51	2.34	23.99	28.34	71.66	41.83
8	Weight of Leaf (g)	0.67 - 1.82	1.23	26.49	32.62	65.94	44.31
9	Weight of stem (g)	0.58 - 1.48	0.97	24.31	39.47	37.94	30.84
10	Leaf/stem ratio	0.60 - 2.16	1.39	26.52	43.62	36.97	33.21
11	Chlorophyll index (%)	26.57 - 41.82	33.20	11.22	15.35	53.43	16.89
12	Days to harvesting	24.67 - 30.00	26.48	7.84	10.77	52.92	11.74
13	Yield ha^{-1} (qt)	2.07 - 4.58	3.12	18.77	28.80	42.51	25.22

Table 2. Genotypic correlation coefficients for various characters

S. N.	Character	Plant height (cm)	No of Leaf	Stem diameter (cm)	Length of leaf (cm)	Width of leaf (cm)	Leaf area (cm^2)	Petiole length (cm)	Weight of leaf (g)	Weight of stem (g)	Leaf stem ratio	Chlorophyll index	Days to harvesting	Yield (q/ha)
		1	2	3	4	5	6	7	8	9	10	11	12	13
1	Plant height (cm)	1	0.420	-0.041	-0.243	-0.051	-0.190	0.530*	0.538*	0.380	0.148	-0.116	-0.081	0.530*
2	No. of leaf		1	-0.526*	-0.381	-0.334	-0.569**	0.189	0.354	0.151	0.088	-0.498	0.300	0.246
3	Stem diameter (cm)			1	0.557*	0.572**	0.652**	0.269	0.199	-0.203	0.385	0.309	-0.010	0.325
4	Length of leaf (cm)				1	0.895**	0.834**	0.231	0.008	-0.017	0.160	0.428	0.378	-0.286
5	Width of leaf (cm)					1	0.840**	0.429	0.230	-0.154	0.402	0.328	0.451*	-0.097
6	Leaf Area (cm^2)						1	0.265	0.010	-0.037	0.178	0.402	0.193	0.011
7	Petiole length (cm)							1	0.186	0.162	-0.103	-0.290	0.615**	0.562**
8	Weight of Leaf (g)								1	0.205	0.752**	0.201	0.072	0.388
9	Weight of stem (g)									1	-0.525*	0.021	-0.106	0.294
10	Leaf/Stem Ratio										1	0.454	-0.056	0.006
11	Chlorophyll index											1	-0.628**	-0.325
12	Days to harvesting												1	0.086
13	Yield ha^{-1} (q)													1

*Significant at 5% ** Significant at 1%

high genetic advance thereby indicated the direct selection of those characters may be useful in improvement of the crop.

Correlation provides the information on the nature and magnitude of the association of different traits with yield, which is regarded as a complex trait. To make an effective selection for this complex trait, basic information on major yield contributing characters and their interrelationship is essential to the plant breeder. In present investigation, yield and its contributing characters were analyzed for their association with yield and among themselves.

The data on association analysis revealed that, out of thirteen character only two characters *viz.* plant height and petiole length exhibited positive and significant association with the yield (q ha^{-1}) (0.530 and 0.562, respectively) beside these characters *viz.* weight of leaf (0.388), stem diameter (0.325), weight of stem (0.294) and number of leave (0.246) recorded positive association with yield, however the associations were non-significant, since the magnitudes were low.

Character weight of leaf was strongly associated with leaf:stem ratio, character stem diameter exhibited strong association with length of leaf, width of leaf and leaf area. Though the length of leaf exhibited negative and non-significant association with yield, it has recorded highest and very strong association with the characters width of leaf and leaf area. Similar is true with width of leaf. The result indicated that the plants with maximum petiole length and plant height are the most important characters contributing to the yield in Amaranth crop. The results are in confirmation with Shukla *et.al* (2009) for plant height.

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Genetic Variability and Correlation Studies for Seed Yield in Cluster Bean

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ABSTRACT

Cluster bean or Guar seeds (*Cyamopsis tetragonoloba* L.) are mainly used for extraction of endospermic gum having binding properties. In all twenty genotypes of cluster bean were evaluated for seed yield and yield contributing characters. Moderate GCV and PCV values were recorded for the characters, weight of pod, seed yield plot^{-1}, internode length, protein content and seed yield. Out of nineteen characters studied, only one character i.e. leaf area recorded high heritability along with high genetic advance there by indicated that direct selection on the basis of leaf area may be useful in improvement of the crop. Similarly, high heritability and moderate genetic advance was recorded by plant height and diameter of pod indicating the predominance of additive gene component, thus there is an ample scope for improving these characters through direct selection. Association analysis revealed that, only two character *viz.* number of secondary branches and diameter of pod exhibited positive and significant association with the yield in cluster bean.

Cluster bean (*Cyamopsis tetragonoloba* L.) is an erect annual growing plant. Cluster bean or Guar seeds are mainly used for extraction of endospermic gum having guar binding properties. The seed contains 30-35 per cent protein, 26.8-32.2 per cent gum, 6.1-7.7 per cent oil and 2.99-3.75 per cent minerals. Seeds having large endosperm that contains galactomannan gum which forms gel in water commonly known as guar gum, which is used in multifarious, cosmetics, explosive, mining and oil industries, also in dairy products throughout the world (Smith, 1976). The crop also has medicinal value for curing diabetes and those having cholesterol levels.

Study of extent of variability particularly in yield and yield contributing characters is a basic to plan out future improvement program in any crop. This is achieved by estimation of genetic variability using suitable parameters like genotypic and phenotypic coefficients of variation, heritability and expected genetic advance for individual characters. Although genetic coefficient of variation is an indicative of presence of degree of variation, the amount of heritable portion can only be determined with the help of estimates of heritability and genetic gain. Similarly, genotypic correlation coefficients give a measure of genotypic association, since it is an inherited relationship between the traits. Therefore, the efforts have been made to study the genetic variability and character association ship between yield and yield contributing characters in cluster bean germplasm lines.

MATERIAL AND METHODS

Twenty germplasm lines of cluster bean were evaluated at Main garden, Department of Horticulture field, Dr. PDKV, Akola in randomized block design with three replications in the year 2012. Observations were recorded on randomly selected 10 plants for yield and yield contributing characters viz. plant height, plant spread, number of primary branches, number of secondary branches, days to first flowering, days to first picking, weight of pods, leaf area, number of pods per cluster, length of pods, chlorophyll content, internode length, diameter of pod, number of pod plant^{-1}, protein content, gum content, crude fiber content, seed yield per plot and hectare. Statistical analysis was carried out as per the standard method as suggested by Panse and Sukhatme (1954).

RESULTS AND DISCUSSION

Analysis of variance revealed that, mean squares were significant for all most all the characters studied. Data pertaining to range, mean, GCV, PCV, Heritability and genetic advance is presented in Table 1.

As regards the genotypic and phenotypic coefficients of variation, moderate GCV and PCV values were recorded for the characters, weight of pod (13.92 and 23.68), seed yield plot^{-1} (12.75 and 20.01), internode length (10.63 and 14.85), protein content (10.58 and 11.35) seed yield q^{-1} (10.29 and 10.49), while low

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Table 1: Estimates of genetic parameters viz. range, mean, GCV, PCV, heritability and EGA

S. N.	Characters	Range	Mean	GCV (%)	PCV (%)	Heritability (h^2) (%)	EGA as % over mean
1	Plant height (cm)	31.85-42.73	34.34	8.30	8.88	87.28	15.98
2	Plant spread (cm)	39.00-41.36	40.57	1.71	2.78	38.02	2.18
3	No. of Primary branches	3.56-5.30	4.69	9.02	12.79	49.81	13.12
4	No. of Secondary branches	6.29-7.56	7.11	4.88	8.11	36.17	6.04
5	Days to first flowering	29.81-32.15	30.59	1.71	2.93	34.19	2.06
6	Days to first Picking	32.21-38.09	36.02	4.50	4.90	84.48	8.52
7	Weight of pod (g)	0.33-2.30	1.75	13.92	23.68	34.57	16.86
8	Leaf area (cm^2)	80.96-82.29	81.70	0.48	0.78	38.94	62.59
9	No. of pod cluster^{-1}	4.53-6.46	5.24	9.97	13.82	52.09	14.83
10	Length of pod (cm)	3.53-4.33	3.80	4.38	8.50	26.57	4.65
11	Chlorophyll index (%)	44.64-54.89	51.99	5.26	5.64	86.78	10.09
12	Internodes length(cm)	3.63-5.67	4.90	10.63	14.85	51.25	15.68
13	Diameter pod (cm)	0.72-0.85	0.79	6.57	7.68	73.16	11.58
14	No. of pod plant^{-1}	52.15-58.59	56.02	2.53	3.07	67.99	4.30
15	Protein content, %	20.21-34.47	25.93	10.58	11.35	86.89	20.32
16	Gum content, %	26.07-33.37	31.24	4.72	5.66	69.54	8.11
17	Crude fiber content, %	18.50-26.61	19.76	3.36	4.98	46.43	4.76
18	Seed yield plot^{-1}	1.57-2.38	2.06	12.75	20.01	40.59	16.73
19	Seed yield ha^{-1}(q)	26.94-43.56	34.42	10.29	10.49	96.26	20.80

magnitude of GCV and PCV was observed for the character plant height (8.30 and 8.88) which are in confirmation with the results reported by S.P. Mital *et al.* (1969), Anandhi and Oommen (2004).

Heritability worked out in broad sense would suggest how far the variation is heritable and selection is effective. Though the estimates are true indicators of genetic potentiality of the genotypes as tool for selection change in the heritability due to fluctuation of environmental factors detected from total dependence on such estimates. However, heritability estimates when considered in conjunction with the predicted genetic gain from a reliable tool in selection. They indicate the EGA of a character in response to selection pressure imparted on them.

In present investigation highest heritability in broad sense to the extent of 96.26 per cent was recorded by the character seed yield (q ha^{-1}) followed by plant height (87.28%), protein content (86.89%), chlorophyll content (86.78%), day to first picking (84.48%), diameter of pod (73.16%), gum content (69.54%) and number of pod plant^{-1} (67.99), while moderate heritability in broad sense was recorded by the character number of pod cluster^{-1} (52.09%), number of primary branches (49.81%), crude fiber content (46.43%), seed yield plot^{-1} (40.59%), plant spread (38.02%). Similar findings were reported by Sohoo *et al.* (1969) in cluster bean and Ram and Singh (1997) for in cowpea.

As regards the genetic advance as percent over mean moderate values were recorded by the characters weight of pod (16.86%), seed yield plot^{-1} (16.73%), plant height (15.98%), internode length (15.68%), number of pod cluster^{-1} (14.83%), number of primary branches (13.12%), pod diameter (11.58%). While rest of characters recorded lower magnitude of genetic advance (GA) as percent over mean. Considering the importance of heritability and genetic advance together, out of nineteen, only one character leaf area recorded high heritability along with high genetic advance, there by indicated that, direct selection on the basis of leaf area may be useful for improvement of the crop. Similarly, high heritability and moderate genetic advance as per cent over mean recorded by the characters viz. plant height, diameter of pod

Table 2: Genotypic correlation coefficients for various characters

S. N.	Character	Plant height (cm)	Plant spread (cm)	No. of sec branches	No. of pod /cluster	Weight of pod (g)	Leaf area (cm^2)	Length of pod (cm)	Internode length (cm)	Diameter of pod (cm)	Seed yield /ha(qt)
1	Plant height (cm)	1	-0459*	0.133	-0.024	0.009	0.262	-0.155	0.309	-0.105	-0.07
2	Plant spread (cm)		1	-0.267	-0.003	-0.025	-0.424*	0.034	0.007	0.143	0.151
3	No. of sec. branches			1	-0.348	0.692**	-0.073	-0.221	-0.900**	0.620**	0.673**
4	No. of pod /cluster				1	-0.059	-0.078	-0.470*	0.036	0.026	0.112
5	Weight of pod (g)					1	-0.014	0.090	-0.0006	0.487*	0.301
6	Leaf area(cm^2)						1	-0.661**	0.308	-0.341	-0.656**
7	Length of pod (cm)							1	0.154	0.428*	-0.114
8	Internode length (cm)								1	-0.490*	-0.837**
9	Diameter of pod (cm)									1	0.632**
10	Seed yield/ha(qt)										1

* Significant at 5% ** Significant at 1%

indicating the predominance of additive gene component, thus there is an ample scope for improving these characters through direct selection. Results were in confirmation with the finding of Anandhi and Oommen (2004) and Saini *et al*., (2005) for plant height, weight of pod, number of pod per cluster, internode length, diameter of pod, protein content, seed yield plot^{-1}.

Correlation provides the information on nature and magnitude of the association of different traits with yield, which is regarded as complex trait. To make an effective selection for this complex trait, basic information on major yield contributing characters and their interrelationship is essential to the plant breeder. In present investigation, yield characters were analyzed for their associationship with yield and among themselves.

The data on association analysis revealed that, out of ten characters studied only two characters *viz*. number of secondary branches and diameter of pod exhibited positive and significant association with the yield per hectare (0.673, 0.632, respectively), while internode length exhibited negative and significant association with yield (0.837). Besides these characters weight of pod (0.301), plant spread(0.151) and number of pod cluster^{-1} (0.112) recorded positive association with yield, however the associationship was not to the level of significance, since the magnitudes are low.

On the basis of heritability and genetic gain leaf area it could be concluded that, plant height and diameter of pod and on the basis of association analysis secondary branches and diameter of pods were the most important characters in cluster bean. Hence in crop improvement program, selection pressure may be imparted on these characters.

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Effect of Biofertilizers with Reduced Doses of Nitrogen on Growth and Yield of Garlic

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ABSTRACT

The result revealed that, application of azotobactor @ 5 kg ha^{-1} + vermicompost @ 5 tones ha^{-1} (T_9) found significantly superior over rest of the treatments for obtaining maximum yield ha^{-1}. The same treatment exhibited its better performance in growth parameters like plant height, number of leaves per plant, neck thickness and yield parameters like fresh yield $plot^{-1}$ and cured yield ha^{-1}. The cured yield ha^{-1} was at par with treatment T_{10} viz., application of Azospirillum 5 kg ha^{-1} + vermicompost @ 5 t ha^{-1}. The quality parameters like bulb weight, bulb diameter, bulb length, clove diameter, clove length, cloves per bulb and clove index were found to be maximum with the application of Azatobactor 5 kg ha^{-1} +vermicompost @ 5 t ha^{-1}(T_9). Fallowed by treatment T_{10} Azospirillum 5kg ha^{-1} + vermicompost 5 t ha^{-1}.

Modern agriculture mainly depends upon inorganic fertilizers to fulfill nutrient demand of the crop. But heavy and long term use of inorganic fertilizers creates severe problems to soil and environmental conditions. Hence, it is an urgent need of contemporary situation to provide nutrients to plants by reducing quantity of inorganic fertilizers and their judicious combinations with organic manures and biofertilizers. Application of inorganic fertilizers causes serious problem to flora and fauna of soil and therefore the application of biofertilizers in the shallow rooted bulbous crop like garlic is an eager need of present era. The biofertilizers utilization in garlic production has not been carried out on large scale yet now. Hence, the present study was conducted.

MATERIAL AND METHODS

The present experiments was laid out in the field of Main Garden, Department of Horticulture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during the *Rabi* 2010-11. The quality planting material of variety Agrifound White (G-41) was obtained from the Directorate of Onion and Garlic, Rajgurunagar, Pune (M.S). The cloves were treated with Azatobactor and Azospirillum in carrier based preparation and planted at the spacing 15 X 10 cm^2 and covered with soil. The observations were recorded on growth characters viz. plant height, neck thickness and leaves per plant and yield observation viz. yield of fresh and cured garlic bulbs kg per plot and q per ha. The observations in respect of growth parameters were recorded at the intervals of 30, 60, 90 and 120 days after planting and at harvest. The yield and quality parameters observations were recorded after harvesting.

RESULTS AND DISCUSSION

1. Growth of garlic

The maximum plant height was recorded in treatment T9 at 60 (33.76 cm), 90 (43.77 cm), 120 (52.18 cm) DAP and at harvesting stage (55.97 cm). The increase in plant height at all the growth stages was observed with the increasing nutrient application. This might be due to the fact that, an application of nitrogen might have accelerated the cell division. Similarly, an application of vermicompost might have helped to improve the soil moisture holding capacity. Further, due to porous soil structure, the micronutrients would have been made available to the shallow rooted crop like garlic easily and sufficiently which would have resulted into the vigorous growth. The similar results have been recorded by Putturaju *et. al*. (2009) in garlic crop and Joi and Shinde (1990), Bhonde *et. al*. (1997), in onion crop. The maximum leaves $plant^{-1}$ were produced in treatment T_9 at 60 (4.69), 90 (4.99), 120 (6.64), DAP and at harvesting stage (9.88) followed by treatment T10. The maximum neck thickness of bulbs were recorded in treatment T9 at 60 DAP (0.82 cm), at 90 DAP (1.08 cm) at 120 DAP (1.53 cm) and at harvesting stage (1.84 cm). However, lowest values for plant height, number of leaves $plant^{-1}$ and neck thickness were recorded in the control treatment which is without application of any fertilizer.

Probably, due to application of the organic manures like vermicompost and biofertilizers like azotobacter which may have provided an additional quantity of the nutrients in the available from, which ultimately resulted into the more production of leaves per plant. The similar results are quoted by Chattoo *et al*.

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Table: 1. Growth of garlic plants influenced by biofertilizers with reduced doses of nitrogen

Treatment	Height of plant (cm)					Leaves per plant					Neck thickness (cm)				
	At 30 DAP	At 60 DAP	At 90 DAP	At 120 DAP	At Harvest	At 30 DAP	At 60 DAP	At 90 DAP	At 120 DAP	At Harvest	At 30 DAP	At 60 DAP	At 90 DAP	At 120 DAP	At Harvest
T_1 - Control without fertilizers	09.20	24.48	32.52	39.09	43.60	1.98	3.51	4.02	5.04	8.03	0.20	0.48	0.77	1.13	1.37
T_2 - RDF 100 kg N+50kg P_2O_5 + 50kg K_2O ha^{-1}	15.84	31.46	38.72	50.33	53.75	3.20	4.28	4.75	6.43	9.65	0.54	0.76	1.01	1.43	1.75
T_3 - *Azotobactor* alone @ 5 kg ha^{-1}	12.60	28.33	36.68	44.63	48.67	2.48	3.61	4.31	5.71	9.11	0.31	0.59	0.90	1.28	1.53
T_4 - *Azotobactor* @ 5 kg ha^{-1} + 100 % N	13.12	32.66	40.85	49.00	52.85	2.90	4.12	4.66	6.31	9.61	0.44	0.73	0.98	1.39	1.71
T_5 - *Azotobactor* @ 5 kg ha^{-1} + 75 % N	13.20	30.79	40.00	47.85	51.90	2.83	4.15	4.56	6.16	9.53	0.41	0.70	0.95	1.38	1.65
T_6 - *Azospirillum* alone @ 5 kg ha^{-1}	12.82	28.51	36.10	43.02	46.70	2.30	3.71	4.23	5.54	8.96	0.30	0.56	0.73	1.24	1.50
T_{7-} *Azospirillum* @ 5 kg ha^{-1} + 100 % N	13.16	30.40	39.02	46.84	50.94	2.67	4.07	4.49	6.05	9.29	0.39	0.65	0.91	1.35	1.61
T_8 - *Azospirillum* @ 5 kg ha^{-1} + 75 % N	13.30	29.73	37.45	45.92	49.97	2.56	3.98	4.41	5.89	9.21	0.37	0.64	0.85	1.28	1.57
T_9 - *Azotobactor* @ 5 kg ha^{-1} + vermicompost @ 5 t ha^{-1}	15.38	33.76	43.77	52.18	55.97	3.08	4.69	4.99	6.64	9.88	0.51	0.82	1.08	1.53	1.84
T_{10} - *Azospirillum* @ 5 kg ha^{-1} + vermicompost @ 5 t ha^{-1}	14.86	32.61	43.49	51.14	54.94	2.97	4.42	4.87	6.54	9.77	0.45	0.79	1.05	1.48	1.79
SE (m) ±	0.47	0.60	1.33	0.79	1.18	0.03	0.07	0.10	0.20	0.08	0.01	0.02	0.03	0.06	0.06
CD at 5 %	1.40	1.80	3.97	2.36	3.53	0.09	0.22	0.29	0.59	0.23	0.04	0.07	0.09	0.20	0.20

Table 2. Yield of garlic plants influenced by biofertillizers with reduced doses of nitrogen

Treatments	Bulb length (cm)	Bulb diameter (cm)	Cured garlic bulb yield(q ha^{-1})	Fresh garlic bulb yield (q ha^{-1})
T_1 - Control without fertilizers	3.26	2.46	65.11	73.71
T_2 - RDF 100 kg N + 50kg	4.27	3.84	101.72	107.99
T_3 - Azotobactor alone @ 5 kg	3.68	3.16	88.97	90.09
T_4 - Azotobactor @ 5 kg ha^{-1} +	4.18	3.72	93.36	103.61
T_5 - Azotobactor @ 5 kg ha^{-1} +	4.09	3.56	83.85	94.28
T_6 - Azospirillum alone @ 5 kg	3.54	2.97	83.06	83.28
T_7 - Azospirellium @ 5 kg ha^{-1} +	3.98	3.51	71.66	82.66
T_8 - Azospirillum @ 5kg ha^{-1} +	3.84	3.37	84.24	93.90
T_9 - Azotobactor @ 5 kg per ha + vermicompost @ 5 t ha^{-1}	4.43	4.02	110.76	119.42
T_{10} - Azospirellium @ 5 kg ha^{-1} + vermicompost @ 5 t ha^{-1}	4.35	3.97	105.78	114.85
SE (m) ±	0.20	0.20	1.11	1.60
CD at 5 %	0.60	0.60	3.32	4.78

(2007), Chandre Gowda *et al*. (2007) in garlic and Joi and Shinde (1990), Dubey *et al*. (2010) in onion crop. This might be due to the fact that, an availability of sufficient nutrients through the inorganic, bio-fertilizers and vermicomposst might have enhanced the meristimatic activities and functioning of the protoplasm, which might have help to improve the neck thickness of garlic plant. Similar results were obtained by Chandre Gowda *et al*. (2007), Ghawade (2009) in garlic and Bhonde *et al*. (1997), Dubay *et al*. (2010) in onion crop.

2. Yield of Garlic

The maximum diameter (4.02 cm) and length (4.43 cm) of garlic bulbs was recorded in treatment T_9 which was at par with treatment $T_{10.}$ The minimum bulb diameter (2.46 cm) and bulb length (3.26 cm) was recorded in control treatment T1. This may be probably due to the fact that, the vermicompost containing higher quantum of available nitrogen, phosphorus and potassium along with rich population of microbes and in addition to this, biofertilizers fixed the nitrogen which might have mobilized the nutrients to available form to the crop and resulted into the better size of garlic bulbs. The results are found to be in close conformity with the findings of Chattoo *et at*. (2007), Ghawade (2009) in garlic and Bhonde *et al*. (1997), Dubay *et al*. (2010) in onion crop.

The maximum fresh yield of garlic bulbs (2.09 kg plot^{-1} and 119.42 q ha^{-1}) was harvested from the garlic plants fertilized with the treatment T_9 followed by treatment T_{10} (2.01 kg plot^{-1} and 114.85 q ha^{-1}). This might be due to the fact that, garlic being a shallow rooted bulbous crop needs the moisture, nutrients and allied substances in easily available form. The incorporation of vermicompost as a organic manure and *Azatobacter* as a biofertilizers solve the above purpose of garlic plants in this treatment, ultimately it would have resulted into the better harvesting of garlic bulbs. These results are in close conformity with the findings of Chandre Gowda *et. al*. (2007), Talware *et. at*. (2010), Gasti *et. at*. (2009), Putturaju *et al*. (2010) garlic and Joi and Shinde (1976), Dubay *et. al*. (2010) in onion crop.

The maximum yield of cured garlic bulbs (1.93 kg per plot and 110.76 q ha^{-1}) was harvested from the treatment T_9 which is at par with treatment T_{10} (1.85 kg plot^{-1} and 105.78 q ha^{-1}). However, all above yield characters were recorded minimum in control treatment which is without application of any fertilizers. This might be due to the fact that, due to an application of vermicompost supplemented with biofertilizers might have resulted into the maximum cured yield of garlic bulbs. These results are in close conformity with the findings of Chandre Gowda *et. al*. (2007), Talware *et. al*. (2009), Gasti *et. al*. (2010), Putturaju *et al*. (2010) garlic and Joi and Shinde (1976), Dubey *et al*. (2010) in onion crop.

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Management of Citrus Mites with Bio-rational Pesticides

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ABSTRACT

The trial on management of mites on 11 year old Nagpur mandarin citrus orchard was conducted at Akola with ten treatments replicating thrice in randomized block design. The objectives of the studies were to assess the efficacy of various biologically balanced insecticides against citrus mites, to assess the efficacy of various biologically balanced insecticides and oils against citrus mites and to develop eco-friendly and efficient management strategies for citrus mites. The pooled mean maximum population reduction at 3 days after spraying was noted in the treatment of petroleum spray oil @1 per cent (64.27) followed in the treatments viz., propargite, and abamectin 1.9 EC @ 0.0007. At 7 days after spraying, propargite 57 EC @ 0.057 per cent and abamectin 1.9 EC @ 0.0007 per cent were the superior treatments. The pooled mean of five years data on mite population reduction at 14 days after spraying indicated that, abamectin was found most effective with 84.60 per cent reduction followed by propargite (82.52 %), ethion 50 EC @ 0.05 per cent (79.83 %), triazophos 40 EC @ 0.06 per cent (79.55) and buprofezin 25 EC @ 0.025 (79.15 %).

More than 60 thousand species of mites have been described from various regions of the world, the undescribed species number is estimated to exceed six lack (Evans, 1992), and the majority of such undiscribed species are expected to live in tropical regions. Habitat of mites are free living forms and parasitic form. Some of free living mites are predaceous and phytophagous (suborder Gamasida and Actinedida), most of this group mites are important as plant pest. Apart from their feeding injury, some species have been found to transmit plant viruses. Many mites are predaceous on other pest and some species have been used in biological control programmes.

In Vidarbha, the activity of Citrus mites *Eutetranychus orientalis* Klien (Tetranychidae: Acarina) synchronized with new flushing periods i.e. June-July, October-November, and January-February under Akola conditions, Maharashtra, India (Dadmal *et al.* 2000). Citrus fruits are attacked by several mite species viz., *Phyllocoptruta oleivora* (Ashm.), *Eutetranychus orientalis* Klien; *Brevipalpus* sp. and *Schizotetranychus hindustanicus* (Hirst). Among them, rust mite, *P.oleivora* is economically important. *P.oleivora* attack berries and grown up fruits of Ambia (spring) as well as Mrig (monsoon) season inflicting undesirable brown irregular patches on fruit surface. The mites are active during March-May on Ambia bahar fruits and during October-December on Mrig bahar fruits. It can reproduce at high rates, and small populations can quickly reach damaging levels (Rao *et al*, 2013). Mite-damaged citrus fruits, loss fruit weight, fruit size, juice volume and titratable acidity (Kalaisekar *et al*. 2000). The mite infestation also increases rind thickness, total soluble solids, sugars and ascorbic acid contents. Safer and effective alternative to synthetic insecticides or acaricides is the need of the day. In this view, bio-rational insecticides or acaricides play a key role in sustainable citrus fruit production. Therefore, field study on assessment of different insecticides/ acaricides viz., 5.0 per cent neem oil, 1.0 and 2.0 per cent petroleum spray oil, ethion (0.05%), abamectin @ 0.0007 per cent, buprofezin @ 0.125 per cent, triazophos @ 0.06 per cent, propargite @ 0.057 per cent and dicofol @ 0.04 per cent were evaluated against citrus rust mite, *P. oleivora* in a 11-year- old Nagpur mandarin (*Citrus reticulata*) orchard during mrig 2008-09, 2009-10 and 2010-11, 2011-12 and 2012-13 at All India Coordinated Research Project on Fruits Experimental Orchard, Dr. PDKV, Akola.

MATERIAL AND METHODS

The trial with following ten treatments replicating thrice was laid in randomized block design on 11 year old Nagpur mandarin orchard planted at 6 x 6 m spacing. The objectives of the experiments were to assess the efficacy of various biologically balanced insecticides against citrus mites, to assess the efficacy of various biologically balanced insecticides and oils against citrus mites and to develop eco-friendly and efficient management strategies for citrus mites. The citrus orchard was maintained on drip irrigation and fertilized as per the University recommendations. On initiation of the mites in October on mrig bahar fruits of Nagpur mandarin, the respective

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Table 1. Population reduction of mites (%) in different treatments at 3 days after treatment

Tr.No.	Treatments	2008-09	2009-10	2010-11	2011-12	2012-13	Pooled
T_1	Neem oil @ 0.5%	80.56	51.52	26.77	52.62	48.41	51.97
		(64.01)	(45.87)	(30.58)	(46.51)	(44.09)*	(46.13)
T_2	Petroleum spray oil @1 %	79.44	62.34	73.48	56.81	49.15	64.27
		(63.94)	(52.24)	(59.22)	(48.95)	(44.51)	(53.28)
T_3	Petroleum spray oil @ 2%	84.72	61.04	29.55	54.61	49.74	55.93
		(67.10)	(51.47)	(32.86)	(47.68)	(44.85)	(48.41)
T_4	Ethion 50EC @ 0.05%	71.67	51.52	31.82	58.88	55.47	53.87
		(58.07)	(45.87)	(33.91)	(50.16)	(48.14)	(47.22)
T_5	Abamectin 1.9 EC @ 0.0007%	67.22	71.86	28.79	70.15	57.44	59.08
		(55.17)	(57.96)	(31.83)	(56.95)	(49.32)	(50.23)
T_6	Buprofezin 25 EC @ 0.025	61.11	43.29	17.93	59.42	53.73	47.09
		(51.56)	(40.54)	(24.50)	(50.43)	(47.16)	(43.33)
T_7	Triazophos 40 EC @ 0.06%	74.72	60.61	22.73	64.37	61.05	56.70
		(60.27)	(51.59)	(23.41)	(53.39)	(51.51)	(48.85)
T_8	Propargite 57 EC @ 0.057%	90.28	70.13	23.23	68.10	61.76	62.70
		(71.97)	(57.19)	(28.58)	(55.74)	(51.82)	(52.36)
T_9	Dicofol 20 EC @ 0.04 %	60.83	27.71	47.22	38.19	60.54	46.89
	(Standard)	(51.64)	(30.67)	(43.40)	(38.15)	(51.09)	(43.22)
T_{10}	Control	-	-	-	-	-	-
	SE (m) $\pm$	3.32	5.11	5.75	2.14	1.769	2.19
	CD at 5%	9.873	15.176	17.079	6.361	5.254	6.514
	CV %	10.59	20.42	32.30	8.28	7.08	8.89

*Figures in parentheses are arc sine transformed values.

treatments were imposed. The pre-treatment observations on population of mites on 15 cm twig were record one day before spraying and post treatment observation at 3, 7 and 14 days after spaying. On the basis of observation on mites in control treatment, per cent population reduction at 3, 7 and 14 days after spray was worked out and the data was analyzed statistically.

RESULTS AND DISCUSSION

The pooled mean maximum population reduction at 3 days after spraying was noted in the treatment of petroleum spray oil @1 per cent (64.27) followed in the treatments viz., propargite, abamectin 1.9 EC @ 0.0007 per cent, triazophos 40 EC @ 0.06 per cent, petroleum spray oil @ 2 per cent, ethion 50 EC @ 0.05 per cent 1.9 EC with 62.70, 59.08, 56.70, 55.93 and 53.87 per cent reduction, respectively and these were at par to each other (Table 1). Neem oil @ 0.5 per cent and buprofezin 25 EC @ 0.025 were the next best treatments.

Pooled data at 7 days after spraying, propargite 57 EC @ 0.057 per cent and abamectin 1.9 EC @ 0.0007 per cent were the superior treatments with maximum mite reduction i. e. 85.51 and 82.20 per cent, respectively (table 2). Triazophos 40 EC @ 0.06 per cent and buprofezin 25 EC @ 0.025 were next best treatments recording, respectively 77.07 and 76.97 per cent reduction.

Table 2. Population reduction (%) of mites in different treatments at 7 days after treatment

Tr.No.	Treatments	2008-09	2009-10	2010-11	2011-12	2012-13	Pooled
T-1	Neem oil @ 0.5%	85.74	73.61	83.87	62.16	66.71	74.42
		(68.52)	(59.38)	(66.75)	(52.15)	(54.93)	(59.66)
T-2	Petroleum spray oil @1 %	82.04	73.61	77.22	60.64	65.51	71.80
		(65.64)	(59.38)	(61.83)	(51.22)	(54.22)	(57.98)
T-3	Petroleum spray oil @ 2%	82.04	75.00	80.84	62.71	66.73	73.47
		(65.64)	(60.51)	(64.18)	(52.61)	(54.82)	(59.16)
T-4	Ethion 50EC @ 0.05%	68.98	75.00	80.25	71.06	76.61	74.38
		(56.28)	(60.00)	(63.91)	(57.51)	(61.28)	(59.62)
T-5	Abamectin 1.9 EC @ 0.0007%	80.83	88.89	83.28	81.24	76.73	82.20
		(68.56)	(70.60)	(66.48)	(64.75)	(61.28)	(65.10)
T-6	Buprofezin 25 EC @ 0.025	70.19	80.56	80.25	79.60	74.28	76.97
		(57.21)	(64.41)	(63.91)	(63.26)	(59.75)	(61.33)
T-7	Triazophos 40 EC @ 0.06%	79.81	77.78	79.71	73.51	74.56	77.07
		(63.49)	(62.48)	(64.16)	(59.17)	(59.97)	(61.62)
T-8	Propargite 57 EC @ 0.057%	95.83	84.72	83.28	82.36	81.34	85.51
		(83.10)	(67.51)	(66.48)	(65.40)	(64.50)	(67.72)
T-9	Dicofol 20 EC @ 0.04 %	71.48	72.22	50.16	72.10	80.40	69.27
	(Standard)	(58.49)	(59.41)	(45.68)	(58.38)	(63.83)	(56.47)
T-10	Control	-	-	-	-	-	-
	SE m) $\pm$	4.73	3.80	5.33	3.29	2.522	1.69
	CD at 5%	14.06	11.28	15.82	9.77	7.49	5.02
	CV %	13.97	11.67	16.38	10.86	8.17	5.34

*Figures in parentheses are arc sine transformed values.

During 2008-09 (Table 3), population reduction of mites in propargite (93.52%) treatment was significantly more than reduction in the treatments neem oil @ 0.5 per cent (78.70), petroleum spray oil @1 per cent (78.70 %), ethion 50EC @ 0.05% (76.85%), buprofezin 25 EC @ 0.025 (79.63%) and dicofol 20 EC @ 0.04 per cent (68.52%) fourteen days after application. Reduction in the treatments petroleum spray oil @ 2 per cent (82.41%), abamectin 1.9 EC @ 0.0007 (87.04 %) and triazophos 40 EC @ 0.06 per cent (87.04 %) does not differ to reduction propargite.

Similar was not the case during 2009-10, all the treatments except neem oil @ 0.5 per cent (45.08%) were significantly effective in reducing mites (Table 3). The application with treatments viz., abamectin 1.9 EC @ 0.0007 per cent (91.67), ethion 50EC @ 0.05 per cent, triazophos 40 EC @ 0.06 per cent, buprofezin 25 EC @ 0.025, petroleum spray oil @ 2 per cent, petroleum spray oil @1 per cent, propargite 57 EC @ 0.057 per cent, dicofol 20 EC @ 0.04 per cent reduced 91.67, 89.77, 85.61, 84.47, 81.44, 76.14, 75.00 and 73.11 per cent mites, respectively. Whereas, during 2010-11, all the treatments except dicofol application, were found significantly effective in reducing the mites. Ethion 50 EC @ 0.05 per cent (87.29%), abamectin 1.9 EC @ 0.0007 per cent (86.89%) and propargite 57 EC @ 0.057 per cent (85.07%) were the most effective treatments during 2011-12 for significant reduction of mites than rest of the treatments. In 2012-13, dicofol 20 EC @ 0.04 per cent (73.45 %), propargite 57 EC @ 0.057 per cent (72.90 %)

Table 3. Population reduction of mites (%) in different treatments at 14 days after treatment.

Tr.No.	Treatments	2008-09	2009-10	2010-11	2011-12	2012-13	Pooled
T-1	Neem oil @ 0.5%	78.70	45.08	85.30	54.54	45.14	(51.83)
		(63.28)	(36.92)	(68.01)	(48.00)	(41.94)	61.75
T-2	Petroleum spray oil @1 %	78.70	76.14	83.11	61.62	46.55	69.22
		(63.28)	(61.56)	(65.83)	(51.81)	(42.81)	(56.37)
T-3	Petroleum spray oil @ 2%	82.41	81.44	82.27	65.38	49.15	72.13
		(65.66)	(64.69)	(65.44)	(54.35)	(44.44)	(58.22)
T-4	Ethion 50EC @ 0.05%	76.85	89.77	85.30	87.29	59.93	79.83
		(61.25)	(74.69)	(68.01)	(69.83)	(50.81)	(63.34)
T-5	Abamectin 1.9 EC @ 0.0007%	87.04	91.67	89.47	86.89	67.93	84.60
		(72.59)	(80.00)	(71.10)	(68.99)	(55.64)	(67.06)
T-6	Buprofezin 25 EC @ 0.025	79.63	84.47	89.47	80.38	61.80	79.15
		(63.22)	(67.25)	(71.10)	(64.05)	(51.96)	(62.84)
T-7	Triazophos 40 EC @ 0.06%	87.04	85.61	82.27	80.70	62.14	79.55
		(68.99)	(71.59)	(65.44)	(64.61)	(52.16)	(63.12)
T-8	Propargite 57 EC @ 0.057%	93.52	75.00	86.14	85.07	72.90	82.52
		(77.92)	(70.00)	(68.39)	(67.57)	(58.64)	(65.66)
T-9	Dicofol 20 EC @ 0.04 %	68.52	73.11	78.94	76.80	73.45	74.16
	(Standard)	(56.28)	(59.69)	(62.73)	(61.61)	(59.14)	(59.48)
T-10	Control	-	-	-	-	-	-
	SE (m) $\pm$	4.46	10.47	2.30	3.98	3.191	1.96
	CD at 5%	13.24	31.10	6.84	11.83	9.47	5.83
	CV (%)	13.03	30.93	6.58	12.52	12.08	6.21

*Figures in parentheses are arc sine transformed values.

and abamectin 1.9 EC @ 0.0007 per cent (67.93%) were the most effective than all other treatment sprays for mite reduction.

The pooled mean of five years data on mite population reduction at 14 days after spraying indicated that, abamectin was found most effective with 84.60 per cent reduction followed by propargite (82.52 %), ethion 50 EC @ 0.05 per cent (79.83 %), triazophos 40 EC @ 0.06 per cent (79.55) and buprofezin 25 EC @ 0.025 (79.15 %) ant these treatments were at par to each other (Table 3); the mite reduction in former two treatment spray applications were significantly more than rest of the treatment sprays. Effectiveness of Abamectin and propargite against rust mites was reported by Rao *et al.* (2014). Bhatti (2012) and Sarda and Ramesh (2012) also reported efficacy of abamectin alone or in combination with petroleum spray oil in citrus. The effectiveness of propargite against mites might be due to contact and systemic effect and abamectin might be due to penetrable potential in to plant tissues and translaminar action.

The minimum cost for plant protection per hectare during 2012-13 incurred on ethion (Rs. 859.16) followed on triazophos (Rs. 1083.53). The cost for dicofol incurred Rs. 1158.32 and for propargite Rs. 1490.72 (Table 4).

It is concluded that the application of abamectin @ 0.0007 per cent and propargite 57 EC 0.057 per cent effectively control the mite population. Therefore, for

Table 4. Plant protection cost for different treatments 2012-13.

Tr.No.	Treatments	Quantity of insecticidefor 10 l(g/ml)	Waterl/ tree	Quantityof insecticide for 277 i.e. ha(g/ml)	Quantityof insecticide (g/ml)	Packing (g/ml)	Cost per packing (Rs.)	Cost of insecticide (Rs.)	No. of labour	Total abour lcost* (Rs.)	Total Cost of Spray (Rs.)	Hiring of spray (Rs.)	Total Pl. Prot. Cost (Rs.)
T-1	Neem oil (0.5%)	50.0	3	831	4155.00	500	300	2493.00	3	360	2853.00	200	3053.00
T-2	Petroleum spray oil (1%)	100.0	3	831	8310.00	1000	180	1495.80	3	360	1855.80	200	2055.80
T-3	Petroleum spray oil (2%)	200.0	3	831	16620.00	1000	180	2991.60	3	360	3351.60	200	3551.60
T-4	Ethion (0.05 %)	10.0	3	831	831.00	500	180	299.16	3	360	659.16	200	859.16
T-5	Abamectin (0.0007 %)	3.7	3	831	306.16	50	300	1836.95	3	360	2196.95	200	2396.95
T-6	Buprofezin (0.025)	10.0	3	831	831.00	500	625	1038.75	3	360	1398.75	200	1598.75
T-7	Triazophos (0.06 %)	15.0	3	831	1246.50	500	210	523.53	3	360	883.53	200	1083.53
T-8	Propargite (0.057 %)	10.0	3	831	831.00	250	280	930.72	3	360	1290.72	200	1490.72
T-9	Dicofol (Standard) (0.04 %)	20.0	3	831	1662.00	500	180	598.32	3	360	958.32	200	1158.32
T-10	Control	-	-	-	-	-	-	-	-	-	-	-	-

effective management of citrus mite in Nagpur mandarin abamectin 1.9 EC @ 0.0007 per cent or propargite 10 EC @ 0.057 per cent applied on initiation of mites and if necessary repeated 15 days after first spray application can be advised.

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Effect of Intercropping, Weed Control and Fertility Management Practices on Growth and Yield of Cotton Under Rainfed Condition

B. V. Saoji

ABSTRACT

A field experiment was carried out at the Agronomy Research Farm, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (MS) during *Kharif* 2007-08 and 2008-09 with an object to study the effect of intercropping, weed control and fertility management practices on growth and yield of cotton. Results revealed that the intercropping of cotton + blackgram (1:1) recorded significantly higher values of growth characters viz., plant height, sympodial branches and total dry matter accumulation plant^{-1} in cotton. Treatment of cotton + blackgram (1:1), cotton + pigeonpea (6:2), cotton + clusterbean (1:1) and cotton + cowpea (1:1) being at par recorded significantly higher number of picked bolls plant^{-1}. In pooled analysis, treatment of cotton + pigeonpea (6:2) resulted in highest production of seed cotton yield. Whereas, treatment of cotton + blackgram (1:1) followed by cotton + cowpea (1:1) stood second. Normal weeding at 25 and 50 DAS recorded significantly higher growth, yield attributes and seed cotton yield by cotton based intercropping systems. While, 100 per cent RDF (50, 25, 25 kg NPK ha^{-1}) and 125 per cent RDF (62.5, 31.25, 31.25 kg NPK ha^{-1}) to base crop of cotton being at par recorded significantly higher ancillary, yield attributing characters in cotton and seed cotton yield.

In Vidarbha, cotton is grown predominantly as a rainfed crop. Major causes of low productivity (352 kg lint ha^{-1}) are erratic behavior of rainfall, growing of cotton on marginal and sub-marginal land and less adoption of improved technologies. October heat is well known in this area during which cotton crop gets flowering and fruiting. Due to high temperature, reproductive parts are shed resulting in less crop yield. Cotton being a long duration but initially slow growing and widely spaced crop offers scope for growing intercrops of resource efficient and effective. Intercropping a risk covering factor, stabilizes the yield of component crops with more returns per unit area even under adverse climatic condition and therefore, intercropping is more prevalent practice in rainfed farming. Assumption from the study was the growing of various intercrops having different abilities and diversification like, short duration, non competitive growth habit, less use of inputs, ability to suppress weeds, fulfill the nutritional requirement of base crop to some extent, gives the additional yields with more returns per unit area. Recent need is to search out the most profitable and resource efficient system that sustains in changing climatic situation. In addition, fertilizer application and weed control are also required for obtaining higher returns. Therefore, this experiment was conducted with an object to identify the most appropriate intercrop in cotton based system and to assess the optimum fertilizer requirement and weed control in cotton.

MATERIAL AND METHODS

A field experiment was carried out at the Agronomy Research Farm, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (MS) during *Kharif* 2007-08 and 2008-09. The experimental site was fairely leveled and uniform in topography. The soil was medium black cotton belonging to *Vertisols*. It was clayey in texture and moderately alkaline in nature (p^H 8.3). As regards nutrient status, it is medium in organic carbon (0.51 %) and available potassium (239.41 kg ha^{-1}), low in available nitrogen (169.76 kg ha^{-1}) and phosphorous (28.68 kg ha^{-1}) and slightly calcarious.

The total rainfall received during 2007-2008 in 23rd - 52 ndMW at Akola centre was771.0 mm in 43 rainy days, it was said to be normal year. Whereas, during 2008-2009 the total rainfall recorded was 528.2 mm in 42 rainy days and it was stated to be abnormal year. Rainfall was deficit by 30.70 per cent as against normal rainfall of 762.8 mm. Soon after sowing to flowering and boll development stage had adversely affected the cotton yields. AKH-8828 an American *hirsutum* variety was used for the experiment. It has a bushy, branchy growth habit attaining the height of about 70-80 cm, 2-4 monopodias, 12-20 sympodias, 50 per cent flowering at 70-75 and 50 per cent boll bursting at 120-125 days after sowing. Crop duration is 170-180 days and average yield is12-14 q ha^{-1} under rainfed condition. The intercrops and their

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varieties popular among the farmers of this area were used in replacement series of experiment and adopted spacing of 45 × 10 cm for drilling and 45 × 30 cm for dibbling by reducing the recommended spacing of 60 × 30 cm and plant population of cotton.

In all treatment combinations were 36 with 12 Main plots (A) Intercropping (6) viz., I_1- Cotton + blackgram (1:1), I_2- Cotton + soybean (1:1), I_3- Cotton + pigeonpea (6: 2), I_4- Cotton + clusterbean (1:1),I_5-Cotton + cowpea (1:1), I_6- Cotton + marigold (1:1) and (B) Weed management (2) W_1- No weeding and W_2- Normal weeding at 25 and 50 days after sowing and three Sub plots (C) Fertilizer management (3) F_1- 75 per cent Recommended dose of fertilizer (37.5, 18.75, 18.75 kg NPK ha^{-1}) to base crop of cotton, F_2- 100 per cent Recommended dose of fertilizer (50, 25 , 25 kg NPK ha^{-1}) to base crop of cotton and F_3-125 per cent Recommended dose of fertilizer (62.5, 31.25, 31.25 kg NPK ha^{-1}) to base crop of cotton. The experiment was laid out in a split plot design with three replications and crop was sown at the spacing of 45 × 30 cm distance. The gross plot size was 6.30 m × 3.60 m, while net plot size was 5.40 m × 3.00 m and recommended dose of fertilizers of cotton was 50, 25, 25 kg NPK ha^{-1} with no fertilizers to the intercrops.

RESULTS AND DISCUSSION

Growth of cotton

Effect of intercropping

During 2007-08, at harvest, intercropping of cotton + blackgram exhibited significantly greater plant height over other treatments. Increased plant height of cotton might be due to no competition of intercrops for space, moisture, nutrients. Similar results were reported by Padhi *et al*. (1993) and Harisudan *et al.* (2009). Whereas, cotton + marigold showed lower plant height of cotton, it might be due to profused branching of marigold that suppressed the growth of cotton (Gode et al.,1992). During 2008-09 at harvest, all the intercropping system being par recorded maximum number of sympodial branches $plant^{-1}$ than the intercropping of cotton + marigold. This might be due to short stature nature of intercrops, compact growth habit, complementary effect and free environment in later stage combined with its adaptability to the soil and climatic condition. Treatment of cotton + blackgram, cotton + soybean, cotton + pigeonpea and cotton + cowpea being par recorded significantly greater number of functional leaves $plant^{-1}$ over cotton + clusterbean and cotton + marigold. Treatment of cotton + blackgram, cotton + pigeonpea and cotton + cowpea being par showed maximum leaf area $plant^{-1}$ over other treatments. Intercrops like blackgram and cowpea in cotton increased leaf area $plant^{-1}$ (Kalyankar, 2001). At harvest, treatment of cotton + clusterbean recorded significantly higher total dry matter accumulation $plant^{-1}$ than rest of the treatments. Higher dry matter accumulation could be attributed to significant increase in growth components like plant height, number of leaves, leaf area etc.

Effect of weed management

Normal weeding recorded significantly greater plant height, leaf area $plant^{-1}$ and total dry matter accumulation $plant^{-1}$ during 2007-08 and higher number of functional leaves $plant^{-1}$ during 2007-08 and 2008-09. Weeding treatment increased plant height because of better availability of natural resources. Irrespective of crops, weeding reduced weed competition at an early growth stage and helped the crop to grow fast and smother the weeds effectively.

Effect of fertility management

During the year 2007-08, treatments of fertility management viz. 100 per cent and 125 per cent RDF to base crop of cotton being par recorded significantly greater plant height and leaf area $plant^{-1}$. Increased levels of fertilizers increased plant height, number of leaves, leaf area and ultimately dry matter accumulation $plant^{-1}$ in cotton might be attributed to better availability of nutrients for development of crop canopy in the initial supported by reproductive parts in latter stages of crop growth.

Number of bolls picked $plant^{-1}$ and seed cotton yield

Data in respect of mean number of picked bolls $plant^{-1}$ (17.56 and 13.56) and seed cotton yield ha^{-1} (12.59 and10.63 q ha^{-1}) were recorded during 2007-08 and 2008-09, respectively with an average pooled seed cotton yield of (11.61 q ha^{-1}).

Effect of intercropping

During 2007-08, treatments of intercropping viz., cotton + blackgram, cotton + pigeonpea, cotton + clusterbean and cotton + cowpea being par recorded significantly more number of picked bolls $plant^{-1}$ over other treatments of intercropping. During 2008-09, intercropping of cotton + blackgram recorded significantly

Table 1. Plant height, number of sympodial branches, number of functional leaves, leaf area, total dry matter accumulation, number of picked bolls and seed cotton yield at harvest as influenced by different treatments during 2007-08 and 2008-09

Treatments	Plant height (cm)		No. of Sympodial branches/plant		No. of Leaves / plant		Leaf area /plant (sq dm)		Total dry matter plant (g)		No of bolls picked /plant		Seed cotton yield(q ha^{-1})		
A) Intercropping (6)	**2007-08**	**2008-09**	**2007-08**	**2008-09**	**2007-08**	**2008-09**	**2007-08**	**2008-09**	**2007-08**	**2008-09**	**2007-08**	**2008-09**	**2007-08**	**2008-09**	**Pooled**
I_1 Cotton + blackgram (1:1)	105.44	102.47	15.24	14.74	47.27	31.11	11.55	8.97	53.56	22.61	18.84	16.97	14.30	12.04	13.17
I_2 Cotton + soybean (1:1)	99.0	101.70	13.97	13.32	47.82	32.14	11.24	8.03	40.50	17.00	16.68	13.23	11.13	9.93	10.53
I_3 Cotton + pigeonpea (6:2)	93.31	97.62	13.73	14.27	38.80	33.90	7.34	9.80	40.28	24.00	17.63	12.54	14.42	13.40	13.92
I_4 Cotton + clusterbean (1:1)	90.19	97.41	14.41	13.99	58.94	24.83	14.26	7.69	41.94	34.72	17.44	14.89	12.35	9.79	11.07
I_5 Cotton + cowpea (1:1)	90.19	96.52	14.27	14.59	40.26	33.89	8.40	8.72	46.78	24.50	19.16	15.41	13.39	10.77	12.08
I_6 Cotton + marigold (1:1)	91.17	94.90	13.47	10.97	47.90	24.91	13.12	7.97	41.28	20.72	15.63	8.30	9.98	7.86	8.92
S. E. (m) ±	3.02	2.61	1.43	0.56	7.30	1.83	2.48	0.38	5.05	3.34	0.68	1.51	0.31	0.32	0.23
C. D. at 5%	8.87	NS	NS	1.65	NS	5.38	NS	1.11	NS	9.80	1.99	1.49	0.92	0.94	0.66
B) Weed management (2)															
W_1 No weeding	87.57	97.91	12.50	12.99	37.86	24.50	8.73	8.14	37.04	17.94	15.49	11.93	11.83	9.32	10.58
W_2 Normal weeding (2 hoeings + 2 weedings at 25 and 50 DAS)	101.56	98.97	15.78	14.31	55.81	35.76	13.24	8.92	51.07	29.91	19.64	15.19	13.36	11.94	12.65
S. E. (m) ±	1.75	1.51	0.82	0.32	4.22	1.06	1.43	0.22	2.34	1.93	0.39	0.29	0.18	0.18	0.13
C. D. at 5%	5.12	NS	2.42	0.95	12.37	3.10	4.20	0.64	6.85	5.66	1.15	0.86	0.53	0.54	0.38
II) Sub plot															
C) Fertility management (3)															
F_1 75 % RDF of base crop of cotton	91.68	97.47	13.54	13.46	44.70	27.84	10.68	7.77	43.61	21.94	16.76	13.11	11.38	9.32	10.35
F_2 100 % RDF of base crop of cotton	94.82	98.51	13.98	13.68	47.73	30.44	10.68	8.88	44.03	23.33	17.79	13.76	12.90	10.92	11.91
F_3 125 % RDF of base crop of cotton	97.80	99.33	14.89	13.80	48.06	32.11	11.60	8.95	44.53	26.50	18.14	13.81	13.51	11.66	12.58
S. E. (m) ±	1.73	1.31	0.84	0.25	3.86	1.34	1.10	0.26	3.02	1.51	0.37	0.28	0.23	0.22	0.14
C. D. at 5%	NS	NS	NS	NS	NS	NS	NS	0.73	NS	NS	1.04	NS	0.67	0.64	0.39
D) Interaction effects															
(I x W)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S. E. (m) ±	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. D. at 5%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(I x F)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S. E. (m) ±	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. D. at 5%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(W x F)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S. E. (m) ±	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. D. at 5%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(I x W x F)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S. E. (m) ±	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.47
C. D. at 5%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.34

higher number of picked bolls plant^{-1} over rest of the treatments. Increased number of bolls picked plant^{-1} due to intercrop of blackgram in cotton was reported by Turkhede (2010). It might be due to increased photosynthetic efficiency on account of higher nitrogen status of soil as an additional advantage of nitrogen fixation by legume root nodules in intercropping.

During 2007-08, treatments of cotton + pigeonpea and cotton + blackgram being at par recorded significantly highest seed cotton yield over other treatments. Treatment of cotton + cowpea was significantly superior over the treatments of cotton + clusterbean, cotton + soybean and cotton + marigold. During 2008-09, cotton + pigeonpea recorded significantly highest seed cotton yield. While, treatment of cotton + blackgram recorded second best position. In pooled analysis, cotton + pigeonpea resulted in greater production of seed cotton yield over other treatments. Treatment of cotton + blackgram stood at second position followed by the treatment of cotton + cowpea. Treatments of cotton + clusterbean and cotton + soybean being par recorded significantly higher seed cotton yield than the treatment of cotton + marigold. Cotton + redgram intercropping being multitier crop combination harvest solar energy efficiently beside the deeper root system explored moisture and nutrient from deeper section of soil. Similar results were reported by Pothiraj and Srinivasan (1993). Seed cotton yield recorded significantly more in cotton + pigeonpea system because of more number of cotton plants in the plot. Cotton intercropped with blackgram significantly increased seed cotton yield in individual year and in pooled also. It might be probably due to the least depressing effect of blackgram in cotton because of its short duration (Balsubramaniyan *et al.,* 1994), no competition for natural resources (Tomar *et al.,* 1994), complementary effect (Harisudan *et al.,* 2009) and more availability of nitrogen through decay of root nodules. Reduction in other cotton based intercropping might be due to medium to long duration of intercrops, their spreading habit coupled with smothering effect on cotton in early stages.

Effect of weed management

Normal weeding treatment produced significantly higher number of picked bolls plant^{-1} and seed cotton yield than the treatment of no weeding during both the years of study as well in pooled analysis. It might be due to effective control of weeds and elimination of competition for light, nutrients, moisture etc. thereby leading to improvement in yield attributes and enhancement in crop yield.

Table 2. Seed cotton yield (q ha^{-1}) as influenced by intercropping × weed management × fertility management interactions (Pooled)

Treatments	Intercropping × weed management × fertility management		
IxWxF	F_1	F_2	F_3
I_1W_1	10.73	11.78	13.34
I_1W_2	12.90	15.34	14.94
I_2W_1	8.39	9.27	10.17
I_2W_2	11.15	12.30	11.89
I_3W_1	12.28	13.16	14.28
I_3W_2	12.73	15.30	15.76
I_4W_1	8.39	9.80	11.94
I_4W_2	10.73	13.09	12.49
I_5W_1	8.97	11.29	12.32
I_5W_2	12.30	14.27	13.35
I_6W_1	7.34	8.20	8.75
I_6W_2	8.26	9.13	11.82
S. E. (m) ±	0.47		
C. D. at 5%	1.34		

Effect of fertility management

Treatments of 100 per cent RDF and 125 per cent RDF of base crop of cotton being par gave significantly more number of picked bolls plant^{-1} during 2007-08 only. Number of picked bolls plant^{-1} was increased with the increase in fertilizer levels (Kalyankar, 2001). While, treatments of 125 per cent RDF and 100 per cent RDF being par recorded significantly higher seed cotton yield during both the years of experimentation. In pooled analysis, every additional dose of RDF to cotton was found significantly superior in recording higher seed cotton yield. Similar results were reported by Kote *et al.* (2005).

Effect of interaction

On pooling the results of reasons, interaction of intercropping × weed management × fertility management (I×W×F) was found significant (Table 2). Treatment combination of intercropping of cotton + pigeonpea and cotton + blackgram with normal weeding under 100 per cent RDF and 125 per cent RDF being at par recorded significantly greater seed cotton yield ha^{-1} than other treatment combinations. Increase in yield under efficient

weed control with increasing level of fertilizers was owing to reduced depletion of nutrients by weeds and concomitant increase in nutrient uptake by crop ultimately resulted in marked improvement in yield.

CONCLUSION

On the basis of two years experimental results, it is concluded that the intercropping of cotton + pigeonpea and cotton + blackgram with normal weeding under recommended dose of fertilizers are suitable for stabilizing the rainfed cotton production in cotton growing area of Vidarbha.

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Performance of Summer Sesame Under Varying Levels of Irrigation and Fertilizer

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ABSTRACT

The present investigation entitled **"**Performance of summer sesame under varying levels of irrigation and fertilizer**"** was carried out to find the effect of various levels of irrigation and fertilizer on growth, yield and economics of summer sesame. Irrigation and fertilizer levels significantly influenced the growth and yield of sesame. Significantly highest values of yield contributing parameter like number of capsules plant^{-1}, seed yield plant^{-1}, test weight and seed and straw yield (q ha^{-1}) were recorded with application of four irrigations compared to three or five irrigations. It also recorded highest gross as well as net monetary return and B:C ratio. Application of 150 per cent RDF recorded highest values of all the growth and yield contributing characters. Similarly, significantly higher values of gross and net monetary return and B:C ratio were recorded with application of 150 per cent RDF, compared to 100 or 200 per cent RDF.

Oilseeds are very important component of tropical agriculture, as they provide easily available highly nutritious human food and animal feed. India has attained self sufficiency in cereals but there is deficit in the oilseed production (Hegde and Damodaran, 2010). Nagpur and Amravati revenue divisions are the most important sesame growing areas in Vidarbha region of Maharashtra state. Sesame, being an important oilseed crop, holds a promising position in the cropping sequence of the region, particularly during summer season. Water requirement of sesame is less compared to most of the other crops and is also very responsive to the fertilizers added. In this context, it was felt necessary to check the response of summer sesame to varying number of irrigations so as to decide whether a farmer having limited irrigation water can go for summer sesame. Similarly, sesame, being a neglected crop now days, farmers are not very much keen to apply fertilizer to this crop, although it gives a good response to the added fertilizer. Hence, to test the response of sesame to increasing doses of fertilizer and varying levels of irrigation, an experiment was carried out.

MATERIAL AND METHODS

A field experiment was carried out during summer 2011-2012 at Agril. College Farm, Nagpur, Maharashtra State, India. The field was fairly uniform and levelled. Soil of the experimental plot was medium black, clayey in texture, low in available nitrogen and phosphorus, and very high in available potash. Organic carbon content was medium and soil reaction was slightly alkaline. The experiment was laid out in Factorial Randomized Block Design (FRBD) with nine treatment combinations consisting three levels of irrigation *i.e.* three irrigations at 20, 40 and 60 DAS (I_1), four irrigations at 15, 30, 45 and 60 DAS (I_2) and five irrigations at 15, 30, 45, 60 and 75 DAS (I_3) and three levels of fertilizer *viz.* RDF (25:25 kg N:P ha^{-1}), 150 per cent RDF and 200 per cent RDF. Sesame variety PKV NT-11, developed specially for summer season by All India Co-ordinated trial was used.

Research trial on Sesame, College of Agriculture, Nagpur was sown by drilling, keeping 30 cm distance between the rows. Nitrogen was applied in two equal splits, while entire phosphorus was applied as basal dose, treatment wise, and the crop was irrigated as per decided schedule.

RESULTS AND DISCUSSION

Growth attributes

Irrigation levels had a significant effect on various growth parameters of the crop. Significantly highest plant height (120.7 cm) was recorded with application of four irrigations (I_2), but it was at par with plant height recorded with five irrigations (I_3) where as three irrigations resulted into significantly lowest plant height. Similarly, significantly highest numbers of branches and dry matter plant^{-1} were recorded with application of four irrigations and application of five irrigations was statistically similar to three irrigations. These results are in close agreement with the findings of Dutta *et al.* (2000) and Sarkar *et al.* (2010).

Fertilizer application also influenced the height of plant, branches plant^{-1} and dry matter plant^{-1}

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Table : Growth, yield and economics of summer sesame as affected by different levels irrigation and fertilizer.

Treaments	Mean Plant height at harvest (cm)	Mean number of branches at harvest	Mean dry matter plant^{-1} at harvest (g)	Seed yield (g plant^{-1})	Seed yield (q ha^{-1})	Straw yield (q ha^{-1})	Cost of cultivation (Rs ha^{-1})	Gross monetary return (Rs ha^{-1})	Net monetary return (Rs ha^{-1})	B :C ratio
Irragation levels (I)										
I_1(Three irrigations)	118.4	5.08	26.13	3.36	7.41	30.33	14215	44460	30245	3.14
I_2(Four irrigations)	120.7	5.71	27.83	3.64	8.08	33.63	14535	48480	33945	3.34
I_3(Fiveirrigations)	120.4	5.42	27.63	3.43	7.50	31.17	14855	45000	30145	3.03
S.E. (m) $\pm$	0.6	0.08	0.23	0.07	0.18	0.76	-	865	866	-
C.D.at 5%	1.9	0.25	0.68	0.22	0.54	2.27	-	2595	2597	-
Fertilizer levels (F)										
F_1(25:25 kg N:P ha^{-1})	117.9	5.23	26.73	3.39	7.26	29.91	13703	43560	29857	3.18
F_2(37.5:37.5 kg N:P ha^{-1})	121.7	5.61	28.50	3.79	8.20	33.47	14503	49200	34665	3.38
F_3(50:50 kg N:P ha^{-1})	119.8	5.38	27.18	3.26	7.53	32.10	15366	45180	29814	2.94
S.E. (m) $\pm$	0.6	0.08	0.23	0.07	0.18	0.76	-	865	866	-
C.D. at 5%	1.9	0.25	0.68	0.22	0.54	2.37	-	2595	2597	-
Interaction (I X F)										
S.E. (m) $\pm$	1.1	0.14	0.39	0.13	0.31	1.37	-	1499	1500	-
C.D. at 5%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	-	N.S.	N.S.	-
G. M.	119.8	5.40	27.48	3.48	7.66	31.83	14535	45980	31445	3.17

significantly. Highest plant height was recorded with application of 150 per cent RDF, which was at par with 200 per cent RDF and significantly superior over 100 per cent RDF. Similarly, application of 150 per cent RDF (F_2) increased the number of branches plant^{-1} significantly over application of 100 per cent RDF and remained at par with 200 per cent RDF. The latter two fertilizer levels were at par with each other. Fertilizer levels also increased the dry matter accumulation plant^{-1}. Application of 150 per cent RDF (F_2) significantly increased the total dry matter accumulation plant^{-1} over 100 per cent RDF (F_1) and 200 per cent RDF (F_1). Higher amount of nitrogen and phosphorus might have resulted into more activities of meristematic tissues of the plant, increased cell size and cell number, which ultimately might have probably resulted into increased growth attributes. Similar results were also obtained by Wairagade (1988) and Jadhav *et. al*. (2008).

Yield attributes

The seed yield (q ha^{-1}) was significantly influenced by different levels of irrigation. Highest seed yield of 8.08 q ha^{-1} was recorded with application of four irrigations (I_2) which was significantly superior over seed yield obtained with three irrigations (7.41 q ha^{-1}) and five irrigations (7.50 q ha^{-1}). Irrigation levels also affected the straw yield of sesame significantly. Highest straw yield (33.63 q ha^{-1}) was obtained by application of four irrigations which was significantly superior over application of three or five irrigations, (30.63 and 31.17 q ha^{-1}, respectively). Higher straw production might be a result of vigorous growth of the plant due to proper moisture supply during the growth period, resulting into more dry matter accumulation. The results are in confirmity with the findings of Sarkar *et. al*. (2010).

Various fertilizer levels also affected the seed yield of sesame (q ha^{-1}) significantly. It was maximum with 150 per cent RDF, which was significantly superior over application of 100 per cent and 200 per cent RDF. Similarly, fertilizer also affected straw yield. Application of 150 per cent RDF recorded highest straw yield of 33.47 q ha^{-1} which was significantly superior over application of 100 per cent RDF (29.91 q ha^{-1}) and was at par with 200 per cent RDF (32.10 q ha^{-1}). Higher straw production might be due to enhanced vegetative growth of the crop resulting into more dry matter accumulation plant^{-1} and ultimately more dry matter ha^{-1}. Similar observations were also reported by Mujumdar *et al*. (1988) and Wairagade (1988).

Economics

Highest gross and net monetary return of Rs. 48,480 and Rs. 33,945 respectively, were recorded with application of four irrigations (I_2) which was significantly superior over application of three (I_1) and five irrigations (I_3). In case of fertilizer application, highest gross monetary return of Rs. 49,200 ha^{-1} and net monetary return of Rs. 34,665 ha^{-1} were recorded with application of 150 per cent RDF (F_2) which was statistically more over 100 per cent RDF (F_1) and 200 per cent RDF (F_3).

Highest B: C ratio of 3.34 was recorded with four irrigations (I_2). Application of 150 per cent RDF also recorded highest B:C ratio of 3.38, followed by application of 100 per cent RDF (3.18) and 200 per cent RDF (2.94). Similar results were also obtained by Sarkar *et al.* (2010).

The interaction effect between number of irrigations and fertilizer levels was not significant in respect of growth attributes, yield and economics of summer sesame.

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Influence of Irrigation Water on Quality of Black Soils in Amravati District, Maharashtra

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ABSTRACT

The present study, thus has been taken up to assess the quality of the selected black soils of Vidarbha influenced by irrigation water. Soil and water samples from eight pedons (one each under irrigated and unirrigated conditions) were collected from each of the four tehsils (Warud, Amravati, Daryapur, Bhatkuli) of Amravati district of Maharashtra for analysis. The water used for irrigation in Amravati soil is in the class C3S2 with sodium adsorption ratio (SAR) value 11.83, electrical conductivity(EC) 1.8 dSm^{-1} and Na^{+} 14.0 $mmol_{c}l^{-1}$ which increased the EC of soils. The higher concentration of Na^{+} and Mg^{2+} ions is responsible for drainage impairment. The irrigation water of Bhatkuli (C4S1) increased EC values of irrigated soils. The reduced saturated hydraulic conductivity (sHC) in irrigated soils as compared to unirrigated soils is attributed to the higher concentration of sodium. The water used for irrigation in Warud and Daryapur tehsil are similar in quality (C3S1). The soils of Daryapur experienced significant increase in EC as compared to Warud soils. This was also associated with decrease in the values of sHC (0.14-0.17 cm h^{-1}) in the Daryapur soils. Moreover exchangeable as well as water soluble Na^{+}, Mg^{++} and EC also increased in the upper layers of the irrigated soils due to application of poor quality irrigation water. This has resulted in deterioration of the quality of these soils.

The majority of Vertisols in India occur in the lower piedmont plains or valleys (Pal and Deshpande 1987), or in microdepressions (Bhattacharyya *et al.* 1993). They are developed mainly in the alluvium of weathering Deccan basalt (Pal and Deshpande 1987; Bhattacharyya *et al.* 1993) mostly in the Holocene period (Pal *et al.* 2001,2006).

In Maharashtra, the total irrigated area is 4.2 Mha which accounts to 19.6 per cent of the gross cultivated land. Vidarbha covers 14.1 per cent of its land irrigated (0.7 Mha). Amravati district is spread over 12,210 sq.km land having nearly 6.9 lakh ha area under cultivation with 0.9 lakh ha irrigated (14.1 %) and the dominant crops are Orange (*Citrus reticulata*), Cotton (*Gossypium* spp.), Redgram (*Cajanus cajan*), Soybean (*Glycine max*.), Greengram (*Vigna radiata*) and Chickpea (*Cicer arietinum*). Irrigation sources are river, canal and predominantly wells. Black soils (Vertisols) are the dominant in Amravati district. Farmers are not able to grow second crop (*Rabi*) due to high intensity- short duration rainfall with long dry spells leaving very less residual. Irrigation becomes the necessity. Poor quality of irrigation water influence the soil health by affecting physical and chemical properties. Often farmers complain about the soil degradation due to application of irrigation water. Therefore, water is a limiting factor for the irrigation of many black soil areas. It has also been noticed that some part of the district ie. The Purna valley faces the problem of poor drainage resulting in water stagnation in *Kharif* and moisture stress in *Rabi* season.

Poor drainage is also the root cause of many problems resulting in the accumulation of salts in these soils which is aggravated by the application of poor quality of irrigation water. Therefore, assessment of water quality on its effects on the soil health is very essential to pinpoint the possible reasons for the development of poor drainage conditions as well as salinity and sodicity development.

MATERIAL AND METHODS

Amravati district lies between $20^{0}30'$ and $21^{0}46'$ N latitude and $76^{0}37'$ and $78^{0}27'$ E longitude with semi-arid (moist) climate having dry season from October through June and wet season from July to September when approximately 85 to 90 per cent of the rainfall is received. April and May have very high temperature and December and January are the coolest months. The soils have ustic moisture regime and hyperthermic temperature regime. The soils of Amravati district are derived from the Deccan trap and shows wide variation in their depth *viz.* shallow soils, medium deep soils and deep soils. Rainfed agriculture is dominant in the area with exception of Warud tehsil where Orange is grown, therefore highly irrigated.

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Soil and water samples from eight pedons (one each under irrigated and unirrigated condition) were collected from each of the four tehsils (Amravati, Daryapur, Bhatkuli and Warud) of Amravati district, Vidarbha, Maharashtra (Fig.1) for finding out the inter-relationship between soil and water characteristics specially the impact of poor quality irrigation water on soil quality.

For spatial distribution of soils of selected site, the soil samples from minipits (0-10, 10-25 and 25-50 cm) were also collected alongwith irrigation water samples from each tehsils and analysed. Water samples were analysed for different chemical constituents as per procedures of Richards (1954). Soil samples were air dried and determination of pH, EC, exchangeable and soluble cations and anions, CEC, ESP and saturated hydraulic conductivity were done by adopting the methods of Richards (1954), Piper (1950), Jackson (1958) and Klute (1986). Mechanical analysis of soils was done by the procedure of Jackson (1979).

RESULTS AND DISCUSSION

Evaluation of water quality

Intensive cropproduction in arid and semi-arid region have to depend on irrigation for second crop *(Rabi)* or even when the monsoon is late or there is long dry spell after onset of monsoon.Climate and soil conditions of this region requires irrigation water of good quality. Quality of irrigation water depends on total concentration of soluble salts, relative proportion of sodium to other cations. In order to avoid deleterious effect of poor quality water on soil properties and plant growth, it is desirable to have quality evaluation prior to its use for irrigation.A scheme proposed by United States Salinity Laboratory (Richards, 1954) has been generally accepted to evaluate irrigation water. Electrical conductivity has been proposed to measure total soluble salts in irrigation water. USSL originally proposed four salinity classes, viz. C1 class of water with EC less than 0.25 dSm^{-1} considered safe and no likelihood of any salinity problem, medium salinity class (C2) with EC between 0.25 to 0.75dSm^{-1}, needs

Fig. 1. Sampling sites of Amravati district

moderate leaching; high salinity class (C3) with EC between 0.75 to 2.25dSm^{-1} and very high salinity class (C4) with EC more than 2.25 dSm^{-1}. Kanwar (1961) included C5 class of water with EC from 5-20 dSm^{-1}, particularly for Indian soils.

The EC of the irrigation water collected from the irrigated profile sites in Amravati district ranges from 0.9 to 3.0 dSm^{-1} as given in table 1.(Warud 0.9, Daryapur 1.6, Amravati 1.8 and Bhatkuli 3.0 dSm^{-1}) which falls under class C3 and C4, unsuitable for irrigation.

In addition to the degree of salinisation, the type of salinisation, the sodium hazard and concentration of residual sodium carbonate have to be taken into account. Therefore, Richards (1954) suggested Sodium adsorption ratio (SAR) according to which water can be classified as low sodium water (S1-SAR 0-10), medium sodium water (S2- SAR 10-18), high sodium water (S3- SAR 18-26) and very high sodium water (S4- SAR > 26).

The irrigation water of the study area falls under low to medium sodicity category with water of Amravati in S2 class and Daryapur, Bhatkuli, Warud in class S1.

Table 1. Chemical composition of irrigation water

Soil site	Mg^{2+} (mmol$_c$ l^{-1})	Na^{+} (mmol$_c$ l^{-1})	pH	EC* (dSm^{-1})	SAR	RSC	Water class
Amravati	2.5	14.0	8.4	1.8	11.8	10.1	C3S2
Daryapur	2.4	11.5	8.5	1.6	9.0	7.3	C3S1
Bhatkuli	11.2	19.0	8.3	3.0	7.8	-0.2	C4S1
Warud	3.5	3.5	7.9	0.9	2.2	1.4	C3S1

*EC - Electrical conductivity

SAR – Sodium adsorption ratio

RSC – Residual sodium carbonate

Water containing CO^{-}_{3} and HCO^{-}_{3} ion in excess of Ca+Mg often leads to much greater alkali formation than as indicated by SAR value (Eaton, 1950). This happens due to precipitation of calcium and magnesium ions resulting in an increase in SAR values. This was in consideration that precipitation of Ca^{++} and Mg^{++} by carbonate to be quantitative when water are applied to soil and proposed the concept of residual sodium carbonate (SAR) for evaluating high carbonate water. Wilcox (1958) considered water with RSC greater than 2.5 meql^{-1} unsuitable for irrigation, those with RSC from 1.25 to 2.5 meql^{-1} may be regarded as marginal and RSC values less than 1.25 meql^{-1} are considered safe for irrigation.

As per criteria mentioned above, the irrigation water from Amravati, Daryapur are unsuitable for irrigation with RSC 10.1 and 7.3 respectively .Warud irrigation water is marginally suitable (RSC 1.4). Bhatkuli tehsils water has low RSC value due to the dominance of Mg ions concentration (Table 1).

When all the parameters (EC, SAR, RSC) are considered, the water used for irrigation is unsuitable for irrigation in clayey soils of Amravati district. The quality of water used for irrigation follows the trend: Warud (C3S1) > Daryapur (C3S1) > Amravati (C3S2) > Bhatkuli (C4S1).

Effect of irrigation water on soil properties

The land in the study area is gently sloping with 1-3 per cent slope in all the pedons except Temburkhed unirrigated soils in Warud tehsil with 3-5 per cent slope. Soils of selected sites are fine to very fine, smectitic, hyperthermic, Typic Hapluesterts. The colour of Shirala irrigated soil is very dark brown to very dark grey to yellowish brown at the lower layer. Unirrigated site of Shirala have very dark greyish brown colour at surface and dark greyish brown at lower depth. Darapur irrigated profile is greyish brown to dark greyish brown to yellowish brown through its depth, unirrigated soils have dark greyish brown which is very dark at slikenside zone and yellowish brown at lower layer of profile. Surface layer of Wathoda irrigated soil show very dark greyish brown colour, dark brown throughout the profile, it is dark yellowish brown to yellowish brown at lower horizons. Unirrigated profile is dark greyish brown in upper layer, dark brown to very dark greyish brown in slikenside zone and dark yellowish brown at lower part of profile. Irrigated soil of Temburkhed in Warud tehsil reflects dark greyish brown to dark brown colour and it is dark yellowish brown near parent material whereas the unirrigated profile shows dark greyish brown colour throughout the layers ending with yellowish brown. All the soils are very deep with very high clay content (45.2 to 77%) (Table 2). The soils have subangular blocky structure becoming angular blocky in subsoil showing very sticky and very plastic consistence.

The soils of the irrigated and unirrigated sites of Amravati district have resembling texture having similar

Table 2. Quality of soils (Weighted mean average values)

Particulars	Soil	Amravati		Daryapur		Bhatkuli		Warud	
	Layer (cm)	Irrigated	Unirrigated	Irrigated	Unirrigated	Irrigated	Unirrigated	Irrigated	Unirrigated
Clay %	0-30	65.6	65.5	66.8	69.8	73.0	67.4	45.2	51.4
	30-50	65.4	67.4	67.6	72.5	77.3	68.6	51.5	56.3
	50-100	69.3	71.2	60.7	63.5	69.8	64.0	51.1	44.3
Silt %	0-30	29.9	29.1	29.8	28.0	23.8	29.6	53.3	43.9
	30-50	30.3	29.4	29.9	25.2	19.8	28.5	44.6	41.1
	50-100	26.4	25.3	34.9	32.3	27.1	26.6	46.0	52.5
Sand %	0-30	4.5	5.3	3.4	2.2	3.2	3.1	4.1	4.7
	30-50	4.3	3.2	2.6	2.4	2.8	2.8	3.9	2.7
	50-100	4.3	3.6	4.4	4.2	3.1	9.4	2.9	3.2

substrate (Table 2). Therefore, they are comparable. The comparative soil properties of irrigated and unirrigated soils are presented in Table 3.

The pH of soil did not reflect any specific comparable trend, but could show higher values of pH in irrigated soil than unirrigated soil of Daryapur tehsil profile particularly in the upper layer. The EC of the irrigated soils ranged from 0.18 to 0.66 dSm^{-1} and 0.13 to 0.21 dSm^{-1} in unirrigated soils. EC was higher in all the irrigated profiles than unirrigated. Highest impact was observed in Bhatkuli tehsil (Irrigated- 0.7 dSm^{-1}, Unirrigated- 0.2 dSm^{-1}).

In general, calcium was the dominant exchangeable cation at all the sites. In Shirala irrigated soil calcium was followed by magnesium, sodium and potassium but in unirrigated profile Na^+ concentration is lesser than K^+, clearly indicating preponderance of Na^+ in irrigated profile is attributed to the use of sodic irrigation water (C3S2). Similar trend was observed in other irrigated soils. This trend was not seen in Warud soils, it may be due to good conduction of water which could leach the excessive salts.

ESP of irrigated profiles in Amravati (1.9- 9.1), Daryapur (6.8- 8.8), Bhatkuli (1.7- 6.1) were higher in all the layers with respect to unirrigated (0.7-1.0, 0.9-1.7, 1.0-1.8 resp.). Warud irrigated soil shows marginal rise in the ESP values over unirrigated profile up to 50 cm depth (Table 3).

The data on the composition of saturation extract of the soils are presented in Table 4. Electrolyte conductivity (ECe) of irrigated soils have been increased over unirrigated soils following the trend of ECiw. An increasing trend of rise in the ECe in the layers indicates that the irrigation water facilitates excessive accumulation of salts in the irrigated profiles.

Bicarbonates, chlorides and sulphates were the dominant anions in irrigated soil of Amravati and Daryapur tehsils (2.2-5.7, 1.4-7.2, 1.1-2.1 $mmol_c l^{-1}$ and 2.7-3.9, 1.2-2.5, 1.7-3.3 $mmol_c l^{-1}$) with much higher concentration than the unirrigated profiles (1.6-2.6, 0.5-1.4, 0.4-1.1$mmol_c l^{-1}$ and1.8-2.8, 0.5-1.1, 0.2-0.4 $mmol_c l^{-1}$). Bhatkuli tehsil irrigated profile had very high values of chlorides and sulphates (12.9 and 11.8 $mmol_c l^{-1}$) over unirrigated soils (1.2 and 0.8 $mmol_c l^{-1}$). Warud irrigated soils show upper layers increased with anion concentration than unirrigated soils (Table 4). Among the soluble cations sodium shows dominance in Amravati and Daryapur tehsils in all the layers (1.3-9.9 and 3.8-6.9 $mmol_c l^{-1}$), these values were too high when compared (0.3-1.0 and 0.3-1.0 $mmol_c l^{-1}$) with the unirrigated sites .Bhatkuli soil shows increase in values of soluble sodium and magnesium (2.0-14.9 and 1.7-5.2$mmol_c l^{-1}$) due to irrigation over unirrigated condition(0.4-1.1 and 0.6-1.2$mmol_c l^{-1}$).Warud soil remained unaffected and had only little increase of sodium in surface, may be due to good drainage conditions. Soluble Ca/Mg ratio was decreased in all the irrigated profiles in comparison with unirrigated soils.

Sodium adsorption ratio (SAR) of Shirala and Wathoda irrigated soils raised in upper layer (6.1 and 6.6) as compared to unirrigated which was 0.4 and 0.5. SAR of Darapur irrigated soil was increased throughout the profile (3.6-9.0) which was very high compared to unirrigated soil (0.3-0.8). Temburkhed site too had impact

Table 3. Comparative soil properties of irrigated and unirrigated soils

Soil layer(cm)	pH	EC(dSm^{-1})	Extractable bases ($cmol(p^+)kg^{-1}$)				ESP*	Saturated Hydraulic Conductivity($cmhr^{-1}$)
			Ca^{2+}	Mg^{2+}	Na^+	K^+		
Pedon 1. Shirala soil – Amravati tehsil (Irrigated)								
0-30	8.4	0.28	53.5	10.1	5.5	1.4	9	0.08
30-50	8.2	0.24	66.7	9.1	2.0	1.4	3	0.22
50-100	8.1	0.21	53.8	11.1	1.3	1.5	2	0.26
Pedon 2. Shirala soil – Amravati tehsil (Unirrigated)								
0-30	8.2	0.15	45.9	8.3	0.4	1.4	1	0.71
30-50	8.3	0.17	45.3	13.2	0.5	1.2	1	0.48
50-100	8.3	0.16	42.1	5.8	0.5	1.2	1	0.41
Pedon 3. Darapur soil – Daryapur tehsil (Irrigated)								
0-30	8.7	0.27	45.5	1.0	4.9	2.2	9	0.14
30-50	8.6	0.26	49.9	1.5	4.1	1.0	7	0.16
50-100	8.4	0.36	44.9	1.1	5.0	0.9	9	0.19
Pedon 4. Darapur soil – Daryapur tehsil (Unirrigated)								
0-30	8.0	0.21	58.1	0.7	0.6	1.5	1	0.40
30-50	8.1	0.13	42.7	0.6	0.5	1.3	1	0.42
50-100	8.2	0.13	45.5	0.8	0.5	1.1	1	0.46
Pedon 5. Wathoda soil – Bhatkuli tehsil (Irrigated)								
0-30	7.9	0.66	48.0	1.2	4.2	1.3	6	0.17
30-50	7.9	0.44	48.7	1.1	2.5	1.0	4	0.22
50-100	7.9	0.53	47.6	1.3	1.0	1.0	2	0.26
Pedon 6. Wathoda soil – Bhatkuli tehsil (Unirrigated)								
0-30	7.9	0.16	52.2	1.2	0.8	1.5	1	0.65
30-50	8.1	0.16	56.4	0.8	0.7	1.2	1	0.67
50-100	8.2	0.17	48.6	0.9	0.6	0.9	1	0.93
Pedon 7. Temburkhed soil – Warud tehsil (Irrigated)								
0-30	8.3	0.19	35.2	12.0	1.3	1.4	3	0.98
30-50	8.3	0.18	36.1	12.2	1.3	1.0	3	0.71
50-100	8.5	0.19	35.2	13.6	1.7	1.0	4	0.47
Pedon 8. Temburkhed soil – Warud tehsil (Unirrigated)								
0-30	8.3	0.17	34.5	11.3	0.6	2.5	1	1.63
30-50	8.3	0.18	33.0	13.6	0.5	1.4	1	0.72
50-100	8.4	0.18	33.2	13.7	1.2	1.1	4	0.78

*ESP- Exchangeable sodium percentage

Table 4. Composition of saturation extract of soils (Weighted mean average values)

Soil layer(cm)	ECe (dSm^{-1})	Soluble anions ($mmol_c l^{-1}$)			Soluble cations ($mmol_c l^{-1}$)				SAR*	Soluble sodium%
		HCO_3^-	Cl^-	SO_4^{2-}	Ca^{2+}	Mg^{2+}	Na^+	K^+		
Pedon 1. Shirala soil – Amravati tehsil (Irrigated)										
0-30	1.59	5.7	7.2	2.1	3.6	1.5	9.9	0.17	6.1	65
30-50	0.83	3.8	3.3	1.1	3.4	1.3	3.4	0.10	2.0	34
50-100	0.59	2.2	2.0	1.3	3.1	0.9	1.3	0.10	0.9	23
Pedon 2. Shirala soil – Amravati tehsil (Unirrigated)										
0-30	0.36	2.6	0.5	0.4	2.2	0.7	0.3	0.08	0.4	11
30-50	0.27	2.3	0.5	0.4	1.4	0.6	0.4	0.04	0.4	17
50-100	0.33	1.9	0.8	0.6	0.6	0.7	0.7	0.03	0.7	24
Pedon 3. Darapur soil – Daryapur tehsil (Irrigated)										
0-30	0.73	3.9	1.7	1.8	0.9	0.5	5.8	0.15	9.0	80
30-50	0.61	3.0	1.2	1.8	0.8	0.4	4.5	0.21	5.9	77
50-100	0.94	3.3	2.5	3.3	1.4	0.6	6.9	0.05	6.7	76
Pedon 4. Darapur soil – Daryapur tehsil (Unirrigated)										
0-30	0.26	1.8	0.5	0.4	1.7	0.5	0.3	0.10	0.3	9
30-50	0.30	2.3	0.6	0.3	2.1	0.6	0.4	0.05	0.3	12
50-100	0.35	2.4	0.7	0.3	1.9	0.7	0.6	0.06	0.5	17
Pedon 5. Wathoda soil – Bhatkuli tehsil (Irrigated)										
0-30	2.47	1.9	12.9	7.1	7.0	3.1	14.9	0.12	6.6	59
30-50	1.23	1.7	2.7	7.3	4.9	1.7	5.7	0.07	3.0	43
50-100	1.50	1.0	1.8	11.8	9.2	3.2	2.0	0.09	0.9	14
Pedon 6. Wathoda soil – Bhatkuli tehsil (Unirrigated)										
0-30	0.34	1.5	1.2	0.4	2.0	0.6	0.4	0.09	0.5	14
30-50	0.31	1.6	0.8	0.5	1.6	0.6	0.5	0.07	0.5	18
50-100	0.34	2.2	0.4	0.8	1.7	0.7	0.6	0.05	0.6	20
Pedon 7. Temburkhed soil – Warud tehsil (Irrigated)										
0-30	0.52	3.0	1.4	0.8	2.2	1.0	1.7	0.11	1.4	36
30-50	0.48	2.3	1.7	0.8	2.1	1.0	1.6	0.05	1.3	34
50-100	0.45	1.8	2.0	0.5	1.2	0.6	2.3	0.05	2.6	58
Pedon 8. Temburkhed soil – Warud tehsil (Unirrigated)										
0-30	0.44	2.8	0.5	1.2	2.4	0.9	0.5	0.13	0.6	14
30-50	0.37	2.9	0.3	0.6	1.9	0.7	0.8	0.05	0.7	34
50-100	0.41	3.0	0.4	0.6	1.4	0.6	1.7	0.08	1.8	45

*SAR – Sodium adsorption ratio

of rise in SAR values in 100 cm depth. The soluble sodium percentage was increased at all the sites in irrigated soils rendering soil sodicity.

In spite of the poor irrigation water, the sHC of Warud irrigated soil (4.5-9.8 $mmhr^{-1}$) is higher when compared with other soils in the district, which may be influenced by the amount of total clay, fine clay and silt fraction and lower ESP, SAR, SSP and Na^+ concentration in comparison with other irrigated soils of the district. In all the other sites sHC has been influenced by the use of poor quality of irrigation water.

CONCLUSION

The soil quality of irrigated sites of Amravati tehsil have been deteriorated in terms of ESP and sHC due to poor quality of irrigation water.

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Performance Evaluation of Straw Cutting Mechanism Under No-till Crop Residue Conditions in the Soil Bin

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ABSTRACT

The straw cutting mechanisms viz., plain disc with twin press wheels and serrated blade with twin press assembly were evaluated for crop residue cutting ability in the soil bin. The straw cutting mechanisms were operated on a wide range of straw densities from 3000 to 5000 kg/ha at forward speed of carriage 2.5 km h^{-1} and at rotational speed of straw cutting mechanism of 150 to 250 rpm and speed ratios from 5.20 to 8.67 and evaluated their performance in the soil bin laboratory of Central Institute of Agricultural Engineering, Bhopal. The experiments of straw cutting mechanisms were conducted according to CRD design and Response Surface Method (RSM) was applied to the experimental data using Design Expert statistical software. The relative effect of the variables of speed ratio, pair of press wheels, straw density and type of blade on the responses of horizontal force (F_h), vertical force (F_v), power consumption and straw cutting percentage were studied. The F_h requirement of serrated blade was observed to be higher by 19 than that for the plain blade at all speed ratios and straw density levels, whereas it was found to be 22 per cent higher in case of serrated blade. The power requirement of plain blade with a pair of twin press wheel assembly was estimated to be 192.66, 280.23 and 356.33 at 3000, 4000 and 5000 kg ha^{-1} straw density, respectively at 5.20 speed ratio, whereas it was found to be 262.82, 396.00 and 585.83 W for serrated blade for the same straw density and speed ratio. The quantity of straw cut with plain blade with a pair of twin press wheels assembly was 100 per cent for all straw densities and speed ratios.

Conservation tillage is a method of cultivating crops which improves soil conservation and can produce lower production costs than conventional tillage systems. In a conservation tillage system, in order to perform the necessary cultivation task adequately, soil engaging implements need to be equipped with residue-cutting tools.

Conservation agriculture technologies have the potential to contribute to increased productivity in a sustainable way. The term conservation agriculture refers to a set of agricultural practices and is based on three fundamental principles namely, no-tillage, permanent soil cover and diversified crop rotations. Conservation agriculture involves practices such as minimum or zero mechanical disturbance, crop residues retention, permanent organic soil cover, diversified crop rotations, precise placement of agro chemicals, in-field traffic control and application of animal manure and crop residues. The benefits of conservation agriculture are lower farm traffic, reduction in use of mechanical power, labour inputs thus resulting in timely field operations, lower risk of crop failure and ultimately resulting in higher yields, lower costs and reduction in environmental pollution.

Rice - wheat is an important crop rotation and covers an area of 72 Mha in the world and 10 to 12 Mha in India. The total area under no-tillage in the world is 90 Mha and in India it is about 3.43 Mha (Saunders *et al*., 2012, and Tandon, 2007). Due to increase in demand for food production, the farmers have started growing more than one crop a year resulting in land degradation, unsound agricultural practices and increase in use of different inputs such as seed, fertilizer, chemicals and agricultural machinery. In North-Western India, combine harvesting of rice and wheat is now a common practice leaving large amount of crop residues in the fields. the conservation tillage systems, besides the high levels of crop residues do present a constraint for adopting conservation tillage, because the residues mechanically interfere with crop residues on the soil surface pose difficulty for uniform seedling establishment in seeding operations. Improved seeding equipment or residue removal may be necessary for successful direct drilling practices. The main operational problem in direct drilling of paddy straw residue is the accumulation and wrapping of loose straw on the tines and frame of no-till drills and traction problems with the ground wheel (Hegazy and Dhaliwal, 2011; Graham *et al*. 1986).

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Proper seed placement is very important component of the crop production system. No-till seeding requires drills capable of cutting through large quantities of crop residue, penetrating untilled soil, and depositing the seed 25 to 50 mm deep. Problem associated with seed placement under no-till and minimum tillage practices are density, toughness of crop residue and soil penetrating resistance. No till drills have indicated that under heavy crop residues, failures of the disc openers to cut through the residue resulted in the seed being placed either in the residue or on the soil surface. The seed was placed on this trash resulting in poor germination. Since, no-till and minimum tillage system have considerable potential for saving energy, time, man hours, machine hours, controlling wind and water erosion, reduction of soil moisture loss by evaporation, it is extremely important to investigate problems associated with seed placement under crop residue conditions (Kushwaha *et al.*, 1886; Baker and Saxton, 2007).

The combine harvested rice-wheat fields are generally left with long loose straw and stubbles in the field which create several operational problems in land preparation for the next crop. Nearly 75 per cent of rice-wheat straw goes as waste besides causing environmental pollution due to straw burning in the field prior to tillage for subsequent sowings. Burning of rice stubbles is widely practiced in Punjab, India, due to a lack of suitable machinery for direct drilling of wheat seed into combine-harvested rice residues. Although direct drilling of seed into burnt stubbles is a rapid and cheap option, and it allows for a quick turnaround between crops, it is causing serious problems for human and animal health due to air pollution, and decline in soil fertility due to loss of nutrients and organic matter (Singh *et al.*, 2008). Considering the problems with direct drilling of wheat into combine-harvested rice fields the study was undertaken to evaluate the performance of straw cutting mechanism under no-till crop residue conditions in the soil bin.

MATERIALS AND METHODS

The research work was carried out in Soil Dynamic Laboratory, Agricultural Mechanization Division, Central Institute of Agricultural Engineering, Bhopal (MP). The experiment of straw cutting mechanism was conducted according to CRD design and Response Surface Methodology (RSM) was applied to the experimental data using Design expert. The relative effect of the variables of speed ratio, pair of press wheels and straw density on the responses was studied. The responses studied were horizontal force (draft), vertical force, power requirement and straw cutting percentage.

The straw cutting mechanisms viz., plain blade with twin press assembly and serrated blade with twin press assembly were developed for studying their straw cutting ability in no-till crop residue conditions in the soil bin. Parametric software Pro-Engineer creo element was used to design the straw cutting mechanism. Based on the design of plain disc, the whole disc of 460 mm in diameter and 4 mm thick was divided in to eight parts for fabrication of plain eight blades (Fig. 1). These plain blades were fixed on the flange of 350 mm diameter. The flange was made up of mild steel from 4.0 mm thick plate. The bevel angle of the blade was 12°. This plain blade has advantage of replacement of damage or blunt blade instead of complete replacement of whole disc. The serrated blade was also developed for evaluating its performance in the soil bin (Fig. 2). A pair of twin press wheel assembly was developed to hold and press the straw under tension during cutting of the straw. Press wheel assembly consists of twin press wheel, fork and ratchet returning spring.

Fig. 1 Plain blade for straw cutting

Fig. 2 Serrated blade for straw cutting

The straw cutting mechanism was operated on a wide range of straw densities from 3000 to 5000 kg ha^{-1} at carriage speed of 2.5 km h^{-1} and at speed ratios 5.20 to 8.67 with a pair of twin press wheels assembly at constant depth of 15 mm. The straw cutting mechanism was fixed on the tool bar provided on the carriage. The carriage was brought and parked over the packed soil and operating depth was set. The tool bar was lowered to the desired depth of penetration from the zero mark. Preparation of straw for an experiment was tedious and time consuming. The paddy straws were taken from the bale for maintaining the uniformity in the all experiments. Pieces of straw of length 400 mm were made and taken for the experiment and maintained the required range of density from 3000 to 5000 kg ha^{-1} (Mangaraj and Kulkarni, 2010). The carriage motor was set at desired speed of 2.5 km h^{-1}. The data acquisition program was run with a data file. Data were collected with straw cutting mechanism running on the straw. Soil force and torque data automatically collected for the working distance of 5 m. Exported the data to MS excel for further analysis purpose. At the end of the run, the straw cutting mechanism was lifted up and the carriage returned. Collected uncut straw pieces from the soil bin for its measurement of uncut and cut straw percentage and the soil was prepared for the next run.

Simulation of soil conditions in the soil bin was the major factor in determining the performance of the straw cutting mechanism. Various operations such as tilling, wetting of soil, leveling and packing were the part of soil preparation. The soil preparation unit includes roto-tiller, deep working tines, sheep foot roller, soil leveler and water application system to obtain uniform moisture and penetration resistance throughout each experiment with repeatability measures. The field condition of soil compaction level was closely simulated in the soil bin. One important parameter is soil compactness and this was measured in the field and in the soil bin with a cone penetro-logger. Data were collected from fields with a cone penetro-logger. Data for soil penetration resistance were collected at seeding time with stubble under no-till conditions on the field of the Central Institute of Agricultural Engineering, Bhopal. Cone index values were evaluated at 0 to 300 mm depth by taking an average of five readings of five different plots.

The core of the complete soil bin system was a computer controlled data acquisition and analysis unit. It was a supervisory control and data acquisition (SCADA) and programmable logic control (PLC) based system. The computer based data acquisition and control system provides on-line display and logging of experimental variables while simultaneously prepares reports in printable format which allows rapid evaluation of experimental results. The experimental design was applied after selection of the ranges. The experiments were randomized in order to minimize the effect of unexplained variability in the observed responses due to extraneous factors. The centre point in the design was repeated six times to calculate the reproducibility of the method. The developed straw cutting mechanism was fixed to the frame provided on front tool bar of the carriage across the bin width. The straw cutting mechanism was fitted on the frame through a sub frame which was entirely supported from the carriage through six appropriately oriented force transducers for measuring the horizontal force, vertical force and lateral force acting on the straw cutting mechanism (Singh *et al.* 2008).

The power was given to the straw cutting mechanism from 3.75 kW motor through chain and sprocket arrangement and the torque sensor was coupled to the shaft of the motor. The proximity switch was fitted at the frame of torque sensor's foundation for counting the rpm of straw cutting mechanism. The effect of various parameters for development of straw cutting mechanism like pair of press wheels, straw density and speed ratio on horizontal force, vertical force, power required for straw cutting mechanism and straw cutting percentage was measured.

RESULTS AND DISCUSSION

Horizontal forces on straw cutting mechanism

From Table 1 it is seen that the requirement of horizontal force (F_h) by the straw cutting mechanism equipped with a serrated blade and twin press assembly was observed to be 14.19, 15.61 and 17.33 kgf at 3000, 4000 and 5000 kg ha^{-1} straw density, respectively at 5.20 speed ratio while it was found to be 12.16, 12.50 and 13.59 kgf at the same straw density level and speed ratio. Similar trend was also observed at speed ratios of 6.94 and 8.67 (Table 1). The increase in F_h in serrated blade as compared to the plain blade may be attributed to the fact that the straw gets trapped in serration of the blade and carrying straws along with its periphery. Whereas, the plain had the continuous contact of its cutting edge with the straw and helped for smooth cutting of straw and resulted into

less requirement of F_h than that plain blade. The values of F_h obtained demonstrated that, higher F_h requirement of 14, 20 and 22 per cent was observed for serrated blade than that for the plain blade at 3000, 4000 and 5000 kg ha^{-1} straw density, respectively. Choi and Erbach (1986) reported that an average horizontal force of 20.1 kgf is required for cornstalk residues shearing by rolling coulter at 38 mm depth. The reported higher value of F_h was due to the higher depth of operation of 38 mm and rolling coulter. The Eq. 1 in terms of actual factors can be used to make predictions about the response of horizontal force (F_h) for given levels of each factor.

Table 1 Requirement of horizontal forces (kgf) for serrated and plain blade straw cutting mechanism

Speed ratio	Serrated blade			Plain blade		
	at straw density, kg ha^{-1}					
	3000	4000	5000	3000	4000	5000
5.20	14.19	15.61	17.33	12.16	12.50	13.59
6.94	14.72	15.92	17.91	12.58	13.68	13.81
8.67	15.28	16.56	18.13	13.24	14.51	14.18

The regression Eq. 1 describing the effects of the variables on horizontal force for serrated and plain blade in terms of actual levels of variables given as,

Horizontal force=2.94+0.29 X_1+2.72 X_2 + 0.0034 X_3+0.260X_20^2 (1)

Where, X_1- speed ratio, X_2- pair of press wheels and X_3- straw density are the variables

Vertical forces on straw cutting mechanism

From Table 2 it is seen that the requirement of vertical force (F_v) by the straw cutting mechanism equipped with a serrated blade and twin press assembly was observed to be 35.83, 38.27 and 41.46 kgf at straw density of 3000, 4000 and 5000 kg ha^{-1}, respectively at 5.20 speed ratio, while it was found to be 12.16, 12.50 and 13.59 kgf at the same straw density level and speed ratio (Table 2). Similar trend was also observed at speed ratios of 6.94 and 8.67 (Table 2). On an average 34 per cent higher F_v was found for straw cutting by serrated blade than that for the plain blade at 5.20 speed ratio. This increase in vertical force (F_v) would have been due to the straw pushed into the soil by the serrated knives of serrated blade and therefore, the serrated knife section demanded higher vertical force (F_v) for their penetration in the soil. The requirement of higher F_v it may due to the impact shearing of straw by the serrated knife it may also due to some straw stayed in serration of the blade and taking straw along with its periphery.

Table 2 . Requirement of vertical forces (kgf) for serrated and plain blade straw cutting mechanism

Speed ratio	Serrated blade			Plain blade		
	at straw density, kg ha^{-1}					
	3000	4000	5000	3000	4000	5000
5.20	35.83	38.27	41.46	27.58	29.91	32.82
6.94	36.52	38.61	41.83	28.37	30.94	32.79
8.67	36.87	38.92	42.78	28.85	31.76	35.05

The regression Eq. 2 describing the effects of the variables on vertical force for serrated and plain blade in terms of actual levels of variables given as,

Vertical force=6.21+0.35 X_1+8.70 X_2+0.0023 X_3-1.270X_20^2 (2)

Effect of variables on power requirement of straw cutting mechanisms

The estimation of power required by straw cutting mechanism equipped with serrated blade and a pair of twin press wheel assembly was found to be 250.39, 396.00 and 585.83 W. Whereas, it was found to be 192.66, 280.23 and 356.33 W for plain blade at 3000, 4000 and 5000 kg ha^{-1} straw density, respectively at 5.20 speed ratio (Table 3). Similar trend was also observed for power requirement at other speed ratios of 6.94 and 8.67. Agreement of Kushwaha *et. al.* (1986) for power consumption of powered coulters working at 55 mm depth and at 4000 kg ha^{-1} straw density was 173.2 for plain coulter. These values of power consumption are lower because of the lower speed ratio of 2.0 whereas, in the present study, the experiments were carried out at 5.2 to 8.67 speed ratio.

Table 3 Power requirements (Watts) of straw cutting mechanisms equipped with serrated and plain blade

Speed ratio	Serrated blade			Plain blade		
	at straw density, kg ha^{-1}					
	3000	4000	5000	3000	4000	5000
5.20	250.39	396.00	585.83	192.66	280.23	356.33
6.94	259.44	415.73	596.08	199.83	284.89	368.60
8.67	285.52	428.11	606.10	203.13	313.57	389.99

Straw cutting performance of the blades

From Table 4, it is depicted that the 100 per cent straw cutting percentage was observed by plain blade at all the straw density levels of 3000, 4000 and 5000 kg ha^{-1} and at all the speed ratio of 5.20, 6.94 and 8.67. It may due to that a pair of twin press wheels assembly was sufficient for holding the straw fitted at both sides of straw cutting blade and plain blade had sooth cutting edge resulted into 100 per cent of straw cutting. Kushwaha *et al*. (1986) also reported that the plain coulter cut the straw nearly 100 per cent at all the rotational speeds and straw densities. Whereas, the straw cutting performance of serrated blade was lower than that of plain blade and it was observed to be 91.00, 90.33 and 92.00 per cent at 3000, 4000 and 5000 kg ha^{-1} straw density, respectively at 6.94 speed ratio. The regression Eq. 3 describing the effect of variables on percentage of straw cut in terms of actual levels of variables is given as,

Straw cut = 16.508+28.858 X_2-0.008 0X_10^2
+6.5060X_20^2-4.39 x 0100^(-9)
0X_30^2 (3)

Table 4 Straw cutting percentages of straw cutting mechanisms equipped with serrated and plain blade

Speed ratio	Serrated blade			Plain blade		
	at straw density, kg ha^{-1}					
	3000	4000	5000	3000	4000	5000
5.20	83.00	85.33	83.00	100.00	100.00	100.00
6.94	91.00	90.33	92.00	100.00	100.00	100.00
8.67	84.33	85.00	83.00	100.00	100.00	100.00

Figure 3 and 4 shows the straw cutting work performed by the serrated blade and plain blade equipped with a pair of twin press wheels assembly. From Fig. 5, it is seen that, after passing the plain blade the straws were cut and the cut straws were completely sectioned into two halves.

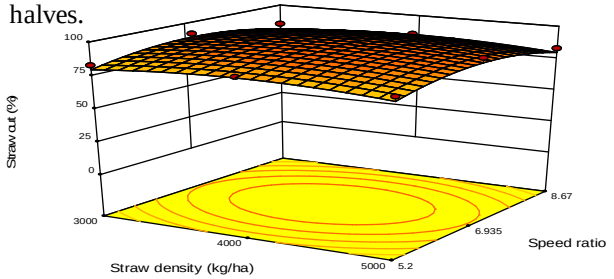

Fig. 3 straw cutting percentage by straw cutting mechanism equipped with serrated blade and a pair of twin press wheel assembly

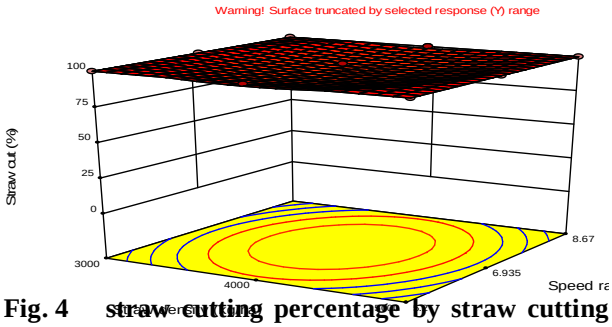

Fig. 4 straw cutting percentage by straw cutting mechanism equipped with plain blade and a pair of twin press wheel assembly

Fig. 5 Straw cutting mechanism equipped with plain blade and a pair of twin press wheels assembly

The amount of clogged straw by straw cutting mechanism with a pair of twin press wheels assembly was observed to be 7.58, 4.51 and 6.22 kg ha^{-1} at 3000, 4000 and 5000 kg ha^{-1} straw density, respectively at 5.20 speed ratio whereas, 38.56, 37.09 and 36.54 kg ha^{-1} was observed for serrated blade at the same straw density and speed ratio. Almost similar results were also obtained at 6.94 and 8.67 speed ratios. A very less amount of clogged straw i.e. 4.01 kg ha^{-1} was observed in straw cutting mechanism of plain blade with a pair of twin press wheels assembly, it was due to that the pair of wheels press hold the laid straw properly at the time of straw cutting. A pair of twin press wheel assembly had higher contact area of press wheels with straw and soil surface, and hence almost all the straw were hold by the pressing wheels and resulted into less straw clogging. A very few amount of clogged straw was found and it may due to the 100 per cent straw cutting. The regression Eq. 4 describing the effect of variables on straw clogged in terms of actual levels of variables is given as,

Straw clogged= -20.436+21.372X_1-54.16X_2-
0.202X_1 X_2-1.5360X_10^2 +
19.0280 X_20^2+ 1.244 x 0100^(-8)
0X_30^2 (4)

CONCLUSIONS

The quantity of straw cut by straw cutting mechanism equipped with plain blade and a pair of twin press wheels assembly was 100 per cent for all straw densities and speed ratios and it performed better under no-till conditions and recommended for no-till sowing under heavy crop residue conditions.

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An Analysis of Price Behavior of Chickpea in Maharashtra State of India

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ABSTRACT

The paper examines the behaviour of market arrivals and prices of chickpea in selected markets in Maharashtra. The results reveal that both market arrivals and prices of chickpea have increasing trends in all selected markets during 1997 to 2011. Seasonal fluctuations were observed in market arrivals as well as in prices of chickpea across the markets. The Intra Year Price Rise and Average Seasonal Price Variation for chickpea varied between 8.26 per cent to 12.49 per cent and 7.93 per cent to 11.75 per cent respectively in markets deciphering stability in the marketing system. Johansen market integration methodology concluded that out of four markets, two are co-integrated. Error correction mechanism established the fact that chickpea markets came to price equilibrium in long run.

Chickpea (*Cicer arietinum* L) commonly known as 'gram' or 'bengal gram' is the most important pulse crop of India. Chickpea occupies about 37 per cent of area under pulses and contributes about 50 per cent of total pulse production of India. Madhya Pradesh is the largest chickpea growing state in India followed by Uttar Pradesh, Rajasthan and Maharashtra. A total areae under chickpea is 8.22 million hectare in 2011-12, out of which 1.25 million hectare comes under Maharashtra. It accounts for 15.27 per cent and 14.14 per cent of the country chickpea area and the production, respectively in the corresponding year.

Chickpea is a *Rabi* crop and comes in market during March to May, but the consumption is spread throughout the year. Spatial market integration indicates the flow of commodities along with price across markets. This helps in bring price stability of chickpea across markets in the state. Perusal of past literature shows that various attempts have been made to investigate the price behaviour of various fruit, vegetable and food crops in India [Kasar *et.al* (1997), Pagire (1998), Mali *et.al*. (1999), Shelke and Kalyankar (2000), Navadkar *et.al* (2002), Pawar and Misal (2004), Asmatoddin *et.al* (2009), Sharma (2011), Reddy (2012)]. This study restrict to Maharashtra state with specific objectives (1) to study the trends and seasonality in arrivals and prices of chickpea markets and (2) to study the extent and pattern of spatial integration in chickpea markets. The knowledge emanating from this research analysis would provide information to the government procurement agencies regarding the suitable timing for purchase and to farmers when and where to dispose off produce is more profitable.

MATERIAL AND METHODS

The major trading centres of chickpea in Maharashtra are Akola, Aurangabad, Hinganghat and Malegaon etc. The market behaviour is analyzed by observing the trends and relationships between arrival of market commodity and resultant wholesale prices whereas market conduct is assessed by using Johnson's Co-integration methodology. The monthly data on market arrivals and wholesale prices of chickpea have been collected for the period of 1997 to 2011 from Maharashtra State Agricultural Marketing Board (MSAMB), Pune, Ministry of Agriculture (website: http://*www.agmarknet.nic.in*) and from Agriculture Produce Market Committees (APMCs) of Akola, Aurangabad, Hinganghat and Malegaon, which are major markets for chickpea in Maharashtra.

Analytical techniques

The Ordinary Least Squares (OLS) method was used to examine the trends and relationship in arrivals and prices of chickpea in selected markets as given below:

$$Y = a + b_t + €$$

Where,

Y = data of arrivals /prices month^{-1},
a = Intercept,
b = Slope or regression coefficient,
t = Time period in months,
€ = Error term

To measure the seasonal variations in prices and arrivals, seasonal indices were calculate employing twelve months ratio to moving average method. The seasonal indices were computed in such a way that their sum becomes 1200. This can be done by working out correction

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factor and multiplying the averages for each month by this correction factor. The correction factor (K) was worked out as follows. K = 1200/S Where, S= Sum of seasonal indices

The extent of seasonal price variation estimated using Intra Year Price Rise (IPR), Coefficient of Average Seasonal Price Variation (ASPV) and the Coefficient of Variation (CV) measures the stability or instability of a specified parameter. The estimates computed using

$$IPR = [\frac{HSPI - LSPI}{LSPI}] \times 100$$

and

$$ASPV = [\frac{HSPI - LSPI}{(HSPI + LSPI)/2}] \times 100$$

,Where HSPI = the highest seasonal price index and LSPI = the lowest seasonal price index.

In order to examine the nature of relationship between market arrivals and prices, the model is:

$$P_t = a + bP_{t-1} + cY_t + U_t$$

Where

P_t = current price (Rs q^{-1}) of chickpea in period t,

Y_t = current arrival (quintal) of chickpea in period t,

P_{t-1} = lagged price of chickpea,

a, b and c = parameters to be estimated,

U_t = error term.

Market Integration

To analyze the market integration Augmented Dickey Fuller test (ADF), Johanson's Co-integration test, and Error Correction Model (ECM) were used. To analyze the market integration and price transmission by Rapsomanikis *et.al.* (2006) was helpful in sharpening the methodology for this study. For co-integration analysis Johansen (1988) maximum likelihood estimators over Engle and Granger (1987) two-step procedure was used. Granger (1969) causality test was used to find out the order and direction of short-term and long-term equilibrium relationships.

RESULTS AND DISCUSSION

Trends in Arrivals and Prices of Chickpea

The study of trends enables us to indicate the general directions of changes in arrivals and prices in different markets over the period. The results of the least squares analysis of trends in arrivals and prices of chickpea in selected markets are presented in Table 1. The results showed that, there was an increasing trend in the prices and arrivals of chickpea in all the selected markets. The annual increase in prices of chickpea was found to be highest in Akola (Rs. 95.99 q^{-1}) whereas lowest in Aurangabad market (Rs. 84.13 q^{-1}). The increasing trend in prices varied from one market to another. The annual increase in price observed in Hinganghat and Malegaon markets were Rs. 86.07 q^{-1} and Rs. 90.16 q^{-1}, respectively.

In Hinganghat market, the market arrival was highest and was found to increase every year by 10904 qtls. In Malegaon market, there was an increasing trend in arrival by 679.15 q. every year. In Akola and Aurangabad markets, the annual increase in the arrivals of chickpea was observed 44.18 q. and 21.65 q., respectively. Increasing trend in prices of all the selected markets are observed because of increase in general price level and increasing demand for chickpea in the study area. Increasing trend in arrivals in all the selected markets may be due to increased production of chickpea by increase in area under production, demand of crop and technological advancement in irrigation facility.

Seasonality in Arrivals and Prices of Chickpea

The study of seasonal variations is considered to be important as a guide for the producer to sell their products in the market at appropriate time to get better prices and for the consumer to plan their purchase according to demand at the right time. Table 2 revealed that in Aurangabad and Hinganghat markets, the seasonal price variations of chickpea were low during the month of March. In Malegaon market it was low during the month of February and Akola market during the month of May. The seasonal indices of price were highest in the month of November in Aurangabad and Hinganghat markets, whereas it was highest in the month of September in Akola market and in October in Malegaon market. Table 3 showed the existence of seasonal variations in the arrivals of chickpea. In all the selected markets, the quantity of market arrivals was found to be more in the months of February to May which later decreased. In Aurangabad and Hinganghat markets, the highest market arrivals were seen during the month of March (233.1 and 263.3, respectively), whereas in Aurangabad and Hinganghat, the arrivals were found to be low in the month of December (30.3 and 11.8, respectively). In Akola market, highest arrival was observed during the month of

Table 1. Price and arrival trend of major chickpea wholesale markets of Maharashtra

Markets	Coefficient of Linear trend (1997-2011)	
	Change in Price (Rs/Qtl/Year)	Change in Arrival (Qtl/Year)
Akola	y = 95.997x + 1064.6	y = 530.17x + 2954.1
Aurangabad	y = 84.13x + 1031.9	y = 259.84x + 2690.4
Hinganghat	y = 86.074x + 986.97	y = 10904x - 32540
Malegaon	y = 90.166x + 1060.2	y = 679.15x + 841.63

Table 2. Seasonal indices of monthly prices of chickpea in selected markets (1997-2011)

Month	Seasonal Index – Price (%)			
	Akola	Aurangabad	Hinganghat	Malegaon
Jan	98.3	97.8	98.4	97.6
Feb	98.8	97.3	99.2	94.5
March	97.3	96.9	96.7	98.6
April	97.5	99.0	98.1	97.2
May	97.0	98.2	96.8	96.5
June	98.6	98.5	98.0	97.5
July	103.0	101.2	100.4	100.9
Aug	102.6	100.4	101.8	100.9
Sept	105.4	102.1	101.2	103.4
Oct	103.1	103.2	103.9	106.3
Nov	100.5	104.9	105.2	104.9
Dec	97.9	100.5	100.3	101.7

Table 3. Seasonal indices of monthly arrivals of chickpea in selected markets (1997-2011)

Month	Seasonal Index – Arrival (%)			
	Akola	Aurangabad	Hinganghat	Malegaon
Jan	38.0	41.4	12.2	55.1
Feb	399.7	183.0	126.4	95.7
March	276.7	233.1	263.3	152.5
April	181.6	206.4	254.7	166.3
May	87.4	147.4	194.3	143.0
June	51.7	89.0	132.1	115.8
July	35.7	55.4	73.6	95.2
Aug	28.2	63.0	52.8	86.3
Sept	25.1	46.3	34.8	74.1
Oct	30.8	61.5	26.5	86.0
Nov	21.4	43.2	17.5	70.4
Dec	23.7	30.3	11.8	59.6

February (399.7) and in Malegaon during the month of April (166.3). In Akola market, lowest arrivals was found in November (21.4) and in Malegaon market in January (55.1).

Seasonal indices of arrivals and prices indicated that the prices were low during high arrivals and vice versa. Hence the producers may be advised to plan their production as well as sale of the crop by storing product during high arrival period.

Seasonal Movement of Chickpea Arrival and Prices

The Intra Year Price Rise (IPR) for chickpea and the range in prices of chickpea over the next several years have important implications for producers, merchandisers, and end users of this crop. The intra year variations were worked out using the Intra Year Price Rise (IPR), the coefficient of Average Seasonal Price Variation (ASPV) and the Coefficients of Variation (CV) in the data. Table 4 showed that the Intra Year Price Rise (IPR) for chickpea was 12.49, 8.68, 8.66 and 8.26, per cent in Malegaon, Hinganghat, Akola and Aurangabad markets, respectively. The value of ASPV for Malegaon, Hinganghat, Akola and Aurangabad wholesale markets were 11.75, 8.32, 8.30 and 7.93 per cent, respectively. The intra year variations and Average Seasonal Price Variation (ASPV) in chickpea may also have important implications for decisions related to pricing annual production. The coefficients of variation for prices were 3.63, 2.82, 2.67 and 2.51 per cent in Malegaon, Hinganghat, Akola and Aurangabad markets, respectively. The coefficients of variation for arrival were 122.74, 93.46, 72.32 and 36.75 per cent in Akola, Hinganghat, Aurangabad and Malegaon market. The results establish negative relationship between the arrivals of chickpea and its price in the state.

Relationship between Price and Market Arrivals of Chickpea

To study the nature of relationship between prices and market arrivals, linear regression equation were used and results are presented in Table 5. The equation indicated that the lagged price of chickpea had a positive and significant correlation with current prices in all markets and a negative relationship with arrival in Akola market. It was observed that the lagged price of chickpea gave a high response and explains higher variation indicating that the lagged price of chickpea is an important factor in determining the current price than market arrivals. Similar finding were reported by Alemayehu and Atteri (2000) for vegetable market in Delhi.

Market Integration

To examine the market integration, it is necessary to identify the stationarity of the price data of selected markets. Augmented Dickey Fuller (ADF) test for unit root test was used for market integration and result is presented in Table 6. It showed that at level series, the ADF values are less than critical values at 1 per cent level indicating the existence of unit root which implied that the price series in all markets are non stationary. In first difference level, the ADF values higher than critical values at 1 per cent level indicated that the price series are free from the consequences of unit root. This implied that the price series are stationary at first difference level.

Johansen's Multiple Co-integration test:

Johansen's test is employed to determine the long run relationship between the price series. The test showed whether the selected chickpea markets are integrated or not. The results of the test are presented in Table 7. On the whole, our results of co-integration test indicate that chickpea prices are integrated in the long run, as two markets are co-integrated out of four markets at 1per cent level of significance. The pair-wise integration of markets of chickpea in Table 8 revealed that the integration of chickpea prices between selected pairs of markets. Akola market integrated with Malegaon market, Aurangabad market integrated with Hinganghat and Malegaon markets. Hinganghat market integrated with Aurangabad and Malegaon markets and Malegaon market integrated with all selected markets. Akola markets are geographically separated far apart from Aurangabad, though; Akola market is major market of this region. Scope of arbitrage in these markets are almost nil because of high transportation and travelling costs.

Granger Causality Tests

Granger Causality test revealed the direction of causation between the markets. The results of Pairewise Granger Causality test (Table9) were showed that there is bidirectional influence on prices of Aurangabad and Hinganghat, Malegaon and Hinganghat markets. The prices at Akola market influencing Aurangabad, Hinganghat and Malegaon markets. Price at Aurangabad market also affected by price at Malegaon market.

Table 4. Descending order of chickpea markets according to IPR, ASPV and CV

IPR (%)		ASPV (%)		CV (%)			
				Price		Arrival	
Malegaon	12.49	Malegaon	11.75	Malegaon	3.63	Akola	122.74
Hinganghat	8.68	Hinganghat	8.32	Akola	2.82	Hinganghat	93.46
Akola	8.66	Akola	8.30	Hinganghat	2.67	Aurangabad	72.32
Aurangabad	8.26	Aurangabad	7.93	Aurangabad	2.51	Malegaon	36.75

Table 5. Relationship between price and arrival of major chickpea wholesale markets of Maharashtra

Markets	Price and arrival equation			
Akola	P_t	=	$118.69 + 0.94P_{t-1} - 0.02Y_t$	$R^2 = 0.87$
			(2.29)** (34.46)*** (-0.83)	
Aurangabad	P_t	=	$82.57 + 0.94P_{t-1} + 0.03Y_t$	$R^2 = 0.90$
			(1.92)* (38.95)*** (1.42)	
Hinganghat	P_t	=	$51.01 + 0.96P_{t-1} + 0.01Y_t$	$R^2 = 0.93$
			(1.39) (44.56)*** (0.40)	
Malegaon	P_t	=	$156.65 + 0.89P_{t-1} + 0.05Y_t$	$R^2 = 0.83$
			(2.73) *** (26.14)*** (1.40)	

Figures in parentheses are t-values. ***, ** and * denote significance at less than one, five and ten per cent respectively.

Table 6. ADF test result of chickpea prices

Markets	Level series	First difference	Critical Value
Akola	-2.075762	-14.64581	-3.466994
Aurangabad	-1.502690	-12.10782	-3.467418
Hinganghat	-1.103333	-13.32715	-3.466994
Malegaon	-1.743797	-16.85138	-3.467205

*Significant at 1 % level

Table 7. Results of Multiple Co -integration Analysis of chickpea markets

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Critical Value+	Criticale Value++
None **	0.160827	72.44030	54.46	47.21
At most 1 **	0.153793	41.75604	35.65	29.68
At most 2	0.069061	12.53249	20.04	15.41
At most 3	5.29E-05	0.009265	6.65	3.76

Trace test indicates 2 cointegrating equation(s) at both 5% and 1% levels.*(**) denotes rejection of the hypothesis at the 5% (1%) level. +, + + denotes significance level at 1% and 5 % level respectively

Table 8. Pairwise Co-integration of chickpea markets

Market	Akola	Aurangabad	Hinganghat	Malegaon
Akola	1	No	No	Yes
Aurangabad	No	1	Yes	Yes
Hinganghat	No	Yes	1	Yes
Malegaon	Yes	Yes	Yes	1

Table 9. Result of Pairwise Granger Causility Test among chickpea markets

Market	Akola	Aurangabad	Hinganghat	Malegaon
Akola	1	→	→	→
Aurangabad	x	1	↔	→
Hinganghat	x	↔	1	↔
Malegaon	x	x	↔	1

↔ Bidirectional, →Unidirectional and x No causality

Table10. Results of Vector Error Correction Model of chickpea markets

Error Correction:	D (IN_AKOLA)	D (IN_AURANGABAD)	D (IN_HINGANGHAT)	D (IN_MALEGAON)
CointEq1	-0.008790	0.028555	-0.019596	0.034557
	[-0.79813]	[2.89649]	[-2.49500]	[2.68449]
D(IN_AKOLA(-1))	-0.092872	0.060272	0.148196	0.029405
	[-1.17138]	[0.84925]	[2.62094]	[0.31730]
D(IN_AKOLA(-2))	-0.104931	-0.056621	0.075529	-0.018782
	[-1.30783]	[-0.78837]	[1.31999]	[-0.20027]
D(IN_AURANGABAD(-1))	0.082083	-0.105376	0.153816	0.547155
	[0.64924]	[-0.93111]	[1.70595]	[3.70250]
D(IN_AURANGABAD(-2))	0.021651	-0.216081	-0.142053	0.194013
	[0.19197]	[-2.14032]	[-1.76611]	[1.47169]
D(IN_HINGANGHAT(-1))	0.144171	0.216452	0.017037	0.089394
	[0.94182]	[1.57963]	[0.15606]	[0.49960]
D(IN_HINGANGHAT(-2))	0.002524	-0.056291	-0.136913	-0.172023
	[0.02102]	[-0.52365]	[-1.59863]	[-1.22549]
D(IN_MALEGAON(-1))	-0.041447	0.204814	0.016110	-0.337257
	[-0.50208]	[2.77170]	[0.27364]	[-3.49519]
D(IN_MALEGAON(-2))	-0.022124	0.056391	-0.056473	-0.173394
	[-0.27715]	[0.78916]	[-0.99196]	[-1.85828]
C	0.006213	0.004243	0.005241	0.005805
	[0.96419]	[0.73571]	[1.14057]	[0.77078]

Vector Error Correction Model

The Johansen's Multiple cointegration test result deciphered that the selected chickpea markets have long run equilibrium relationship and there exists cointegration between them. Hence the Vector Error Correction Model (VECM) is employed to know the speed of adjustments among the chickpean markets for long run equilibrium. The estimates of Vector Error Correction Model (Table 10) revealed that Akola, Aurangabad Hinganghat and Malegaon markets arrived at to equilibrium in long run. The prices of chickpea in Akola markets influenced by prices at Aurangabad and Malegaon markets. The Aurangabad market is influenced by price at Hinganghat market. The price in Hinganghat market influenced by Aurangabad and Malegaon markets. Malegaon market influenced by Akola and Hinganghat markets. The results showed that short term fluctuations in chickpea prices will be observed in long run equilibrium relationship. This established the fact that markets are relatively stable in long run.

CONCLUSION

The chickpea is a very important pulse crop in India and most of the farmers produce pulses only for their own domestic consumption with little marketed surplus. The study concluded that increasing positive trend in arrivals and prices of chickpea during study periods in all the selected markets. Seasonal indices of arrivals and prices were negatively related to each other especially in peak arrival period. Hence the producers may be advised to plan their production as well as sale of the crop using price information system (like market intelligence system and market information system. The market integration showed that out of four markets, two are integrated and have a association between the prices of chickpea, thereby influencing the prices from one market to other markets. This brings scope in price stabilization in creation of a healthy competitive chickpea market environment in Maharashtra would increase the interest of producers as well as consumers.

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Popularization of Weaning Foods Developed by Department of Foods and Nutrition in Rural Areas of Parbhani District

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ABSTRACT

One hundred and twenty women having the infants of age 3-18months were randomly selected from villages, Erendeshwar and Singnapur. They were divided into four groups, 30 in each group. The study about the popularization of weaning foods was conducted into two phases. In the first phase the information about socio-economic status, education, family background and knowledge of weaning foods and nutrition. After an interview of two months, impact of study was conducted. It was found that cent per cent women were knowledge about the weaning foods and the acceptability of weaning foods was shown by 91.66 per cent. The rural women (95.83%) told that these foods can be given to infants after six months. Only 4.16 per cent said that it may be difficult to digest for infant, so it should be given after one year. The preparation of these weaning foods was perfectly known to 81.66 per cent and partially known to 18.33 per cent to rural women. All the weaning foods were liked by 90.83 per cent but RB MIX (rice flakes + puffed Bengal gram + ground nuts) was liked by 74.16per cent. Interest to popularize these weaning foods was seen amongst 90.83 per cent of rural women.

Weaning is a process by which foods other than breast milk are introduced gradually into the diet of an infant ,to complement breast milk and then to replace it progressively so as to enable the infant to get adopted for the mixed diet containing solid foods. The time at which weaning should begin is determined is the lactation performance of mother and the rate of growth and maturation of the infants. As the child grows older, a progressively great proportion of the energy and nutrients need to be met by weaning foods rather than by breast milk. Considering the limited gastric capacity of the infant, concentration of nutrients and semi -liquid consistency of the weaning foods should be decided . Ideal weaning foods must provide 300 kcal and 6-8 gm of good quality protein. (Reddy *et al* 1992).

The food chosen fair a weaning mix should be easily available locally at low cost and should be used frequently in most households. The use of traditional processing techniques like, roasting, puffing, germination and fermentation need to amplify while developing weaning foods. The processing techniques enhance the nutritive value of foods by improving the availability and digestibility of nutrients.

Several nutritionally adequate weaning mixes are being produced in developing countries and are available in the market, but the availability is in scare and are beyond the reach of the poor. Hence, there is a need to develop satisfactorily low cost nutritious weaning mixes from locally available resources. The Department of Foods and Nutrition has developed certain weaning foods with the objectives to popularize these weaning foods, to create awareness about the weaning foods among the mothers, to convince the mothers to prepare and feed the weaning foods and to find out the impact of these weaning foods among the mothers. Keeping these objectives in mind, the research study on weaning foods was undertaken.

MATERIAL AND METHODS

One hundred and twenty women having the infants of age 3-18 months were randomly selected from the villages, Erandeshwar and Singnapur . They were divided into four groups, 30 in each group. The study was conducted into two phases. In the first phase the women were educated with talks, posters and demonstration about the weaning food developed by the Department t of Foods and Nutrition. The weaning foods selected were JB MIX (Rice flakes + Puffed Bengal gram + Groundnuts) BRB Milk (Bajra + Rice flakes + Bengalgram *dal*). In a second phase, after an interview of two months, the impact of the study was seen about the use, preparation, likings and storage of these weaning d foods.

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RESULTS AND DISCUSSION

General information of the subject is presented in table 1. It is evident from the table that majority of the respondents (72.50%) belong to younger age groups (20-35 yrs) and middle age (36-50) were 27.49 per cent. With reference to education, it is observed that 52.50 per cent were illiterate. Same proportion of the respondents (16.66%) were educated to primary school and middle school respectively and 14.16 per cent were educated up to high school. Respondents from nuclear family were 81.66 per cent and 18.33per cent belong to joint family. It is observed that 68.33 per cent of respondents having 1-4 members ,18.33 per cent were having 5-8 members and 13.33per cent were having 9 and above members in the family. Major occupation of the family was agriculture (50%) followed by Government Services (16.66%), business (15%) and labour (18.33%). The annual income of 76.66 per cent respondents was up to Rs.10000 year^{-1} while 23.33 were having of Rs 20000 years^{-1}.

Table 1. Personal and socio -economic characteristics of the respondents

Variable & Category	Number	Per cent
Age (Yrs)		
Young 20-35	87	72.50
Middle 36-50	33	27.49
Education		
Illiterate	63	52.50
Primary	20	16.66
Middle	20	16.66
High School	17	14.16
Family Type		
Nuclear	98	81.66
Joint	22	18.33
Family Structure		
1-4 members	82	68.33
5-8members	22	18.33
9 and above	16	13.33
Main Family Occupation		
Agriculture	60	50.00
Govt.Services	20	16.66
Private Bussiness	18	15.00
Labour	22	18.33
Annual Income		
Up to Rs 10000 year^{-1}	92	76.66
Up to Rs 20000 years^{-1}	28	23.33

Table 3 Information regarding the infants

S.N.	Starting of breast feeding from 1st day of delivery	No.	Percent
1	Breast fed	108	90
2	Bottle fed	12	10

Table 4. Age of Introduction of semi –solid foods to infants

S. N.	Age group	No. of infants	Percent
1	3-6months	63	52.50
2	7-9months	46	38.33
3	After one year	9	7.50
4	13-18months	2	1.66

Feeding pattern of different age groups is shown in Table 2. A decline in breast feeding practice from 72.22 to 66.66per cent and increased in partial foods was liked by 90.83 per cent, but RB MIX (prepared with rice flakes +groundnut and puffed Bengal gram) was liked by 74.16 per cent. 90.83 per cent of the respondents were interested to popularize these foods.

Table 2 Feeding pattern of infants of different age groups

S.N.	Age in Month	No. of infants		Fully Breast Fed		Partially Breast Fed	
		Frequency	Per cent	Frequency	Per cent	Frequency	Per cent
1	3-6	36	30.00	26	72.22	10	27.77
2	7-9	40	33.33	35	87.50	5	12.50
3	10-12	24	20.00	18	75.00	6	25.00
4	13-15	14	11.66	8	57.14	6	42.85
5	16-18	6	5.00	4	66.66	2	33.33

Table 5 Distribution of respondents according to knowledge about the weaning foods

S. N.	Variable and category	Frequency	Per cent
1	Knowledge of weaning foods before study	Nil	Nil
2	Knowledge of weaning foods after study	120	100
3	Acceptability of weaning foods		
	i. Accepted	110	91.66
	ii. Not accepted	10	8.33
4	Age of introducing weaning foods		
	i. After 6 months	11	95.83
	ii. After one year	55	4.16
5	1.Storage of weaning foods		
	i. In air tight container	11	98.33
	ii. In dabba	82	1.66
6	Preparation of weaning foods		
	i. Perfectly known	98	81.66
	ii. partially known	22	18.33
7	Liking of weaning foods by babies		
	i. Liked	84	70.83
	ii. Not liked	36	29.17
8	Which weaning foods is liked more		
	i. WB mix (wheat +Green gram)	86	71.66
	ii. JB Mix(jower + Rajgeera seeds)	87	72.55
	iii. RB Mix (rice flakes + puffed Bengal gram + groundnut)	89	74.16
	iv. BRB mix (bajra + rice flakes+ Bengalgram dal)	80	66.66
9	Cost of weaning foods		
	i. Low cost	109	90.83
	ii. Not good	11	9.16
10	Want to popularize		
	i. Yes	109	90.83
	ii. No	11	9.16

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Coverage and Utility Perception of Farmers About Training Programmes

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ABSTRACT

The present study was carried out in Akola district of Maharashtra State. All the sub-divisions in one window system in the selected district were covered in order to evaluate the training programmes. A sample of 120 trainee farmers were selected for the present study. Findings revealed that the majority of the trainee farmers perceived that the subject matter was partially covered for both the training programmes and it is highly useful to them. Whereas training participation index for the both training programmes was found to have hundred percent. It is obvious that as the participation of the trainees farmers was hundred per cent, then the TPI was also found to be hundred percent.

Agricultural research and education is becoming advanced to a considerable extent. However, the extension machinery is still not able to cope up with this scientific advancement. A big gap still exists between the productive technologies available and its transfer to the farmers at appropriate time. This gap needs to be reduced in future at the earliest possible. Various extension functionaries are working for the welfare of the farmers and doing the work of transfer of technology for them. The transfer of technology to the farmers is of utmost importance in proper way and at appropriate time. The State Department of Agriculture is one of the important extension functionaries involved in transfer of technologies to the farmers. It conducts various training programmes for the extension functionaries and the farmers. It was, therefore, felt necessary to evaluate and analyze the different training programmes conducted by this department. The present study was, therefore, undertaken with the specific objectives to study the coverage and utility of subject matter and to appraise the effectiveness of the training programmes.

MATERIAL AND METHODS

The study was conducted in Akola district (Dr. PDKV Jurisdiction) of the State. All the sub-divisions in one window system in the selected district were covered in order to evaluate the training programmes. The Maharashtra State Department of Agriculture had organized the training programmes on different topics. Out of these, two training programmes i. e. one on IPM in Cotton and the other on Organic Farming were selected for the present study. Similarly, two batches of the trainee farmers were also selected for this study for evaluating the training effectiveness. Thus, in all 120 trainee farmers were the sample respondents for the present study. The data were collected by personally interviewing the respondents with the help of specially designed interview schedule.

RESULTS AND DISCUSSION

I. Coverage of Subject Matter

From the Table 1, it is found that, 53.34 per cent of trainee farmers indicated full coverage of subject matter

Table 1. Distribution of trainee farmers according to their perception about coverage of subject matter in the training programme

S. N.	Coverage Category	Trainee Farmers				Total(n = 120)	
		T1 (n1 = 60)		T2 (n2 = 60)		No.	Percentage
		No.	Percentage	No.	Percentage		
1.	Less covered	06	10.00	11	18.33	17	14.17
2.	Partially covered	22	36.66	35	58.33	57	47.50
3.	Fully covered	32	53.34	14	23.34	46	38.33
		60	100.00	60	100.00	120	100.00

X^2 = 10.93** (** significant at 0.01 level of significance)

T1 = Training programme on IPM in Cotton and T2 = Training programme on Organic Farming

1. Assistant Professor and 2 & 3 Associate Professor, Department of Extension Education, Dr. PDKV, Akola

taught during their training on IPM on Cotton, followed by 36.36 per cent indicating partial coverage of the subject matter and only 10.00 per cent quoted less coverage of the subject matter.

In case of training on organic farming, 58.33 per cent trainee farmers opined that the topics were partially covered, followed by 23.34 per cent of them in the category of fully covered and only 18.33 per cent appeared in the category of less covered of subject matter.

The coverage of topics in both the training programmes was found to be highly significant (X^2 = 10.93).

II. Utility Perception of Subject Matter:

The perception about the utility of the subject matter taught during the training programme is an important indicator of the effectiveness of training programme. From Table 2, it is observed that 61.66 per cent of the trainee farmers perceived that utility of subject matter of the training on IPM in cotton was high, followed by moderately useful (30.00%) and less useful (8.34%). Regarding the utility of subject matter of the training on organic farming, some changeable observations have been found. It is observed that 51.67 per cent trainee farmers perceived the training programme moderately useful, followed by the opinion highly useful by 33.33 per cent trainee farmers and only 15.00 per cent of the trainee farmers reported the training programme as less useful. The utility of the subject matter in both the training programmes was found to be highly significant (X^2 = 9.64). Similar results were reported by Desai *et.al*., (1996), Ahire *et.al*. (1999), Kaur &Talukdar (2007) and Wankhade *et.al.*, (2011).

III. Coverage and utility perception of subject matter in Training of IPM in Cotton

As regards to the practicewise coverage of subject matter in IPM training programme, it was found that the cultural practices were partially covered, as opined by 63.33 per cent of trainee farmers, whereas the use of pest resistant varieties was rated by only three per cent trainees farmers. Regarding the biological control of pest and disease, 51.67 per cent of them said that it was fully covered whereas use of plant product (neem seed extract) was not covered at all. As regard to the practice of pheromone traps, 58.33 per cent replied that it was partially covered and in case of chemical control 51.67 per cent opined that it was fully covered.

It is observed that under the topic of cultural practices, 56.67 per cent of trainee farmers said it is very useful and also use of pest resistant varieties was rated by 70.00 per cent. In biological control only 48.33 per cent said it useful, in case of use of plant product more than 50 percent i.e. 65 per cent of trainee farmers said it was useful. The use of pheromone traps 63.33 per cent expressed that it was useful.

Table 2. Distribution of trainee farmers according to their utility perception about subject matter of training programme

S. N.	Utility Category	Trainee Farmers				Total(n = 120)	
		T1 (n1 = 60)		T2 (n2 = 60)		No.	Percentage
		No.	Percentage	No.	Percentage		
1.	Less useful	05	08.34	09	15.00	14	11.67
2.	Moderately useful	18	30.00	31	51.67	49	40.83
3.	Highly useful	37	61.66	20	33.33	57	47.50
		60	100.00	60	100.00	120	100.00

X^2 = 9.64** (** significant at 0.01 level of significance)

Table 3. Coverage and utility perception of subject matter in training of IPM in Cotton

S. N.	Topics Covered	Respondents n1 = 60					
		Coverage of Subject matter			Utility of Subject matter		
		Fully covered	Partially covered	Not covered	Very Useful	Useful	Not Useful
1.	Cultural practices	18 (30.00)	38 (63.33)	04 (06.67)	34 (56.67)	24 (40.00)	02 (03.33)
2.	Use of pest resistant varieties	25 (41.67)	32 (53.33)	03 (05.00)	42 (70.00)	15 (25.00)	03 (05.00)
3.	Biological control of Pests/Diseases	31 (51.67)	24 (40.00)	05 (08.33)	26 (43.33)	29 (48.33)	05 (08.33)
4.	Use of plant products (Neem Seed Extract)	38 (63.33)	22 (36.67)	00 (00.00)	21 (35.00)	39 (65.00)	00 (00.00)
5.	Use of pheromone traps	21 (35.00)	35 (58.33)	04 (06.67)	17 (28.33)	38 (63.33)	05 (08.33)
6.	Chemical control	31 (51.67)	27 (45.00)	02 (03.33)	35 (58.33)	25 (41.67)	00 (00.00)

IV. Coverage and utility perception of subject matter in Training on Organic Farming

It is found that exactly equal per cent of trainee farmers said that it was partially covered and not covered as regards to the topic of land preparation. Under the varietal selection, 65 per cent of them said that it was partially covered. As regards to the seedrate and sowing, 51. 67 per cent of the respondents stated that it was

Table 4. Coverage and utility perception of subject matter in Training on Organic Farming

S. N.	Topics Covered	Respondents n1 = 60					
		Coverage of Subject matter			Utility of Subject matter		
		Fully covered	Partially covered	Not covered	Very Useful	Useful	Not Useful
1.	Land preparation	08 (13.33)	26 (43.33)	26 (43.33)	18 (30.00)	33 (55.00)	09 (15.00)
2.	Varietal selection	13 (21.67)	39 (65.00)	08 (13.33)	28 (46.67)	23 (38.33)	09 (15.00)
3.	Seedrate and sowing	07 (11.67)	31 (51.67)	22 (36.67)	06 (10.00)	50 (83.33)	04 (06.67)
4.	Manuring	30 (50.00)	30 (50.00)	00 (00.00)	21 (35.00)	39 (65.00)	00 (00.00)
5.	Techniques of compost preparation	15 (25.00)	45 (75.00)	00 (00.00)	14 (23.33)	46 (76.67)	00 (00.00)
6.	Weed management	23 (38.33)	33 (55.00)	04 (06.67)	05 (08.33)	52 (86.67)	00 (00.00)
7.	Selection of crop rotation	10 (16.67)	38 (63.33)	12 (20.00)	05 (08.33)	46 (76.67)	09 (15.00)
8.	IPM strategies for Plant Protection	10 (16.67)	43 (71.67)	07 (11.67)	16 (26.67)	40 (66.67)	04 (06.67)

partially covered, in manuring nearly equal percent of the respondents appeared (50 %) in both the category i.e. fully covered and partially covered the topic. Techniques of compost preparation, 75.00 per cent of the respondents said it was partially covered, in weed management, 55.00 per cent expressed partially covered the topic. In selection of crop rotation 63.33 per cent fall in partially covered category and in IPM strategies for plant protection, 71.67 said that it partially covered.

It is revealed from Table 4, that under the topic of land preparation, selection of crop rotation and varietal selection, 15.00 percent trainee farmers said that it was not useful in each case. In case of seedrate and sowing and IPM strategies for plant protection nearly equal per cent (6.67 %) said that it was not useful. For manuring and compost preparation more than 50 per cent of trainee farmers said that it was useful to them.

V. Training Participation Index, Training Utility Index, Training Effectiveness Index of Training Programmes

From Table 5, it was found that training participation index (TPI) for both the training programmes was found to have cent percent. It is obvious that as the participation of the trainees farmers was cent percent, then the TPI was also found to be cent percent. It was also observed that training utility index of the training on IPM on cotton was found to be 93.33 per cent and organic farming it was found to be 84.16 per cent. It could be concluded that the training utility index of both the trainings was found to be more than 60 percent. It meant that most of the trainees found the training course useful to them.

Table 5. Training Participation Index, Training Utility Index, Training Effectiveness Index of Training Programmes.

S.N.	Content	T1	T2	Total
1.	Training Participation Index	100.00	100.00	100.00
2.	Training Utility Index	93.33	75.00	84.16
3.	Training Effectiveness Index	93.33	75.00	84.16

The training effectiveness index of training of IPM in Cotton was found to be 93.33 per cent and training effectiveness index of training of organic farming was found to be 75.00 per cent. The training effectiveness index seems to be high in case of IPM training programme because of the efficient conduct of training programme in terms of trainees participation as well as the coverage of need based subject matter as compared to training of organic farming. Chandargi *et al.* (1989) reported that the 68.40 per cent of the trainees expressed their opinion on the training programme as very good.

It is concluded that the majority of trainee farmers perceived that the subject matter was partially covered for both the training programmes but it was highly useful to them. Whereas training participation index for the both training programmes was found to have cent per cent. It is obvious that as the participation of the trainees farmers was hundred percent then the TPI was also found to be cent per cent.

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Utility Perception Use of Information Communication Technology by Post Graduate Students

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ABSTRACT

The present study was undertaken in the year 2012 to find out the Utility perception about use of Information Communication Technology (ICT) by Post Graduate students at Post Graduate Institute, Dr. PDKV, Akola (MS) with the sample size of 120 students. It was found that majority of students 63.33 per cent had high level of Utility Perception of ICT. The relational analysis revealed that subject of specialization, academic performance, training of ICT, family income, availability of ICT gadgetry, extent of knowledge about ICT, attitudes towards ICT had positive and significant relationship with utility perception and use of ICT. Whereas, age, parent's occupation, family background did not established any significant relationship between utility perception of ICT.

Agriculture is the backbone of India's economy. Research in agriculture in our country is growing fast, in spite of all the odds and speed-breakers, but the speed of agricultural communication is very slow. Information and Communication Technology (ICT) has been one of the most ambitious field in agriculture sector. The country is having rapid computerization in different fields of agriculture i.e. from weather forecasting to production of crop. The different Information Technologies like Remote Sensing, Expert System, Database of research and Project modeling Techniques, different agricultural calculators integrated management are being extensively used after mechanization of Indian Agriculture Computerization will only support the Green Revolution by efficient management of agricultural research (Kolhe and Kamble, 2004).

Information Communication Technology tools plays an effective role in educational institute. The use of ICT in the Agricultural Universities has increased and various professional bodies are now aiming for setting ICT standards for students and teachers. This is an important aspect of preparing students for their future in a complex knowledge based world. The majority of the students use ICT tools for education and research career. ICT offers the ability to link the information held up at different agricultural institutions. It is therefore a wide range of information can be available anywhere at any time. The importance of Information and Communication Technology in education increasing day by day. The recent advances in ICT provide agriculture students a vehicle to update their knowledge in agriculture. Computers are being used extensively for research, statistical analysis, job search and updating knowledge. Considering the importance of ICT in agricultural education and research, the study was framed with the objectives to study the use of ICT by PG students and to find out the relationship between profile of PG students with their utility perception of ICT.

MATERIAL AND METHODS

The present study was confined to Post Graduate Students which was conducted at Post Graduate Institute, Dr. PDKV, Akola (MS) with the exploratory research design of social research. There are 14 Departments in Post Graduate Institute, Dr. PDKV, Akola (MS). From these Departments, the list of 60 boys and 60 girls' was obtained those were appearing in IInd year Post Graduate studies were considered for the study. Thus 120 students were constituted the sample for the study. Data were collected by personally contacting the respondents.

Utility perception of Information Communication Technology (ICT)

In the present study, utility perception defined as the perceived usefulness of ICT with regards to quality of information such as compatibility, practicability, user friendliness and easy access. Responses were taken on three-point continuum with scores as 0, 1 and 2 for not useful, moderately useful, highly useful, respectively and categorization done on the basis of equal interval method as follows.

1. P.G. Student, 2 & 5. Assistant Prof., 3. Senior Res. Asstt. and 4. Head, Department of Extension Education, Dr.PDKV, Akola(MS).

S. N.	Category	Index range
1.	Low	Upto 33.33
2.	Medium	33.34 to 66.66
3.	High	Above 66.66

The score has been used to compute the utility perception index by using following formula

$$\text{Utility perceition index} = \frac{\text{sum of utility perception score obtained}}{\text{Sum of obtained utility perception socre}} \times 100$$

Appropriate statistical method was used to calculate mean, percentage, standard deviation and correlation while analyzing data.

RESULTS AND DISCUSSION

Utility Perception about Information Communication Technology.

Detailed item wise utility perception about information communication technology perceived by students has been furnished in Table 1.

The data in Table 1 reveled that, in case of Computer Aided Instruction (CAI), Computer and CDs were highly useful for 83.33 per cent and 45.83 per cent students respectively. Whereas Internet, LCD, Digital Camera and Websites were useful for 83.33 per cent, 75.00 per cent, 58.33 per cent and 45.00 per cent, respectively while the VCDs, scanners were no useful for 50.00 per cent and 41.67 per cent students, respectively.

In case of A.V. Aids, TV was useful for 45.83 per cent respondents and films and VCD players not useful for 70.83 per cent and 60.83 per cent, respectively.

In case of Audio aids, radio, public address equipments and telephone were highly useful for 47.50 per cent, 48.33 per cent and 75.00 per cent respectively. Tape recorder and VCR were no useful for 60.00 per cent and 88.33 per cent, respectively.

In case of projected aids OHP, Opaque projector and slide projector were highly useful for 58.33 per cent, 81.67 per cent and 52.50 per cent, respectively.

In case of non projected aids, Chalk board and display boards were highly useful for 75.00 per cent, 53.33 per cent and 75.00 per cent, respectively. Model specimen, flannel graph and blow ups were useful for 62.50 per cent, 45.00 per cent and 39.17 per cent respectively and photographs were useful for 50.00 per cent respondents.

In case of printed material, sectional library, news papers, journals, books, periodicals were highly useful for majority of respondents 80.83 %, 75.00 %, 81.67 %, 85.00 % and 58.33 % , respectively. Magazines and circular letter were useful for 45.00 and 48.33 per cent, respectively and news letters were useful for 37.5 per cent respondents.

It was observed from Table 2, that majority of the students (63.33%) had high level of Utility Perception of ICT and remaining (36.67 %) students had medium level of Utility Perception of ICT. None of the students observed in low category of Utility Perception of ICT. The findings are in line with the findings of Tyagi (2011)

The probable reason for high level of utility perception of Information Communication Technology by students due to their more and more need of information and awareness about these ICT resources which easily available to them.

Relational analysis

The coefficients of correlation were worked out, to find out as to whether any relationship between personal, socio-economic, physiological and communication characteristics of respondents and their utility perception about Information Communication Technology.

The perusal of the data in Table 3 clearly indicates that, selected characteristics of respondent students, viz., subject of specialization, academic performance, training of Information Communication Technology, family income, availability of Information Communication Technology gadgetry, extent of knowledge about Information Communication Technology have positive and significant relationship at 0.01 level of probability with utility perception whereas, attitude towards Information Communication Technology found positive and significant relationship at 0.05 level of probability with utility perception. Hence, it was concluded that these characteristics were correlated with utility perception.

The plausible reasons for positive and significant relationship between these characteristics with utility perceptions of information communication technology of respondent students might be the students who had high academic performance, they required more and more information regarding their subject. Respondent students who

Table 1. Item wise distribution of respondents according to Utility Perception about Information Communication Technology.

S. N.	ICT gadgetry	No Useful		Useful		Highly Useful	
		Freq.	%	Freq.	%	Freq.	%
A.	**CAI**						
1.	Computer	-	-	20	16.67	100	83.33
2.	Digital camera	-	-	70	58.33	50	41.67
3.	CDs	15	12.50	50	41.67	55	45.83
4.	VCDs	60	50.00	30	25.00	30	25.00
5.	LCD	20	16.67	90	75.00	10	08.33
6	Internet	05	04.17	100	83.33	15	12.50
7.	Websites	00	-	70	58.33	50	41.67
8.	Scanner	50	41.67	40	33.33	30	25.00
9.	CD Writer	40	33.33	54	45.00	26	21.67
B.	**A.V. Aids**						
1.	TV	45	37.50	55	45.83	20	16.67
2.	Films	85	70.83	15	12.50	20	16.67
3.	VCD player	73	60.83	12	10.00	35	29.17
C.	**Audio Aids**						
1.	Radio	50	41.67	13	10.83	57	47.50
2.	Tape-recorder	72	60.00	16	13.33	32	26.67
3.	Public address equipments	47	39.17	15	12.50	58	48.33
4.	Telephone	-	-	30	25.00	90	75.00
5.	VCR	106	88.33	14	11.67		
D.	**Visual Aids**						
	a) Projected Aids						
1.	OHP	36	30.00	14	11.67	70	58.33
2.	Opaque Projector	00	00.00	22	18.33	98	81.67
3.	Slide projector	47	39.17	10	8.33	63	52.50
	b) Non Projected Aids						
1.	Model specimen	30	25.00	75	62.50	15	12.50
2.	Chalk board	5	4.17	25	20.83	90	75.00
3.	Flannel graphs	45	37.50	54	45.00	21	17.5
4.	Photographs	60	50.00	20	16.67	40	33.33
5.	Blowups	39	32.50	47	39.17	34	28.33
6.	White Boards	30	25.00	26	21.67	64	53.33
7.	Display boards	10	8.33	20	16.67	90	75.00
	c) Printed Material						
1.	Sectional Library	08	6.67	15	12.5	97	80.83
2.	Magazines	40	33.33	54	45.00	26	21.67
3.	News letters	45	37.5	37	30.83	38	31.67
4.	News papers	-	-	30	25.00	90	75.00
5.	Journals	-	-	22	18.33	98	81.67
6.	Books	-	-	18	15.00	102	85.00
7	Periodicals	37	30.83	13	10.83	70	58.33
8.	Circular letter	47	39.17	58	48.33	15	12.50

Table 2 . Utility perception of Information Communication Technology

Sr. No.	Categories	Index	Frequency (n=120)	Percentage
1.	Low	Up to 33.33	0	00.00
2.	Medium	33.34 to 66.66	44	36.67
3.	High	Above 66.66	76	63.33
		Total	**120**	**100.00**

Table 3. Correlation between personal and socic-economic characteristics of the respondents and their Utility Perception of Information Communication Technology.

S. N.	Variables	'r' values
1.	Age	-0.170 NS
2.	Subject of specialization	0.293 **
3.	Academic performance	0.376**
4.	Training of Information Communication Technology	0.253 **
5.	Parents occupation	-0.103 NS
6.	Family income	0.336 **
7.	Family background	-0.067 NS
8.	Availability of Information Communication Technology gadgetry	0.300 **
9.	Extent of knowledge about Information Communication Technology	0.273 **
10.	Attitude towards Information Communication Technology	0.224 *

** = Significant at 0.01 level of probability

* = Significant at 0.05 level of probability

NS = Non significant.

had high family income , high knowledge about Information Communication Technology and with large availability of Information Communication Technology gadgetry have more opportunities and potentialities to adopt variety of innovations. Due to proper training, knowledge and skills of respondents increases and also younger students had good vision about future than older age respondents. These findings are line with the finding of Panpatil (2006) and Joyathi *et.al.* (2009).

The data in Table 3 further revealed that, remaining characteristics of respondent students such as age, parent's occupation and family background did not establish significant relationship with utility perception. Hence it was concluded that these characteristics were not correlated with utility perception. The probable reasons for that younger respondent are more energetic, more educated and they work for excellence in their life and their own interest, need and eager these things matter on utility perception. These findings are in accordance with findings of Kale and Khupse (1982) and Thanaskodi (2008), Panpatil (2006) and Gore (2006), respectively.

CONCLUSION

From the findings of the study, it is concluded that maximum students had knowledge about ICT and they use ICT in their education and research. They perceived moderately utility of ICT. Training of ICT should compulsorily provide to the University PG students, as it is need for use of ICT. Most of the students use the ICT facilities in Agricultural Research Information System (ARIS) and University Library rather than Department. Hence University should concentrate on the point that the departmental facilities

should be provided to the students. It will be easy and time saving for the students therefore they will not have to pay to private cyber café or institute.

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Utilization of Information Sources and Their Credibility for Farm Information Perceived by Farmers

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ABSTRACT

The present investigation was carried out in Nagpur district of Maharashtra keeping in mind the importance of information sources in communicating improved production technology of mandarin cultivation and their credibility among the farmers. The present study revealed that majority of farmers had medium level of utilization of information sources. The agricultural input dealers were found to be main source utilized by farmers for getting farm information. The farm information communicated through television was found to be the most credible source perceived by respondents for farm information. The majority of respondents (65 %) perceived medium level of credibility of communication sources for agricultural information. The present study indicates the need to put more efforts for enhancing the credibility of information sources among the growers for agricultural information.

The role of communication is of paramount importance in transfer of latest technology from research station to the farmers. Information about improved agricultural technology can be communicated through various sources to the farmers. Out of many information sources, farmers uses few depending on the credibility of information source perceived by them.

The information sources enhances the ability of farmers to get more information about current affairs as well as information on recent agricultural technology or innovation and in turn widens the mental horizon of the farmers to accept and adopt the practices. The communication sources like television, newspaper, radio provides information on improved agricultural technology along with the experience of successful farmers which reinforces confidence in other farmers to take up similar activities or try out innovation.

The fast changing agricultural technology demands for more information to be transmitted to our increasing volume of cliental. But the farmers generally rely on few sources for acquiring need based information, as the farmers perceive a few only as credible sources of information. This information credibility is decided by the degree to which a communication source is perceived as trustworthy and competent by the growers.

Nagpur mandarin orange is one of the most important fruit of Maharashtra. The unit area of production of mandarin depends upon the adoption of improved production technology of mandarin cultivation by orange growers which is directly or indirectly related to utilization of credible sources. Hence keeping in mind the importance of information sources utilized by farmers for getting farm information and its credibility among farmers, the study was conducted.

MATERIAL AND METHODS

The present investigation was carried out in Nagpur district of Maharashtra. Two blocks namely Katol and Narkhed (five villages from each chosen block) were purposefully selected having highest area under mandarin cultivation. A sample of 100 mandarin growers was selected randomly from 10 villages of two chosen blocks and from each village 10 growers as respondents. The data were collected with the help of well structured interview schedule. Before actual investigation for data collection, the interview schedule was pre-tested.

The identified concepts for study were to know the extent of utilization of different information sources and their credibility perceived by farmers for getting the information about improved production technology of mandarin cultivation. The data were collected by personal interviewing the sample respondents. The data were checked, tabulated and analyzed with the help of frequencies, percentage, mean and standard deviation.

The extent of utilization of each identified source was measured on a three point continuum scale. The source

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'0' was given for never,'1' for sometimes and '2' for always. On the basis of the extent of utilization of various information source the respondents were categorised as high, medium and low level using mean and standard deviation. The utilization of information source were ranked based on mean percent score (MPS).

The credibility of information source for farm information as perceived by farmers was measured in terms of their extent of belief on the farm information disseminated by these sources. Information credibility was measured on three point continuum scale. The source '0' was given for not credible, '1' for partially credible and '2' for most credible. The credibility index was obtained by using the following formula. Credibility index = Total score obtained by the respondent for perceived credibility of information sources/maximum obtainable score obtained by the respondent for perceived credibility of information sources 100 .The categories of credibility were made on the basis of the credibility index as high, medium and low level using mean and standard deviation. The credibility of information source for farm information as perceived by growers were ranked based on mean percent score (MPS).

RESULTS AND DISCUSSION

The results of the present research work are presented below.

Utilization of information sources :

The table 1 indicates that 64 per cent farmers had medium level of utilization of information sources followed by 19 per cent respondents had low of utilization of information sources and 17 perc ent respondents had high of utilization of information sources.

Table 1. Distribution of the respondents on the basis of their utilization of information source

S.N.	Utilization of information sources	Respondents	
		Frequency	Percentage
1.	Low (Below 2.25)	19	19.00
2.	Medium (2.25 to 8.41)	64	64.00
3.	High (above 8.41)	17	17.00

Mean=5.33 S.D. =3.08

Credibility of information sources :

The data in Table 2 shows that 65 per cent farmers perceived medium (some) credibility of information sources for agricultural information while 16 per cent respondents reported low credibility of these resources. There were only 19 per cent respondents who perceived high credibility of these resources.

Table 2. Distribution of the respondents on the basis of credibility of information sources

S.N.	Credibilit of information sources	Respondents	
		Frequency	Percentage
1.	Low (Below 27.30)	16	16.00
2.	Medium (27.30 to 59.80)	65	65.00
3.	High (above 59.80)	19	19.00

Mean=43.55 S.D. =16.25

This clearly indicates the need to put more efforts for enhancing the credibility among the growers of these sources for agricultural information. This finding was supported by Kothikhane (2003)

Table 3. Rank of information source in relation to their utilization and their credibility for farm information perceived by farmers

S.N.	Information source	Source utilization Credibility			
		M.P.S.	Rank	M.P.S.	Rank
1	Progressive farmers	38.50	3	66.00	2
2.	Agricultural officer	23.50	5	39.00	5
3.	Village level worker	14.50	9	15.50	9
4.	Subject matter specialist	23.00	6	55.50	3
5.	Agricultural input dealers	58.50	1	45.50	4
6.	Newspaper	26.00	4	30.50	8
7.	Television	46.00	2	74.00	1
8.	Radio	19.50	7	36.50	6
9.	Agricultural magazines	15.50	8	33.00	7

The data in Table 3 reveals that agricultural input dealer was main source utilized by farmers for getting agricultural information, as it has ranked first. Majority of growers make use of television and progressive farmers for farm information which were ranked as second and third respectively among the selected sources of farm information. Also newspaper, agricultural officer, subject matter specialist were ranked as fourth, fifth, and sixth, respectively. But it was observed that information source

like radio, agricultural magazine and village level worker were less utilized by the growers for farm information.

Also it is clear from the Table 3 that the television was considered the most credible source to the respondents for collecting farm information. The progressive farmers and subject matter specialists were ranked as second and third credible source, respectively followed by agricultural input dealers, agricultural officer and radio. Least credibility has attached to agricultural magazine, newspaper and village level worker. The probable reason for low credibility of these information sources may be due to least understandibility, believability etc. The results are in conformity with finding of Phuse *et.al.* (2007)

CONCLUSION

It may be concluded that the majority of respondents (64 %) had medium level of utilization of communication sources for getting agricultural information. It is also revealed from the present study that agricultural input dealers, television and progressive farmers are mostly utilized communication sources by growers for getting agricultural information. Majority of growers (65 %) perceived medium level of credibility of these communication sources for farm information. It may be concluded that farm information communicated through television, progressive farmers and subject matter specialists were perceived to be more credible sources by orange growers for collecting agricultural information.

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Aspirations of Higher Secondary Students Learning Agriculture as a Vocational Subject

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ABSTRACT

Present study was conducted in Akola district of Maharashtra state with whole population of 153 students from six junior colleges offering agriculture as a vocational subject ,with an objective to study the socio-economic profile and aspirations of the higher secondary students studying agriculture as an vocational subject. It was concluded that respondents had higher family educational status with rural background, high annual income and good academic performance of students had an influence on aspirations of students.

Education not only trains and prepares for life, but also trains the mind, body and spirit of every individual and helps to become a competent person. Because of these reasons, traditionally education has always been at the most vulnerable position in the Indian society.The realm of education, now a days, decides the occupational pattern of an individual, thus deciding the way in which one leads his life.

In this broader educational sphere, agricultural education plays an important role in imparting specialized job related skills to agricultural graduates as they will be the managers of rural development in 21st century. The agricultural development depends upon ability to attract the talented youths to agriculture and the resource- fulness with which we train them. Today education is seem to be an important agent of development both in urban and rural areas.

Vocational education is a distinct stream, intended to prepare students for identified occupations spanning several areas of activities. These courses will ordinarily be provided after the secondary stage, but keeping the scheme flexible, they may also be made available after class VIII.

The introduction of one vocational subject along with two / three academic subjects in the first degree curriculum would provide an option to a student to develop employable skills relevant to national economy and occupational life of the local community. It is commonly agreed that education must be related to the needs and aspirations of the people.The students undergoing education by offering agriculture as a optional subject in higher secondary schools, generally come from rural background with farming as a main occupation. These students can also use their knowledge and techniques on their field. Personal interest about agricultural education may decide the use of new technologies on their own farm. It was therefore, felt necessary to study the socio-economic profile and aspirations of the higher secondary students who have opted for agriculture as an vocational subject and to study relationship of their socio-economic characteristics with their aspirations.

MATERIAL AND METHODS

The present study was carried out in six different Junior colleges from Akola district offering agriculture as vocational subject during 2010-11. Akola district was selected purposively because there were six junior colleges namely Lokmanya Tilak Rashtriya Shala,Umari, Tal.Akola, Dist. Akola, Jogeshwari High School and Junior College, Wadegaon,Tal.Balapur, Dist.Akola, Tulsabai Kawal High School and Junior College, Patur, Tal. Patur, Dist.Akola, Akot Krishi Kanishtha Mahavidyalaya, Akot,Tal. Akot, Dist. Akola, Vijayatai Deshmukh Junior College, Aalegaon, Tal. Patur, Dist. Akola. Dnyanprakash Kanishtha Mahavidyalaya, Pinjar, Tal. Barshitakli, Dist. Akola that offer Agriculture as vocational subject. In these colleges, 121 students were boys and 32 students were girls in all there were 153 students (both boys and girls) studying in selected colleges' in 12th standard and thus all the population of student's i.e.153 were selected purposively as respondents for the study.

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Table 1. Socio-economic and personal characteristics of respondents

S. N.	Attributes	Categories	(N=153)	%
1	**Caste**	Backward Categories (SC/ST/NT/VJ)	64	41.83
		Other Backward Categories (OBC)	67	43.79
		General(Open)	22	14.38
2	**Family Education**	Illiterate	00	00.00
		Pre-primary	04	02.61
		Primary	21	13.73
		Secondary	58	37.91
		Higher Secondary	36	23.53
		Graduation	29	18.95
		Post -graduation	05	03.27
3	**Annual income**	Upto Rs.50000/-	31	20.26
		Rs.50000 –100000/-	78	50.98
		Above Rs.100000/-	44	28.76
5	**Land holding**	Landless -	05	03.27
		Marginal Upto 1.00 ha	51	33.33
		Small 1.01 to 2.00 ha	27	17.65
		Semi medium 2.01 to 4.00 ha	44	28.76
		Medium 4.01 to 10.00 ha	20	13.07
		Large 10.01ha and above	06	03.92
6	**Family Size**	Small Upto 3	33	21.57
		Medium 4 to 7	114	74.51
		Big Above 7	06	03.92
7	**Family background**	Rural	110	71.90
		Urban	43	28.10
8	**Parents occupation**	Service	31	20.26
		Farming	86	56.21
		Business	21	13.73
		Dairy farming	06	03.92
		Labour	09	05.88
9	**Academic performance of students**	Distinction Above 75.00	05	03.27
		First class 60.00 to 74.99	84	54.90
		Second class 45.00 to 59.99	52	33.99
		Pass class Below 44.99	12	07.84

Aspiration is defined as the level of standards of achievement which an individual sets for oneself and which one expects to attain. For the present study, aspiration was operationally defined as the extent of earnest desire and the expectation of student attaining vocational subject with regard to education, job, self employment, economic status, profession and social status. This variable was measured by following the procedure adopted by Deshmukh (2005). Data were collected by personally contacting the respondents. Collected data were tabulated, mean and standard deviation and pearson's correlation coefficient were used to analyze the data.

RESULTS AND DISCUSSION

It was observed that (Table 1) majority of the respondents (43.79%) were belonged to other backward category (OBC).These findings found contrasting with the findings of Waman *et. al.* (2000) and Deshpande and Deshmukh (2004) who were found that majority of respondents belonged to open category. More than one third of the respondents (37.91%) family has educated up to secondary level. None of the respondent families were found illiterate. More than half of the respondents (50.98%) had annual income between Rs.50000 to 100000/-. This finding are in line with the findings reported Iswalkar (2001) and Jondhale and Wattamwar (2004). One third (33.33%) of respondents family belongs to marginal categories of land holding having upto 1.00 ha land. These findings are similar to findings of Deshmukh (2005).

Data in Table 1 revealed that nearly three forth of the respondents (74.51%) were medium family size having family members 4 to 7. Majority of the respondents (56.21%) were from farming as parental main occupation whereas (71.90%) were belonged to rural area and 54.90 per cent of the respondents had secured first class in X and XI standards. These findings are line with the results reported by Bothikar (2008).

Aspirations of Higher Secondary Student learning Agriculture as a vocational subject

The results with regards to educational aspiration, job aspiration, self employment aspiration of higher secondary students have been furnished in Table 2.

Educational aspirations

Data in Table 2 revealed that 43.14 per cent of respondents aspired to the complete their graduation in agriculture, followed by 28.10 per cent of respondents aspired to complete short term course or diploma. Whereas, 16.34 per cent of respondents aspired to complete post graduation while equal percentage of respondents aspired to complete degree course other than agriculture (04.58%) and to complete doctoral studies (04.57%) and only 03.27 per cent of the respondents had no any aspirations about education. The findings are in line with the findings of Jondhale and Wattamwar (2004) .

Job aspirations

A perusal of the data in Table 2 revealed that 20.26 per cent of the respondents aspired to secure administrative position in Government Departments, followed by 18.30 per cent of respondents aspired to secure academic position in Agricultural University. Whereas, 13.73 per cent of respondents aspired to secured job in Nationalized Bank while, 12.42 per cent of the respondents aspired to secure job in corporate sector. While, 11.11 per cent of respondents aspired to secure job in private organization, followed by 07.84 per cent of respondents had no any aspirations about job. Only 05.88 per cent of respondents aspired to secure job in Panchayat Raj Institution (PRI). Equal number of respondents (05.23%) aspired to secure administrative position in Department of Agriculture and job in voluntary organizations. The similar results were found by Shigwan (2002) and Bothikar (2008).

Self Employment aspirations

The data in Table 2 shows that 69.28 per cent of the respondents aspired to start own business, followed by 13.73 per cent of students were aspired to start own farming, whereas, only 6.54 per cent of the respondents aspired to render consultancy, service about landscaping, horticulture and pest control. While 10.46 per cent of the students were found no any aspirations about self employment. These findings without association with the findings of Shigwan (2002) and Bothikar (2008) who observed that majority of the respondents aspired to start own business.

Relation analysis

To find out relationship between aspirations of higher secondary students studying agriculture as vocational subject and the selected personal and socio-economic characteristics viz. caste, family education, annual income, land holding, family size, family background, parents occupation and academic performance of the respondents, correlation coefficients were worked out. The results have been furnished in Table 3.

Table 2. Distribution of respondents according to their aspirations

S. N.	Aspirations	(N=153)	Percentage
1	**Educational aspiration**		
	To complete doctoral studies	07	04.57
	To complete post graduation	25	16.34
	To complete undergraduate studies	66	43.14
	To complete short term course/diploma	43	28.10
	To complete a degree course other than agriculture	07	04.58
	No any aspirations about education	05	03.27
2.	**Job aspirations**		
	To secure administrative position in Government Departments	31	20.26
	To secure administrative position in Department of Agriculture	08	05.23
	To secure academic position in Agricultural Universities	28	18.30
	To secure job in private organizations	17	11.11
	To secure job in Nationalized Banks	21	13.73
	To secure job in corporate sector	19	12.42
	To secure job in Panchayat Raj Institutions	09	05.88
	To secure job in voluntary organizations	08	05.23
	No any aspirations about job	12	07.84
3.	**Self employment aspirations**		
I	**To start own business**		
	Nursery	15	09.80
	Fruit processing unit	19	12.42
	Agro service center	22	14.38
	Dealer of agricultural inputs	06	03.92
	Poultry	14	09.15
	Dairy	07	04.58
	Mushroom production	23	15.03
II	**To start own farming**		
	Irrigated horticultural crops	08	05.23
	Rainfed/Dry land horticultural crops.	05	03.27
	Field crops	08	05.23
III	**To render own consultancy**		
	Landscaping	01	00.65
	Horticulture	06	03.92
	Pest control	03	01.96
IV	**No any aspiration about self employments**	16	10.46

Table 3. Relationship between personal and socio-economic characteristics of the respondents and their aspirations

S.N.	Characteristics	Correlation coefficient 'r' values
1.	Caste	0.1637NS
2.	Family education status	0.1806 *
3.	Annual income	0.2282 **
4.	Land holding	0.0328 NS
5.	Family size	0.1124 NS
6.	Family background	0.2018*
7.	Parents occupation	0.1378 NS
8.	Academic performance of students	0.3082**

** = Significant at 0.01 level of probability

* = Significant at 0.05 level of probability

NS = Non significant

The data in the Table 3 shows that out of eight personal and socio-economic characteristics studied, only characteristics namely annual income and academic performance were found to have positive and highly significant correlation at 0.01 level of probability, where as family education status and family background could establish positive and significant correlation with the aspirations of the respondents at 0.05 level of probability. The variables such as caste, land holding, family size and parent's occupation did not show any significant association with the aspirations of the respondents.

Further findings of the study clearly indicated that respondents had higher family educational status with rural background, high annual income and good academic performance of students had an influence on aspirations of respondents

These findings are in line with Iswalkar (2001) who reported family background was positively and significantly correlated with aspirations of the respondents. Shigwan (2002) and Bothikar (2008) who stated that positive and significant correlation between academic performance of students and aspirations of students.

Further, it was found that caste, land holding, family size parents occupation did not affect aspirations of students. These findings are in accordance with the findings of Sarita (2000) who reported that all these variables are non-significant relationship with aspirations of girl's students in agricultural education

CONCLUSION

The study brought forward the aspirations of the students regarding their education, monthly earnings, profession and social aspect. Most of the students wished to complete the graduation in agriculture, to secure administrative position in Government department. This implies that the higher secondary students aspired to make career in diversified field, which is indicative of their varied interests. Their teachers, counselors and parents should try to understand their specific aspirations and guide and support them technically, as well as, morally.

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Comparative Study of Lipolytic Changes in Different Source of Shrikhand During the Storage

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ABSTRACT

The experiment was planned to study the quality of market Shrikhand vis-à-vis laboratory prepared Shrikhand and its storage life. Shrikhand samples were collected from marketed in Akola (C_1) and Amravati (C_2) cities of Maharashtra state along with preparation of Shrikhand in the laboratory (LS_3). The market samples were collected from two sources viz. organized sector manufacturers (OSM)-S_1 and vendors –S_2. The interaction of Shrikhand sources with storage temperature and storage interval influenced non significantly the changes in fat content of Shrikhand during 5 days storage at both storage temperatures. The results showed that the loss of fat during storage would depend upon initial fat levels of the samples. With regards to liberation of total free fatty acid (FFA) in term of oleic acid during storage, it was noticed that Shrikhand marketed by OSM and vendor in Akola city contained significantly more FFA over rest of Shrikhand samples and there by possibilities of earlier deterioration in Akola marketed samples. All the Shrikhand samples stored at 30 ± 2^0C showed significantly higher FFA content (4.15%) than their counter part stored at 5 ± 1^0C (3.90%). Similar trend was observed when the storage of Shrikhand samples was continued for 35 days at 5 ± 1^0C temperature. The Shrikhand sold by vendors in both cities had shown significantly more FFA (9.12 to 9.71%) on 35th day of storage while, the FFA content in rest of the samples was 8.49, 7.58 and 7.92 per cent for Akola OSM, Amravati OSM and laboratory Shrikhand, respectively.

Shrikhand is a semisoft, sweet sour, protein and fat rich indigenous fermented milk product. The keeping quality of Shrikhand depends on the method of preparation and initial microflora like, bacteria, yeast and moulds and other contaminants. Despite containing as high as about 50% sugar in Shrikhand the product is known to develop off flavour and odour under commercial condition of storage. Shrikhand is now being manufactured by organized dairies and very little information is available on the microbiological quality of Shrikhand stored under commercial conditions. The product contains less number of micro-organisms initially; it is the post manufacture contamination during storage that needs vigorous checking. The contamination results into a considerable increase in population of spoilage organisms, thereby lowering the keeping quality of the product. Shrikhand is popular throughout the state and need was felt to know the quality of Shrikhand in terms of lipolytic changes i.e. fat content which was sold in other cities of Maharashtra State

MATERIAL AND METHODS

The samples collected from the market and prepared in the laboratory were stored at room temperature (30 ± 2^0C) and at refrigeration temperature (5 ± 1^0C). The samples stored at room temperature were analysed daily till it got spoiled viz. for a period of five days, while the refrigeration samples were analysed at an interval of seven days till thirty-five days when it got spoiled. Thus following treatments were formed in the study.

A) Type of sample source

C_1S_1 - Akola organized sector manufacture (OSM), C_1S_2 - Akola vendor, C_2S_1 - Amravati organized sector manufacture (OSM), C_2S_2 - Amravati vendor, LS_3 - Laboratory

B) Storage temperature

T_1 - Room temperature (30 ± 2^0C RH 50 to70%),
T_2 - Refrigeration temperature (5 ± 1^0C RH 85%)

There were ten treatment combinations (5 sources x 2 temperature) on which the storage study was carried out in five replications at Department of Animal Husbandry and Dairy Science, Dr. PDKV, Akola and Shri. Shivaji Agriculture College, Amravati during 2007-2008.. The fat percentage of Shrikhand was determined by the method recommended by Choudhari (1959). Five grams of sample was weighed in a cup of butyrometer used for the determination of fat content of Shrikhand. To it 10ml of concentrated H_2SO_4 (Sp.gr.1.82) and 1 ml of amyl alcohol was added. Then sufficient quantity of distilled water was added in order to make up the volume. The

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rubber stopper was fixed in the butyrometer and the content of the butyrometer were mixed thoroughly. It was placed on water bath maintained at 70^0C till the sample was completely dissolved. It was centrifuged at 1400 rpm for 3-4 minutes and the reading of the fat was recorded.

Free fatty acids were determined as per the procedure given by Aggarwala and Sharma (1961) fat was extracted from 5 gm of Shrikhand by Soxhlet's method. Then 12.5 ml of 95 per cent alcohol was added in extracted fat and titrated against 0.1N NaOH solution using phenolphthalein indicator. After titration the mixture was heated to boiling in order to dissolve the free fatty acids as completely as possible. The mixture was cooled down and titrated with 0.1N NaOH until the pink colour persist after vigorous shaking. The results are expressed as percentage of Oleic acids. The formula used is a below.

$$\text{Percentage of free fatty acid (expressed as Oleic acid)} = \frac{\text{Number of ml NaOH x 2.82}}{\text{Weight of fat taken}}$$

Statistical analysis

The data collected from the study was analysed by complete factorial randomized block design (CFRBD) with three factors i.e. type of city, sources of collections and storage temperatures as per procedure described by Amble (1975).

RESULTS AND DISCUSSION

The interaction of Shrikhand source with storage temperature and storage interval influenced non significantly the changes in fat content of Shrikhand during 5 days storage at both storage temperatures. Thus the changes in fat content during storage was affected independently by the source of Shrikhand, storage temperature and storage interval. It was observed that fat content exhibited steady decrease from 4.36 to 4.15, 2.85 to 2.71, 5.96 to 5.81, 3.79 to 3.67 and 8.11 to 7.97 per cent during 5 days storage irrespective of storage temperature in Akola OSM, Akola vendor, Amravati OSM, Amravati vendor and laboratory Shrikhand, respectively.

Table 1: Effect of source and storage interval on Fat content of Shrikhand (%) at both temperature (T_1 and T_2)

Storage interval (days)	Source of Shrikhand					Days pooled
	C_1S_1	C_1S_2	C_2S_1	C_2S_2	LS_3	means
1	4.36	2.85	5.96	3.79	8.11	5.01
2	4.24	2.78	5.86	3.73	8.04	4.93
3	4.14	2.71	5.81	3.66	7.96	4.85
4	4.05	2.64	5.74	3.59	7.88	4.79
5	3.96	2.57	5.66	3.52	7.81	4.70
Pooled means (s)	4.15	2.71	5.81	3.67	7.97	
Attribute	**Source**	**Storage interval**		**Source X Storage interval**		
Results	Sig.	Sig.		NS		
SE (m)±	0.057	0.057		0.129		
CD at 5%	0.159	0.159		-		
CV %	8.37					

Table 1 (a) : Combined effect of storage temperature and storage interval on Fat content of Shrikhand (%)

Days	T_1	T_2
1	5.02	5.02
2	4.86	5.01
3	4.71	4.99
4	4.58	4.98
5	4.44	4.97
Attribute	**Storage Temp.**	**Storage Temp. X Storage interval**
Results	Sig.	Sig.
SE (m)±	0.036	0.081
CDat 5%	0.100	0.225

The trend therefore revealed that the fat content decrease in all the samples irrespective of storage temperature with the advancement of storage interval. However, the degree of fat loss in Shrikhand was more at 30 ± 2^{0}C storage temperature than at 5 ± 1^{0}C. The fresh Shrikhand contained 5.02 per cent fat irrespective of source which decreased to 4.44 and 4.97 per cent in five days storage at 30 ± 2^{0}C and 5 ± 1^{0}C temperature, respectively, the difference was significant. Thus the results demonstrated that one could control the loss of fat in Shrikhand during storage by storing at lower temperature (Table 1).

The results also indicated that storage interval and interaction between Shrikhand source x storage interval did not influence significantly on the changes in fat content of Shrikhand during storage at 5 ± 1^{0}C for 35 days. Irrespective of Shrikhand source the pooled fat content of 4.97 per cent on 5th day of storage reduced to 4.70 per cent on 35th day of storage but the difference was non significant. Hence the results showed that the loss of fat during storage would depend upon initial fat levels of the samples.

With regards to liberation of total free fatty acid (FFA) in term of oleic acid during storage, it was noticed that Shrikhand marketed by OSM and vendor in Akola city contained significantly more FFA over rest of Shrikhand samples and there by possibilities of earlier deterioration in Akola marketed samples. The initial FFA contents irrespective of storage temperature were 3.71, 3.96, 3.11, 3.52 and 3.16 per cent which increased to 5.26, 5.17, 4.15, 4.34 and 3.96 per cent on 5th day of storage in Akola OSM, Akola vendor, Amravati OSM, Amravati vendor and laboratory Shrikhand, respectively. Moreover, it was also observed that there was continuous significant increase in FFA value of Shrikhand with the advancement of storage period. The pooled initial values of 3.49 per cent reached to 4.58 per cent on 5th day of

Table 2: Effect of source and storage interval on Free fatty acid (FFA) content of Shrikhand (Oleic acid %) at both temperature (T_1 and T_2)

Storage interval (days)	Source of Shrikhand					Days pooled
	C_1S_1	C_1S_2	C_2S_1	C_2S_2	LS_3	means
1	3.71	3.96	3.11	3.52	3.16	3.49
2	4.14	4.16	3.36	3.80	3.31	3.75
3	4.57	4.53	3.60	4.00	3.50	4.04
4	4.82	4.86	3.82	4.14	3.75	4.28
5	5.26	5.17	4.15	4.34	3.96	4.58
Pooled means (s)	4.50	4.54	3.61	3.96	3.54	
Attribute	**Source**	**Storage interval**	**Source X Storage interval**			
SE (m)±	0.043	0.043	0.096			
CDat 5%	0.119	0.119	0.267			
CV %	7.55					

Table 2 (a) : Combined effect of different interaction on Free fatty acid content of Shrikhand (Oleic acid %)

	Source X storage temperature			Storage temperature X storage interval	
Source	T_1	T_2	**Days**	T_1	T_2
C_1S_1	4.78	4.22	1	3.49	3.49
C_1S_2	4.60	4.47	2	3.83	3.68
C_2S_1	3.78	3.43	3	4.18	3.90
C_2S_2	4.06	3.86	4	4.46	4.10
LS_3	3.54	3.53	5	4.80	4.35
Temp. pooled means	4.15	3.90			
Attribute	**Storage Temp.**	**Source X Storage Temp.**		**Storage Temp.X Storage interval**	
SE (m)±	0.027	0.061		0.061	
CDat 5%	0.075	0.168		0.168	

Table 2 (b). Effect of source and storage interval on Free fatty acid content of Shrikhand (Oleic acid %) at 5 ± 1⁰C

Storage interval(days)	Source of Shrikhand					Days pooled
	C_1S_1	C_1S_2	C_2S_1	C_2S_2	LS_3	means
Fresh	3.71	3.96	3.11	3.52	3.16	3.49
5th day	4.22	5.08	3.84	4.15	3.91	4.24
7	5.09	5.56	4.10	4.53	4.21	4.70
14	5.99	6.68	5.47	5.82	4.97	5.78
21	6.77	7.52	5.96	7.10	5.92	6.65
28	7.61	8.55	6.49	7.93	6.93	7.50
35	8.49	9.71	7.58	9.12	7.92	8.56
Pooled means (s)	6.79	7.60	5.92	6.90	5.99	
Attribute	**Source**	**Storage interval**	**Source X Storage interval**			
SE (m)±	0.083	0.083	0.185			
CDat 5%	0.229	0.229	0.513			
CV %	6.23					

Note : C_1S_1 - Akola OSM, C_1S_2 – Akola vendor, C_2S_1 – Amravati OSM, C_2S_2 – Amravati vendor and LS_3 – Laboratory Shrikhand, T_1 – 30 ± 2⁰C, T_2 – 5 ± 1⁰C

storage, indicating more metabolic activates of micro-organisms in Shrikhand. However, the liberation of FFA could be reduced by storing Shrikhand at lower temperature. All the Shrikhand samples stored at 30±2⁰C showed significantly higher FFA content (4.15%) than their counter part stored at 5 ± 1⁰C (3.90 %). Similar trend was observed when the storage of Shrikhand samples were continued for 35 days at 5±1⁰C temperature. The Shrikhand sold by vendors in both cities had shown significantly more FFA (9.12 to 9.71 %) on 35th day of storage while, the FFA content in rest of the samples was 8.49, 7.58 and 7.92 per cent for Akola OSM, Amravati OSM and laboratory Shrikhand respectively. Thus it can be said that vendors Shrikhand of both cities would spoiled earlier followed by Akola OSM Shrikhand and lastly Amravati OSM and laboratory Shrikhand on the basis of FFA content at the end of 35 days storage at 5 ± 1⁰C. The differences in FFA values between both city vendors as well as between Amravati OSM and laboratory Shrikhand were found non significant (Table 2).

The past workers like Sharma and Zariwala (1980), Upadhyay *et al.* (1985), Patel *et al.* (1993), Kadu *et al.* (1994) and Bobade (2000) also noticed increase in FFA content at all the storage temperatures with increase of storage period. Moreover, these authors reported that the rate of increase in FFA was faster at higher temperature than that of lower temperature.

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Effect of Different Levels of Papaya (*Carica papaya*) Pulp on Quality of Ice-cream

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ABSTARCT

The present investigation was undertaken in order to standardize the optimum acceptable level of papaya pulp that can be added to ice-cream, to study the physico-chemical characteristics of papaya pulp ice-cream and to estimate it's cost structure. It was observed that, the average fat percentage was significantly ($P<0.05$) highest in treatment group T_1 i.e. plain ice cream without addition of papaya pulp while it was found to be lowest in treatment group T_5 i.e. ice cream with addition of papaya pulp at 25 per cent level. The variation in the total solids content of ice-cream was significant ($P<0.05$). With the increase in proportion of papaya pulp the total solids content ,the protein content of ice-cream , overrun and the cost of production decreased. The total sugar content of ice-cream blended with 25 per cent papaya pulp was significantly ($P<0.01$) higher than total sugar content of ice-cream (s) blended with 10, 15 and 20 per cent papaya pulp respectively. The flavour , body and texture, colour and appearance , overall acceptability of ice-cream blended with 15 per cent papaya pulp. The colour and appearance of ice-cream was higher significantly ($P<0.01$) affected by the addition of papaya pulp up to a certain limit. The cost of production of 1 kg ice-cream in treatment T_1 was Rs.57.00. With the increase in proportion of papaya pulp the cost of production kg^{-1} of ice-cream also increased.

One notable shift in the ice-cream consumption pattern is from impulse purchase by youngsters as fun food to it's regular use as desert. With the enhancement in purchasing power of consumers, demand for fancy ice-cream(s) including ice-cream(s) fortified with different fruit pulps having pleasant flavours and colors. Fortification with different fruit pulps apart from creating novelty, also enhances the nutritive value, color, flavor, texture, consumer acceptability and demand of ice-cream in the market. Papaya pulp is abundantly available in Vidarbha region and it is a good source of minerals and vitamins. It contains 0.5 per cent proteins, 0.1 per cent fats, 9.5 per cent carbohydrates, 0.01 per cent calcium, 0.06 per cent phosphorous and 2020 IU vitamin A , 0.04 mg Vitamin B_2 ,40 mg Vitamin C and 0.2 mg nicotinic acid, 0.25 mg riboflavin (Bose and Mitra, 2002). But so far nobody has tried to use it in ice-cream. Hence, the present investigation was undertaken in order to standardize the optimum , acceptable level of papaya pulp that can be added to ice-cream, to study the physico-chemical characteristics of papaya pulp ice-cream and to estimate it's cost structure .

MATERIAL AND METHODS

The present investigation was undertaken in 2010. Fresh , clean , whole cow milk was procured from Dairy farm of College of Agriculture, Nagpur. It was strained through two fold clean, muslin cloth to remove extraneous matter and then it was subjected to electrically driven cream separator and fresh skimmed milk was obtained. The milk was analysed for it's fat, protein, SNF and total solids and protein to know it's initial composition. The milk fat content was determined by Gerber's method as described in IS : 1224 (Part-I), 1977. Milk protein content was determined by Kjeldahl's method as described in IS : 1224 (Part-I), 1977. SNF and total solids content were determined as per IS: 1479 (part-II), 1961 and BIS handbook of Food analysis. Part XI, SP:18,(1981) respectively .

Fresh , fully ripened papaya fruits were purchased from the local market. They were cleaned, skin was peeled off and cut into pieces and subsequently converted into homogenous pulp by crushing them into an electrically driven fruit processor. Then five lots of ice-cream mixtures in 1 litre lots each were prepared by adding 600 g whole milk, 200g cream, 47 g skimmed milk powder, 150 g sugar and 3 g stabilizer. Then they were pasteurized by heating them up to 68^0 C for 30 minutes with constant stirring. The pasteurized ice –cream mixtures were cooled immediately to room temperature. Then they were kept for aging at 0 to 4^0 C in refrigerator. Then the papaya pulp was added at different levels viz. zero per cent (T_o) , 10 per cent (T_2) ,15 per cent (T_3) , 20 per cent (T_4) and 25 per cent (T_5) per cent into the different lots of ice-cream mixtures just before freezing. Wooden hand operated

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domestic type ice-cream pots were used for ice-cream preparation. A cooling medium comprising ice and common salt in the proportion of 5:1 was used for freezing the ice –cream mixtures. During freezing, the ice –cream mixtures were stirred slowly with uniform revolution speed intermitantly to secure uniform ice-cream without grittiness. When it was ready, the softy was drown out and distributed in paper cups and subsequently kept for hardening at -23 ^{0} C in deep freezer for 4 hours.

The samples of ice-cream were subjected to physic-chemical analysis. The fat content of ice –cream was determined by Gerber's method as described in IS : 1224 (part-I), 1977. The protein content of ice –cream was determined by IS1: 1479 Part II (1961).The samples of ice-cream were subjected to organoleptic evaluation for overall acceptability by a panel of 5 judges by using a 9 pint hedonic scale as prescribed by Nelson and Trout (1964). For hedonic rating the score(s) for like extremely, like very much , like moderately , like slightly, neither like or dislike, dislike slightly, dislike moderately , dislike very much and dislike extremely were 9, 8, 7, 6, 5, 4, 3, 2 and 1, respectively .

The papaya pulp was also subjected to physioco-chemical analysis as per procedure by AOAC (1990) . The evaluation of ice –cream was done as per Pal and Gupta (1985). In the score card used for sensory evaluation, the points given for different attributes such as flavour, body and texture, color and appearance were 45,35 and 20, respectively. The score of 5.5 and above indicates acceptability within the score of 1 to 9. The cost of preparation of ice-cream was calculated as per prevailing rates of milk and other ingredients required for preparation of ice-cream blended with different levels of papaya pulp. The experiment was laid out in CRD with 5 treatments in 4 replications. The data obtained was analyzed statistically as per Snedechor and Cochran (1994) .

RESULTS AND DISCUSSION

Chemical composition of papaya pulp

The moisture, SNF, fat and total solids content(s) of papaya pulp were observed to be 92, 7.8, 0.2 and 8 per cent, respectively.

Fat content

It was observed that, the average fat percentage was significantly ($P<0.05$) highest in treatment group T_1 i.e. plain ice cream without addition of papaya pulp while it was found to be lowest in treatment group T_5 i.e. ice cream with addition of papaya pulp at 25 per cent level (Table 1) . This might be due to extremely lower fat content (0.2 %) of papaya pulp. This is in agreement with Amale (1980) who found that with the increase in content of orange juice there was decline in the fat percent level of ice-cream. Similar results were obtained by Gaikwad (2007) who added mango pulp in ice-cream.

Total solids content

It was observed, that the variation in the total solids content of ice-cream was significant ($P<0.05$). It was further observed that, with the increase in proportion of papaya pulp the total solids content of ice-cream decreased (Table 1). This might be due to extremely lower total solids content (8 per cent) of papaya pulp. Similar to these results Kolhe (2003) reported that with the increase in proportion of papaya pulp the total solids content of burfi decreased. The total solids content of ice-cream prepared during the present study were as per ISI specifications referred by De (1982) .

Protein content

It was observed that, with the increase in proportion of papaya pulp the protein content of ice-cream decreased. This might be due to extremely lower protein content (0.5 to 0.7 %) of papaya pulp (Table 1). The protein content of ice-cream in control group was 4.09 percent which is in ideal range (4.00 to 4.60 %) of protein in good quality ice-cream. These results are in tune with Pinto *et al.* (2004) who obtained similar results with addition of ginger juice to plain ice-cream. De (1982) stated that the according to PFA rules (1976) ice-cream should contain not less than 3.5 percent protein whereas , during the present study, the protein content in ice-cream in various treatments were above 3.5 per cent.

Total sugars

The total sugars content of ice-cream blended with 25 per cent papaya pulp was significantly ($P<0.01$) higher than total sugar content of ice-cream (s) blended with 10, 15 and 20 per cent papaya pulp, respectively (Table1). Whereas, total sugar content of plain ice-cream was lowest (22.78 %). These results are in agreement with Gaikawad (2007) who reported that, with increase in the percentage of mango pulp, there is proportionate increase in total sugar content of ice-cream.

Table 1 : Effect of varying levels of papaya pulp on various physico- chemical attributes of ice-cream.

Treatments	Parameters				
	Fat content	Total solids content	Protein content	Total sugar content	Overrun
T_1	10.03[a]	4.09[a]	4.09[a]	22.78[e]	39.46[a]
T_2	9.53[b]	3.94[b]	3.94[b]	22.84[d]	38.87[b]
T_3	9.13[c]	3.83[c]	3.83[c]	23.05[c]	38.25[c]
T_4	8.45[d]	3.75 [d]	3.75 [d]	23.55[b]	37.35[d]
T_5	8.03[e]	3.61 [e]	3.61 [e]	23.66a	37.21[e]
S.E. (m) ±	0.034	0.056	0.056	0.042	0.283
C.D.	0.103	0.196	0.196	0.127	0.854

Table 2 : Score card for sensory evaluation of ice-cream

Treatments	Parameters			
	Flavour	Body & Texture	Colour & appearance	Overall acceptability
T_1	34.86[4]	22.06[4]	11.20[4]	7.48[4]
T_2	36.79[2]	25.00[2]	13.55[2]	8.04[2]
T_3	37.42[1]	30.13[1]	15.63[1]	8.19[1]
T_4	35.88[3]	23.89[3]	11.66[3]	8.00[3]
T_5	33.70[5]	21.60[5]	8.50[5]	6.48[5]
S.E. (m)±	0.253	0.269	0.199	0.163
C.D/	0.762	0.813	0.602	0.492

Table 3: Cost of production of ice-cream Kg^{-1} (Based on cost of ingredients only)

Ingredients	Rate	Treatments									
		T_1		T_2		T_3		T_4		T_5	
		Qty (Kg)	Cost (Rs)	Qty (Kg)	Cost (Rs)	Qty (Kg)	Cost (Rs)	Qty (Kg)	Cost (Rs)	Qty (Kg)	Cost (Rs)
Milk (Rs l^{-1})	18	0.600	10.80	0.600	10.80	0.600	10.80	0.600	10.80	0.600	10.80
Cream(Rs Kg^{-1})	160	0.200	32	0.200	32	0.200	32	0.200	32	0.200	32
Papaya pulp (Rs Kg^{-1})	30	--	---	0.100	3.00	0.150	4.50	0.200	6.00	0.250	7.50
Sugar (Rs Kg^{-1})	35	0.150	5.25	0.150	5.25	0.150	5.25	0.150	5.25	0.150	5.25
SMP(Rs Kg^{-1})	200.00	0.047	9.4	0.047	9.4	0.047	9.4	0.047	9.4	0.047	9.4
Stabilizer (Rs Kg^{-1})	600.00	0.003	1.8	0.003	1.8	0.003	1.8	0.003	1.8	0.003	1.8
Total cost (Rs)			59.25		62.25		63.75		65.25		66.75
Cost kg^{-1} (Rs)			57.00		59.92		61.00		62.90		64.36

Physical properties of ice-cream

Overrun is one of the important characteristic for controlling the economics of ice-cream. If the overrun is more, the profit is more. It was observed that, the overrun of ice-cream decreased with proportionate increase in papaya pulp (Table 1). It was highest in control group i.e. plain ice-cream and lowest in ice-cream blended with 25 per cent papaya pulp. These results are not in agreement with Gaikwad (2007) who reported that, with decrease in the percentage of mango pulp, there is proportionate increase in overrun of ice-cream.

Sensory evaluation of ice -cream

Flavour

It was observed that, the flavour of ice-cream was significantly ($P<0.01$) affected by the addition of papaya pulp up to a certain limit. It was specifically noted that, the flavour of ice-cream blended with 15 per cent papaya pulp had superior flavour whereas , blending with papaya pulp beyond this level (15 %) there is decline in it's flavor (Table 2). Similarly, Gaikwad (2007) who reported that, incorporation of 10 per cent mango pulp produced ice-cream having best flavour but beyond this level there was decline in it's flavour.

Body and Texture

It was observed that, the body and texture of ice-cream was significantly ($P<0.01$) affected by the addition of papaya pulp upto a certain limit. It was specifically noted that the body and texture of ice-cream blended with 15 per cent papaya pulp was superior whereas , blending with papaya pulp beyond this level (15 %) there is decline in it's body and texture (Table 2). Similarly, Gaikwad (2007) who reported that, incorporation of 10 per cent mango pulp produced ice-cream having best body and texture but beyond this level there was decline in it's body and texture of ice-cream.

Colour and Appearance

It was observed that the colour and appearance of ice-cream was significantly ($P<0.01$) affected by the addition of papaya pulp upto a certain limit. It was specifically noted that, the colour and appearance of ice-cream blended with 15 per cent papaya pulp was superior whereas , blending with papaya pulp beyond this level (i.e. 15 %) there is decline in it's colour and appearance (Table-2). Similarly, Gaikwad (2007) who reported that incorporation of 10 per cent mango pulp produced ice-cream having best colour and appearance but beyond this level there was decline in it's colour and appearance of ice-cream.

Organoleptic evaluation of ice-cream

Organoleptic evaluation for overall acceptability of ice-cream was judged by a panel of judges and it was specifically noted that, the overall acceptability of ice-cream blended with 15 per cent papaya pulp was highest whereas , blending with papaya pulp beyond this level (15 %) there is decline in it's overall acceptability (Table 2). Similarly, Kedar (1972) reported that incorporation of 10 per cent mango pulp or 4 per cent banana powder gave highest overrun as compared to ice cream with 7 per cent mango pulp or 13 per cent banana powder.

Cost structure of ice-cream

The cost of production of 1 kg ice-cream under various treatments was calculated by considering the prevailing retail market prices for various items i.e. milk, cream, papaya pulp, sugar , skimmed milk powder and stabilizer. The cost of production of 1 kg ice-cream in treatment T_1 was Rs.57.00 (Table 3). With increase in percentage of papaya pulp, the cost of production of ice-cream also increased proportionately in various treatments and the same were Rs 59.92, 61.40 , 62.90 and 64.36 in T_2, T_3 , T_4 and T_5, respectively.

CONCLUSION

From the above investigation it is concluded that, incorporation of 15 per cent papaya pulp added neutraceuticals to ice cream, created novelty and eventually an ice cream having excellent quality, good consumer demand and acceptability

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Sensory Evaluation of Peda Prepared from Cow Milk Blended with Skim Milk Powder

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ABSTRACT

Peda was prepared from cow milk blended with skim milk powder in the Dairy Technology laboratory of Department of Animal Husbandry and Dairy Science, Dr. PDKV, Akola. Peda prepared from five different combinations of cow milk and skim milk powder i.e. 100:00(T_1), 40:60(T_2), 50:50 (T_3), 60:40(T_4) and 00: 100 (T_5) was evaluated for various sensory attributes and it was found that peda prepared from whole cow milk was superior as compare to other treatments, considering the economics and acceptable quality, peda can be prepared from 50 per cent cow milk and 50 per cent skim milk powder. The area where availability of milk or khoa is insufficient, the use of SMP is the best alternative for making peda, which not only economical but it also save energy and time required for its preparation.

Khoa is of great importance in the field of Indian Dairy Industry, since it is used as a principal base material for the preparation of variety of Indian sweets such as *Peda, Burfi, Gulabjamun, Kalakand, Kunda,* etc. These sweets have longer storage life as compared to khoa. Therefore, peda is also one of the important means of conservation of total solids. Peda is a one of most popular khoa based Indian sweetmeat the production of which exceeds than that of any other indigenous milk based sweets. During festival season, the demand of sweet including peda increases many folds and the manufacturers find it difficult to meet the same due to availability of milk, time required for khoa preparation, etc. Skimmed milk powder contains almost the same amount of proteins (26%) and carbohydrates (37%) as in the liquid form on dry basis. Skim milk is a source of lactose and casein and other nutrients. Therefore the efforts were made to use skim milk powder as alternative source for milk khoa.

MATERIAL AND METHODS

The present investigation on "Sensory evaluation of peda prepared from cow milk blended with skim milk powder" was carried out in the Department of Animal Husbandry and Dairying, Post Graduate Institute, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The experiment was planned with five different combinations of cow milk and skim milk powder i.e. 100:00(T_1), 40:60(T_2), 50:50 (T_3), 60:40(T_4) and 00: 100 (T_5).

Method of preparation of Burfi suggested by De (1980) was used with slight modification as shown in the flow chart. The standardized cow milk (4.5 % fat) and skim milk powder was concentrated to a dough stage by evaporating in iron Karahi on a gentle fire. At this stage sugar was added @ 30 per cent and mixed properly. The product was taken out and spread into a stainless steel tray and was allow to cool and cut into desirable size.

Preparation of peda (Flow Diagram)

Receiving of standardized cow milk (4.5% fat) and skim milk powder (0.5%fat)

↓

Mixing of milk and SMP as per treatment

↓

Heating with continuous stirring

↓

Viscous product with pasty consistency

↓

Addition and mixing of sugar (@30%)

↓

Heating the mixture and stirring the content (till sugar dissolved)

↓

Allowing setting

↓

Shaping to round flat peda

↓

Packing

↓

Storage

Peda was analyzed for sensory evaluation by offering the product to the team of ten judges. Modified

1, 3 and 4. PG Students and 2. Assistant Professor, Department of Animal Husbandry and Dairy Science, Dr. PDKV, Akola

100 points numeric score card of khoa as suggested by Pal and Gupta (1985) was used for judging different quality attributes of peda. Data obtained from all five treatments with five replications were statistically analyzed with completely randomized design by adopting standard method of analysis of variance (Amble, 1975).

RESULTS AND DISCUSSION

The data obtained for various attributes of sensory evaluation i.e. flavour, body and texture, colour and appearance and overall acceptability were tabulated and presented in Table 1.

Flavour : It is observed from Table 1 that, the average score obtained for flavour of peda prepared from skim milk powder blended with cow milk were 43.12, 42, 41.5, 37.5, and 35.50 for peda prepared under treatments T_1, T_2, T_3, T_4 and T_5 respectively. The highest score 43.12 was recorded by T_1 the peda prepared by this treatment seems to be significantly superior than peda from T_4 and T_5. Peda prepared from skim milk powder up to 50 per cent blending of skim milk powder also got the acceptable score. These results are in agreement with Thompkinson and De (1981) they found that the peda made from cow khoa powder had chalky and chocolate flavour. The flavour of peda for all treatments were significantly differ from each other at per cent level. It means that the SMP was affected on the flavour of peda at 10 per cent variation in combination.

Body and texture : The average scores obtained for body and texture of peda prepared from skim milk powder blended with cow milk were 33.00, 32.80, 32.22, 29.00, and 27.35 under treatment T_1, T_2, T_3, T_4 and T_5, respectively. The highest score was obtained by peda of treatment T_1 while the lowest score was recorded by treatment T_5. The results of present study were like the results reported by Thompkinson and De (1981). They observed that the peda made from cow milk khoa powder had soft texture and sticky body.

Colour and appearance: The average scores obtained for colour and appearance of peda prepared from skim milk powder blended with cow milk for T_1, T_2, T_3, T_4, and T_5 were 18.91, 18.60, 18.00,16.01and 15.00, respectively. Treatment T_1 got higher score as compared to other treatments. The colour of the whole milk was more attractiveness and the bright appearance but significant decrease was found in colour and appearance of peda. Which might be due to the heat treatment resulted in to browning of peda due to Millard and caramalization occurs in peda. Thompkinson (1981) indicated that the peda made from cow milk khoa powder showed slightly gumminess as compare to whole milk peda.

Overall acceptability: It is observed from Table 1 that, the peda prepared from T_1, T_2, T_3, T_4 and T_5 treatment were having 95.05, 93.27, 91.73, 82.31, and 77.85 score, respectively. It means that peda prepared from 100per cent cow milk khoa is superior but peda prepared from skim milk powder blending up to 50 per cent also got the score of acceptable quality. Peda with treatment T_1 has obtained highest score and significantly superior due to the flavour, body and

Table 1. Effect of on various sensory attributes of peda prepared from cow milk blended with skim milk powder. (Mean Score values of ten judges for five replications)

Treatments	Flavour (Max. 45)	Body and texture	Colour and (Max. 35)	Overall acceptability appearance (Max. 20) (Max. 100)
T_1	43.12	33.00	18.91	95.04
T_2	42.00	32.80	18.60	93.27
T_3	41.50	32.22	18.00	91.73
T_4	37.50	29.00	16.01	82.31
T_5	35.50	27.35	15.00	77.85
SE(m)±	0.03	0.02	0.0194	0.118
CD at 5%	50.112	80.0851	0.0579	0.354

Table 2. Cost of peda prepared from cow milk blended with skim milk powder (Rs/kg)

Ingredients	Rate (Rs.)	Treatments									
		T1		T2		T3		T4		T5	
		Qty in (ml or g)	Cost (Rs.)	Qty in (ml or g)	Cost (Rs.)	Qty in (ml or g)	Cost (Rs.)	Qty in (ml or g)	Cost (Rs.)	Qty in (ml or g)	Cost (Rs.)
Cow milk (Rs/lit)	24	1000.00	24.00	600.00	14.40	500.00	12.00	400.00	9.60	-	00
Skim milk powder (Rs/kg)	90	--	--	400	36.00	500	45.00	600	54.00	1000	90.00
Sugar (Rs/kg)	32	60	1.90	180	5.80	210	6.70	230	7.40	360	11.50
Miscellaneous cost (Labour, utensils etc.) @ Rs.15/hr		--	15.00	--	15.00	--	15.00	--	15.00	--	15.00
Fuel quantity in gm and charges	Cylinder cost 420/14 kg)	500	15.00	400	12.00	300	9.00	250	7.50	200	6.00
Quantity of peda obtained in gm and cost of production in Rs.	--	270	55.90	790	83.20	910	87.70	1000	93.50	1550	122.50
Total cost of production/kg peda	--	--	207.00	--	105.30	--	96.40	--	93.50	--	79.00

texture and colour and appearance. All treatments were significantly differing from each other for all sensory properties at 5 per cent level of significance; indicate that SMP contributes on sensory parameters of peda. Thompkinson and De (1981) and Mane (1994) noted that peda made from cow milk khoa powder had chalky flavour and soft body.

Economics of peda preparation:

The prevailing costs of each ingredient and services were taken into consideration and the cost of economics of preparation of peda was worked out by using the standard economics procedure as presented in Table 2.

It is observed from Table 2 that, the cost of production of peda ranges from 207.00 to 79.00 Rs. kg^{-1}. The cost of production was found Rs. 207.00, 105.30, 96.40, 93.50 and 79.00 for treatment T_1, T_2, T_3, T_4 and T_5, respectively. It is noticed that as the proportion of skim milk powder increased, the cost of production of peda was decreased. He peda prepared by using 50 per cent cow milk and 50 per cent SMP was required approximately half cost as compared to control and found acceptable on sensory attributes.

CONCLUSION

The peda from whole cow milk was superior as compared to other treatments, considering the economics and acceptable quality; peda can be prepared from 50 per cent cow milk and 50 per cent skim milk powder with in half price of control peda. The area where availability of milk or khoa is not sufficient, the use of SMP is the best alternative for making peda which is not only economical but it also save energy and time required for its preparation.

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Effect of Source, Storage Interval and Temperature on Moisture and Total Solid Content of Shrikhand

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ABSTRACT

The ten treatment combinations of Shrikhand samples i.e. five sources (C_1S_1- Akola OSM, C_1S_2-Akola vendor, C_2S_1-Amravati OSM, C_2S_2- Amravati vendor and LS_3-laboratory) and two temperatures i.e. room (30 ± 2^0C)- T_1 and refrigeration temperature (5 ± 1^0C)-T_2 were studied for proteolytic changes in five replicates. The samples stored at T_1 were analyzed daily till it get spoiled viz, for period of 5 days, while samples at T_2 were analyzed at an interval of 7 days, till 35 days when it got spoiled. The changes in moisture and TS content were influenced independently by the source of Shrikhand, storage interval and storage temperature. Laboratory Shrikhand contained significantly higher moisture (38.36%) than rest of Shrikhand samples. source of Shrikhand and storage interval had significant effect on moisture and T.S. content during continued storage at 5^0C for 35 days. The moisture and T.S. content decreased significantly with the advancement of storage period.

Fermented milk products like curd, Dahi and butter milk have acquired unique position in Indian dairies. They are well recognized for their therapeutic and nutritive value. Shrikhand is one of the fermented milk product belongs to this group. It is fermented and coagulated milk product as defined by Patel and Chakraborty (1988). A popular product in Maharashtra and Gujarat being served as sweet dish during religious and social functions. However, its popularity has been spread over across the Country due to wide distribution of the product manufactured by many famous dairies viz, Amul, Warna, Arey etc. Discussing present and future market share of indigenous milk product in India, marketing of Shrikhand by National Dairy Development Board is an example of successful large scale operation for indigenous product (Kurian, 1991) as a result with the increase in graph of the sale and market share of Shrikhand. The product contains less number of micro-organisms initially; it is the post manufacture contamination during storage that needs vigorous checking. The contamination results into a considerable increase in population of spoilage organisms, thereby lowering the keeping quality of the product. Now there is need to know the quality of Shrikhand in terms of moisture and total solids which was sold in other cities of Maharashtra State

MATERIAL AND METHODS

The Shrikhand samples collected from the market and prepared in the laboratory were stored at room temperature (30 ± 2^0C) and at refrigeration temperature (5 ± 1^0C). The samples stored at room temperature were analysed daily till it got spoiled viz. for a period of five days, while the refrigeration samples were analysed at an interval of seven days till thirty-five days when it got spoiled. Thus following treatments were formed in the study.

A) Type of sample source

C_1S_1 - Akola organized sector manufacture (OSM), C_1S_2 - Akola vendor, C_2S_1 - Amravati organized sector manufacture (OSM), C_2S_2 - Amravati vendor, LS_3 - Laboratory

B) Storage temperature

T_1 -Room temperature (30 ± 2^0C RH 50 to70%),

T_2 -Refrigeration temperature (5 ± 1^0C RH 85%)

There were ten treatment combinations (5 sources x 2 temperature) on which the storage study was carried out in five replications at Department of Animal Husbandry and Dairy Science, Dr. PDKV, Akola and Shri. Shivaji Agriculture College, Amravati during 2007-2008. The moisture content of Chakka and Shrikhand was determined using ISI (1961) method. The moisture content of the sample was determined by following formula.

$$\% \text{ Moisture} = \frac{\text{Weight of sample} - \text{Weight of residue}}{\text{Weight of sample}} \times 100$$

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The total solids content was determined as per the procedure described in Part-II of ISI:1479 (1961). The total solids content of sample was calculated by following formula.

$$\% \text{ Total solids} = \frac{\text{Weight of residue}}{\text{Weight of sample}} \times 100$$

The data collected from the study was analysed under complete factorial randomized block design (CFRBD) with three factors i.e. type of city, sources of collections and storage temperature as per procedure describe by Amble (1975).

RESULTS AND DISCUSSION

The results on changes in moisture and T.S. content of Shrikhand during storage at 30 $\pm$ 2^{0}C and 5$\pm$1^{0}C for 5 days are tabulated in Table 1, 1(a) and 1 (b). The results of continued storage at 5$\pm$1^{0}C for 35 days are shown in Table 1 (c). A perusal of Table 1 indicates that source of Shrikhand and storage interval together did not affect significantly the moisture content during storage for 5 days at 30$\pm$2^{0}C and 5$\pm$1^{0}C temperature. This means that the changes in moisture levels during storage were influenced independently by the source of Shrikhand and storage interval. The initial moisture content was 37.40, 35.11, 36.23, 34.94 and 39.15 per cent in C_1S_1, C_1S_2, C_2S_1, C_2S_2 and LS_3 Shrikhand, respectively.

The corresponding decrease in five days storage was to level of 35.86, 33.60, 35.38, 33.30 and 38.36 per cent, respectively. However, the moisture level was found significantly higher in LS_3 Shrikhand that of rest Shrikhand samples, whereas moisture content between C_1S_1 and C_2S_1 as well as between C_1S_2 and C_2S_2 did not differ significantly.

Thus the results did indicate that there was decrease in moisture content in all Shrikhand samples. But degree of decrease in moisture level from the initial content was found more (0.95 to 1.64%) in market Shrikhand against an reduction of 0.76 per cent in laboratory Shrikhand. This indicates that the loss of moisture during storage was not dependent on initial value.

This contention is confirmed from the fact that inspite of highest initial value of moisture in laboratory Shrikhand the decrease was minimum at the end of 5 days storage irrespective of storage temperature. The moisture content irrespective of source and storage temperature showed significant decreasing trend with the increase of storage interval. The initial level of 36.57 per cent was decreased to 34.47 per cent on 5th day of storage. This loss of moisture worked out to the extent of 2.1 per cent from initial value. However, Sonawane *et al.* (2007) noticed a decrease in moisture from 49.27 to 46.77 i.e. 2.5 per cent during storage. This loss in moisture appeared marginally higher than the present value. Similarly Kadu *et al.* (1994) and Bobade (2000) observed loss of moisture during storage which agrees with present trend. On the contrary, Sharma and Zariwala (1980) reported no marked charge in moisture during storage but observed earlier deterioration in Shrikhand having higher moisture. This trend do not support the present results.

Examination of Table 4 further revealed similar trend in respect of T.S. losses in Shrikhand during storage. The TS content of Shrikhand prepared by vendors in both the cities was more as compared to rest of the Shrikhand while, laboratory Shrikhand indicated lowest value for TS content and OSM occupied intermediate position. The rate of decrease in TS content from the initial value was ranging from 1.21 to 1.54 per cent in market Shrikhand while, it was negligible of 0.67 per cent in laboratory Shrikhand. Therefore the trend indicates that more deterioration with regards to quality in market Shrikhand might have taken place during storage at both the temperatures.

In general, it was observed from Table 1 (a) that loss of moisture and TS from the Shrikhand was found significantly more at 30$\pm$2^{0}C temperature than at 5$\pm$ 1^{0}C temperature. The temperature pooled values of moisture and TS were 34.81 and 61.44 per cent at 30$\pm$2^{0}C respectively. The corresponding content at 5$\pm$1^{0}C was 35.79 and 62.91 per cent, respectively. Moreover, a reference to Table 1(b) reveals that the interaction between storage interval and storage temperature was significant indicating that moisture and TS losses were significantly more at 30$\pm$2^{0}C storage temperature than that at 5$\pm$1^{0}C during all the stages of storage intervals. This trend also confirmed the earlier observation on the effect of storage temperature on moisture and total solids content in Shrikhand. The source of Shrikhand and storage interval had also shown significant effect on moisture and TS content of Shrikhand during continued storage at 5$\pm$1^{0}C for 35 days. It is evident from Table 1 (c) that moisture and TS content were decreased significantly with the advancement of storage period. The initial moisture content of 36.57 per cent irrespective of source of Shrikhand reduced to 35.38 per cent on 5th day of storage

with a further decreased to 33.92 per cent on 35th day of storage. While, the corresponding decrease in TS content was from 63.42 to 62.60 per cent and further to 54.34 per cent respectively. It was specifically observed that the TS content of all Shrikhand samples had reduced below 58 per cent on 28th day of storage and a further decrease on 35th day of storage. This means that none of the Shrikhand sample was meeting the BIS and PFA standard after 21st day of storage at 5±1^{0}C temperature and thereby they could classify as below standard Shrikhand.

Moreover, at the end of 35 days storage laboratory Shrikhand exhibited significantly higher moisture content (37.37%) with lower TS content (56.38%) over rest of Shrikhand samples. Whereas lower moisture content (32.73%) with higher TS content (59.64%) was noticed in C_2S_2 Shrikhand. This means laboratory Shrikhand was not fulfilling the minimum prescribed standard 58 per cent TS after 35 days storage, While, market Shrikhand were just touching the standards.

The results therefore clearly indicated that decrease in moisture and TS content during storage was dependent on initial values. Because, the initial content of TS in laboratory Shrikhand was less than that of market Shrikhand on account of use of lower levels of sugar. However, if this trend is looked upon from the degree of losses during storage a different picture is emerged out. In general irrespective of source of Shrikhand the loss of moisture and TS from the initial contents were to the level of 2.65 and 9.08 per cent in 35 days of storage at 5±1^{0}C respectively. However, the rate of degradation in milk constituents was lower (4.46%) in laboratory Shrikhand followed by organized sector Shrikhand (4.42 to 5.38%) and higher (5.25 to 5.87%) in vendor Shrikhand. More or less similar trend was also noticed in respect of moisture content, the losses being to the extent of 1.78 per cent in laboratory Shrikhand followed by the level of 1.72 to 2.63 per cent in OSM Shrikhand and by 2.18 to 2.21 per cent in vendors Shrikhand. As a result of this one can expect spoilage of vendors Shrikhand earlier followed by OSM Shrikhand and lastly the laboratory Shrikhand. Upadhyay *et al.* (1985) mentioned significant correlation among chemical changes and sensory evaluation, indicating spoilage of the product earlier with more degradation or loss of nutrients. These views was support our logic. On the other hand Sharma and Zariwala (1980) expressed that samples containing higher moisture were deteriorated faster. These views do not agree with our logic, as present study logic is dependent on degree of losses during storage rather than the content of moisture in the product. Moreover, the moisture content of laboratory Shrikhand was more as compared to market Shrikhand.

Table 1 (a). Combined effect of source and storage temperature on Moisture and Total Solids content of Shrikhand (%)

Source	Moisture		Total Solids	
	T_1	T_2	T_1	T_2
C_1S_1	35.49	36.22	60.27	62.16
C_1S_2	32.73	34.46	62.43	64.26
C_2S_1	35.13	35.62	61.43	63.18
C_2S_2	32.54	34.06	63.12	64.55
LS_3	38.16	38.57	59.93	60.41
Temp. pooled mean	34.81	35.79	61.44	62.91

Attribute	Moisture		Total Solids	
	Storage Temp.	Storage Temp. X Source	Storage Temp.	Storage Temp. X Source
Results	Sig.	NS	Sig.	NS
SE (m) ±	0.214	0.303	0.140	0.314
CD at 5%	0.593	-	0.388	-
CV %	4.28	2.52		

Table 1 (b). Combined effect of storage temperature and storage interval on Moisture and Total solids content of Shrikhand (%)

Days	Moisture		Total solids	
	T_1	T_2	T_1	T_2
1	36.57	36.57	63.42	63.42
2	35.24	35.80	61.80	62.98
3	34.61	35.66	61.19	62.84
4	34.07	35.53	60.70	62.72
5	33.57	35.38	60.07	62.60

Attribute	Moisture	Total Solids
	Storage Temp. x Storage Temp. Source	Storage temp. x Storage Temp. Source
Results	Sig.	Sig.
SE (m) ±	0.303	0.314
CDat 5%	0.838	0.869
CV %	4.28	2.52

Table 11. Combined effect of source and storage interval on Moisture and Total Solids (TS) content of Shrikhand (%) at both temperature (T_1 and T_2)

Storage interval	Moisture						Total solids (days)					
	Source of Shrikhand					Days pooled means	Source of Shrikhand					Days pooled means
	C_1S_1	C_1S_2	C_2S_1	C_2S_2	LS_3		C_1S_1	C_1S_2	C_2S_1	C_2S_2	LS_3	
1	37.40	35.11	36.23	34.94	39.15	36.57	62.59	64.88	63.76	65.05	60.84	63.42
2	36.18	33.83	35.56	33.50	38.51	35.52	61.37	63.62	62.56	64.09	60.29	62.39
3	35.62	33.53	35.26	33.03	38.26	35.14	60.98	63.14	62.14	63.74	60.08	62.01
4	35.21	32.97	35.01	32.69	38.11	34.80	60.77	62.73	61.73	63.37	59.95	61.71
5	34.88	32.55	34.82	32.34	37.80	34.47	60.37	62.35	61.33	62.93	59.70	61.34
Pooled mean (s)	35.86	33.60	35.38	33.30	38.36		61.22	63.34	62.30	63.84	60.17	

Attribute	Moisture			Total Solids		
	Source	Storage interval	Source X Storage interval	Source	Storage interval	Source X Storage interval
SE (m)±	0.214	0.214	0.479	0.221	0.221	0.497
CDat 5%	0.593	0.593	-	0.614	0.614	-
CV %	4.28	2.52				

Table 1 (c) : Effect of source and storage interval on Moisture and Total Solids content of Shrikhand at 5 ± 1^{0}C

Storage interval (days)	Moisture (%)						Total Solids (%)					
	Source of Shrikhand					Days pooled means	Source of Shrikhand					Days pooled means
	C_1S_1	C_1S_2	C_2S_1	C_2S_2	LS_3		C_1S_1	C_1S_2	C_2S_1	C_2S_2	LS_3	
Fresh	37.40	35.11	36.23	34.54	39.15	36.57	62.59	64.88	63.76	65.05	60.84	63.42
5th Day	35.60	34.40	35.32	33.65	38.24	35.38	61.99	63.83	62.73	64.21	60.75	62.60
7	35.53	33.94	35.27	33.59	38.21	35.31	61.34	62.84	62.47	63.83	60.01	62.10
14	34.90	33.30	34.48	33.08	37.31	34.61	60.33	60.88	60.50	61.60	57.91	60.24
21	34.69	32.89	34.34	32.69	37.19	34.36	58.79	59.28	58.75	59.79	56.53	58.63
28	34.50	32.44	34.18	32.32	37.12	34.11	56.05	57.24	56.50	57.58	54.64	56.40
35	34.25	32.08	34.27	31.98	37.02	33.92	54.36	54.81	54.32	55.40	52.82	54.34
Pooled mean (s)	34.77	32.93	34.51	32.73	37.37		58.17	59.01	58.51	59.64	56.38	

Attribute	Moisture			Total solids		
	Source	Storage interval	Source X Storage interval	Source	Storage interval	Source X Storage interval
SE (m)±	0.296	0.296	0.663	0.372	0.372	0.832
CDat 5%	0.821	0.821	-	1.029	1.029	-
CV %	4.29	3.18				

Note : C_1S_1 - Akola OSM, C_1S_2 – Akola vender, C_2S_1 – Amravati OSM, C_2S_2 – Amravati vender and LS_3 – Laboratory Shrikhand T_1 – 30 ± 2^{0}C, T_2 – 5 ± 1^{0}C

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Nutritional Evaluation of Sunflower Heads Based Complete Feed in Crossbred Calves

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ABSTRACT

The feeding value of sunflower heads (SFH) was judged in order to assess the suitability, acceptability, palatability and nutritive value of SFH straw based complete feed. Four complete feeds with 50per cent wheat straw (T_1), 50 per cent SFH straw (T_2), 30 per cent SFH + 20 per cent Subabul meal (T_3) and 25 per cent wheat straw + 25 per cent SFH straw (T_4) were formulated in which the remaining 50 per cent component was made of concentrate mixture. Digestibility of DM, CP, CF and EE were significantly higher in T_2 diet. DCP content of diets differed on account of differences in the digestibility of nutrients, being 10.42, 11.49, 11.14 and 10.66 per cent under T_1, T_2, T_3 and T_4 diets, respectively. With corresponding TDN levels of 63.75, 62.65, 61.07 and 63.22 per cent, respectively. With regards to growth performance daily gain in BW of calves was significantly more in T_2 group. Moreover the feed conversion efficiency i.e. feed nutrients resulted in body weight gain was found higher(22.51%) in 50 per cent SFH straw diet in relation to other diets, being 16.32, 21.83 and 17.23 per cent in T_1, T_3 and T_4, respectively. Feeding of 50 per centSFH straw diets established potential economic gain by reducing the feeding cost kg^{-1} body weight gain to the extent of 34 per cent as compare to diet containing 50 per cent conventional wheat straw roughage.

Feeding alone contributes 60 to 70 per cent of total expenditure, thereby having direct impact on economics of dairying. Hence there is need of judicious feeding to animals. However, it is observed that present farming system does not permit the diversification of land for forage production. Under the present rural scenario the size of land holding is decreasing sharply as a result of subdivision and fragmentation of land holding in every generation. Hence hardly 4.4 per cent of cropped area is under fodder crops (Upadhyay 2005), under these circumstances sunflower straw appears to be promising alternative source of rougage in livestock feeding. Total area under sunflower in the world is about 21.5 million ha India has the fourth largest area under sunflower (2 million ha) during 2009-2010 which accounts for 9.00 percent of world hectarage. Maharashtra ranks third in sunflower area with 0.29 million ha (Anonymous 2009) out of which 118, 108 and 20 hundred ha of land was put under sunflower in Amaravati division under Kharif, Rabi and Summer seasons, respectively, While corresponding acreage in Akola district was 25, 26, 16 hundred ha of land respectively, which worked out to 21.19, 24.07 and 80 percent of the division acreage under sunflower crop (Anonymous, 2009). It could be expected that large quantity of residual material would be available for livestock feeding. The sunflower straw (SF) contained 2 to 3 percent CP, while sunflower heads straw (SFH) had 6 to 7.5 per cent CP but because of low palatability livestock do not relish the sole sunflower straw (Madan Mohan *et al.* 1997 and Rao *et al.* 1999). It is therefore, necessary to find out suitable solution for the effective use of this straw, which presently goes as waste material. Hence efforts were made to undertake experiment on feeding of sunflower heads based complete feed in crossbreed calves.

MATERIAL AND METHODS

The present investigation was carried out at Livestock Instructional Farm of Dr Panjabrao Deshmukh Krishi Vidyapeeth, Akola. Sixteen crossbred calves were randomly selected from the herd on the basis of body weight age and divided into four groups. Four complete feeds with 50 per cent wheat straw (T_1), 50 per cent SFH straw (T_2), 30 per cent SFH + 20 per cent Subabul meal (T_3) and 25 per cent wheat straw + 25 per cent SFH straw (T_4) were formulated in which the remaining 50 per cent component was of concentrate mixture containing soybean (DOC) (20%), maize grains (25%), urea (2%) and mineral mixture (3%). The nutrient requirements of calves in terms of dry matter, DCP and TDN were computed for the individual calf as per the ICAR feeding standard (1985) on the basis of body weight. The average daily quantity of feed required under different treatments at the start of feeding trial was calculated as per feeding standards (ICAR, 1985) and computation of ration was revised every

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week on the basis body weight achieved by the calves. The daily water intake of each animal during 24 hours was recorded. The calves were offered measured quantity of clean fresh water daily in the morning and evening hours and the water consumption was recorded by measuring the left water in bucket. Body weights of the experimental animals were recorded at start of experiment and later on weekly interval. Chemical analysis of the feeds and faeces was estimated as per the procedure recommended by the AOAC (1990). Economics of feeding was calculated on the basis of daily cost of feeding and feed cost kg^{-1} weight gain and considering the rates of roughages approved by the University, purchase rates of concentrate ingredients processing charges, labour requirement electric, consumption and other miscellaneous charges. The data were analyzed statistically by applying FRBD and RBD design as per the procedure given by Snedecor and Cochran (1967) and Amble (1975).

RESULTS AND DISCUSSION

Chemical composition of feed stuffs

In the present study, four complete feeds were developed by using sunflower heads straw as source of roughages, which was compared with complete feed formulated by utilizing wheat straw as roughages source. It seems, therefore, necessary to discuss the composition of complete feeds with sunflower heads straw and subabul meal as roughages source and soybean DOC as concentrate source. In view of this the data related to proximate principles of sunflower heads straw and subabul meal, the basic ingredients of complete feeds and soybean cake are presented in Table 1 along with the composition of complete feed T_1 with 50 per cent wheat straw (WS) T_2 with 50 per cent sunflower heads straw (SFH), T_3 with 30 per cent SFH + 20 per cent SM and T_4 with 25 per cent WS + 25 per cent SFH.

CP content (6.22 % on DM basis) of sunflower heads straw appeared to be substantially higher over the established conventional straws like jowar, wheat, paddy and other dried grasses. Therefore, SFH could form good protein source in the ration of animals. The CP content of sunflower heads reported by Reddy *et. al.* (1991) and Rao *et al.* (1999) are comparable with present results.

Plane of Nutrition

Plane nutrition of calves as affected by different diets in terms of availability of digestible nutrients in reference to their recommended level was worked out. In

Table 1. Average Proximate Principles of feed stuffs (% DM basis)

S.N.	Attributes	Different CompleteFeeds				Sunflower head straw (SFH)	Subabul meal (SM)	Soybean cake solvent extracted
		T_1	T_2	T_3	T_4			
1	DM	95.25	90.30	92.37	92.45	90.50	92.0	——
2	CP	18.23	19.27	20.77	18.94	6.22	13.49	48.52
3	CF	20.62	18.80	17.81	19.06	22.63.	31.07	6.78
4	Ash	6.80	7.28	6.98	7.95.	10.66	6.97	6.52
5	EE	1.44	2.40	2.58	1.97	2.90	2.15	0.93
6	NFE	52.91	52.25	51.86	52.08	57.59	46.32	37.25

Table 2. Plane of nutrition of calves in relation to recommended level under different complete feed treatments

Treatments	Average BW (kg)	Actual intake (kg)			Recommended level (kg) (ICAR 1985)			% Excess /deficient over recommended level		
		DM	DCP	TDN	DM	DCP	TDN	DM	DCP	TDN
T_1	94.96	2.40	0.250	1.522	2.13	0.237	1.50	+12.07	+5.48	+1.4
T_2	102.07	3.02	0.351	1.900	2.29	0.255	1.63	+31.87	+37.65	16.56
T_3	104.14	2.98	0.332	1.815	2.34	0.260	1.66	27.35	+27.69	+9.04
T_4	95.96	2.42	0.258	1.528	2.15	0.240	1.51	12.578	+7.50	+0.664

view of daily DM, DCP and TDN intakes in calves under different treatments are tabulated in Table 2.

The results of foregoing pages clearly established that DCP and TDN levels of the experimental diet did show significant differences which might have reflected on intake of digestible nutrients in calves. On this background it was observed that intakes of DM, DCP TDN were higher than recommended level in all the calves. However, the rate of consumption on 50 per cent SFH straw based diet (T_2) was found more over rest of the treatments. Reddy *et al.* (1991) also reported higher intake of DCP and TDN than recommended level on SF and SFH straw based complete feed which was a reflection of higher digestibility of nutrients.

From the intake of different nutrients and excreta in the faeces, in the digestibility of different nutrients were calculated and presented in Table 3.

Table 3. Effect of feeding treatments on digestibility coefficient of different nutrients (%)

Treatments	DM	CP	CF	EE	NFE
T_1	58.79a	58.28a	57.98a	65.99b	72.94
T_2	62.98b	61.89b	58.30ab	70.21b	70.06
T_3	59.53a	57.15a	60.40b	60.55a	70.22
T_4	57.12a	56.35a	56.12a	66.23b	74.66
SE(m) ±	1.122	1.147	0.773	1.746	1.972
CD (0.05)	3.431	3.521	2.372	5.357	-
CV %	3.77	3.94	2.65	5.32	5.48

Digestibility of DM, CP, CF and EE were significantly higher in T_2 diet over rest of the diets. The digestibility values of DM were 58.79, 59.53and 57.12 percent in T_1, T_3, and T_4, respectively .The increased palatability of 50 per cent SFH straw complete feed might have resulted in higher dry matter digestibility. Reddy *et al.* (1987) reported that DM from SF straw and SM were more digestible than paddy straw. This observation gave partial support present trend. It was noted that significantly higher CP digestibility was observed on T_2 diet over rest of treatments, the values being 58.28, 61.89, 57.15 and 56.35 per cent for T_1, T_2 ,T_3 and T_4, respectively. Moreover there were not significant differences in CP digestibility between T_1, T_3, T_4 treatment indicating that the calves reared on these diets had received more or less equal amount of digestible proteins. Madan Mohan *et. al.* (1997) Rao *et. al.*, (1997) observed higher CP digestibility with feeding of complete feed containing SFH, straw over complete feed having conventional straws. These observations are in agreement with present results. A reference to EE digestibility on different complete feeds, it was noticed that significantly low EE digestibility (60.55%) was obtained on T_3 diet containing 30 per cent SFH straw + 20 per cent SM base roughage over rest of the treatments. While EE digestibility did not show significant differences between T_1, T_2 and T_4, being 65.99, 70.21 and 66.23 per cent respectively. This means that SFH straw was more digestible but blending with SM reduced EE digestibility. Madan Mohan *et al.* (1997) also found higher EE digestibility on SF based diet. In contrast Reddy *et al.* (1987) observed highest EE digestibility on 30 per cent SFH straw + 20 per cent SM based diet which do not agree with the present trend. NFE digestibility did not exhibit significant differences between treatments. NFE from SFH straw was equally digestible as that of NFE present in wheat straw. Thus in general results indicated that inclusion of SFH straw at 50 per cent level in the formulation of complete feed had no adverse effect on availability of different nutrients to calves on the other hand SFH diets provided more amount DM, CP, CF, and EE to calves in comparison to other diets.

Feed conversion efficiency

It is necessary to evaluate the different complete feeds from their feed conversion efficiency point of view. With this object the data in respect of nutrient requirements per kg gain in body weight of calves, were worked out and are presented in Table 4.

Table 4. Feed Conversion Efficiency of Different Complete feed Treatment groups

S.N.	Particulars	T_1	T_2	T_3	T_4
1	Total gain (kg)	28.25	46.35	43.06	30.25
2	Total DM intake(kg)	173.08	205.93	196.83	175.53
3	Total DCP intake(kg)	22.75	31.94	30.21	23.47
4	Total TDN intake(kg)	138.50	172.90	165.16	139.04
5	Nutrient requirements per kg gain in BW (kg)				
i	DM	6.12	4.44	4.57	5.80
ii	DCP	0.800	0.689	0.701	0.775
iii	TDN	4.90	3.73	3.83	4.59
6	Feed conversion efficiency (%)	16.32	22.51	21.83	17.23

The calves from all the treatments consumed required quantities of different nutrients, therefore it was expected that this could be converted into productive purpose like gain in BW. In reference to this, it was noted that the calves reared on 50 per cent SFH straw T_2 required minimum quantity of DM, DCP and TDN to achieved one kg gain in BW , the values being 4.44, 6.89 and 3.73 kg respectively against the corresponding the requirements of 6.12 ,0.800 and 4.90 kg, respectively under T_1 containing 50 per cent wheat straw. The calves from T_2 treatment consisting 50 per cent SFH straw required minimum amount of DM, DCP and TDN to achieve one kg gain in BW; the values being 4.44, 0.689 and 3.73 kg respectively. Gongode and Fulpagare (2004) reported feed higher conversion efficiency of 12.58 per cent on feeding the diets with cotton straw over the efficiency of 10.18 per cent under conventional feeding. These observations do support the trend on utilization of SFH non-conventional straw in the diet of growing crossbred calves.

Economics of Feeding Complete Diet

It was observed that the cost of daily feeding of the calves was more (Rs 23.00 and 24.69) in T_2 and T_3 against feeding cost of (Rs.20.18to 20.87) under T_1 and T_4. In spite of this the cost of feeding per kg BW gain was substantially lower (Rs 48.41) under T_2 and T_3 when compared to the cost of (Rs. 62.44 to 64.47) in T_1 and T_4 .Thus, the feeding of 50 per cent SFH straw diet or 30 per cent SFH + 20 per cent subabul meal diet established potential economic gain by reducing the feeding cost per kg BW gain to the extent of 34.00 per cent as compared to diet containing 50 per cent conventional wheat straw roughage.

Table 5. Economics of feeding different complete diets to calves

S.N.	Particulars	T_1	T_2	T_3	T_4
1	Feed consumed day (kg)	2.00	2.510	2.347	2.092
2	Cost of feed day (Rs)	20.18	24.69	23.00	20.87
3	Total BW gain (kg)	28.25	46.36	43.06	30.25
4	Weight gain day^{-1} BW gain	0.310	0.509	0.469	0.329
5	Feed consumption kg^{-1} BW gain	6.43	4.92	4.94	6.27
6	Cost of feed kg^{-1} BW gain(Rs)	64.87	48.41	48.42	62.44

Reddy *et al.* (1991) reported that cost of feed per kg FCM production in cows and cost of feed per gain in sheep respectively was lower on completed feed containing SFH straw as compared to conventional ration. While, Rao *et. al.* (1999) also noted cost of feeding kg^{-1} FCM production was 27.19 and 30.53 per cent less on complete diet with 15 per cent sunflower straw and 20 per cent sunflower head straw respectively compared to conventional diet. Moreover Reddy *et. al* (2004) reported lower cost of feed kg^{-1} gain in sheep by feeding complete feed with dried sunflower head roughages. These observations are supportive to present results.

CONCLUSIONS

- Sunflower heads straw (SFH) could emerge, out as an potential roughages possessing higher nutritional value . The straw contained 6 to 7 per cent CP, of which 62 per cent is digestible.
- The higher digestible coefficient associated with complete diet having 50 per cent SFH straw could possess more feeding value in terms of DCP and TDN.
- The feed conversion efficiency is more on 50 per cent SFH diet.
- The SFH straw is economical on the basis of lower feed cost required to achieve one kg in calves per kg BW gain.

It is therefore, appealed to the sunflower crop growing farmers that they should utilized the sunflower straw in the ration of animals by formulating complete feed .

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Table 1. Simple correlation among nine quantitative yield contributing

Characters	Day to 50% flowering	Days to maturity	Plant height (cm)	Number of primary branches pt^{-1}	Number of capitula plant^{-1}	Number of seeds capitulum^{-1}	100 seed weight(cm)	Oil content (%)	Seed yield plant $^{-1}$(g)
Day to 50% flowering	1	0.46*	-0.13	-0.20*	-0.12	0.10	-0.13	0.11	-0.08
Days to maturity		1	-0.05	-0.05	0.02	0.03	-0.05	0.12	-0.01
Plant height (g)			1	0.28*	0.23*	0.24*	0.15	0.01	0.21
*Number of primary branches plant^{-1}				1	0.65*	0.10	0.16	0.04	0.43*
Number of capitulas plant^{-1}					1	0.03	0.19*	0.15	0.45*
Number of seeds capitulum^{-1}						1	-0.08	0.04	0.11
100 Seed weight (g)							1	-0.17*	-0.03
Oil content (%)								1	0.27*
Seed yield plant^{-1}									**1**

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Field Efficacy Some Newer Insecticides Against Sucking Pests of Bt Cotton

Field evaluation of chemical insecticides from organophosphate, phenyl pyrol and neonicotinoid group were evaluated against sucking pests of Bt cotton at Cotton Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.) during Kharif 2010-2011. The results revealed that the aphids were effectively checked by 0.004 per cent of acetamiprid 20 SP and 0.005 per cent of thiamethoxam 25 WG and leaf hoppers by 0.11 per cent each of acephate 95 SG and 75 SP up to 10 days after treatment. Thiamethoxam 25 WG @ 0.005 per cent, diamethoate 30 EC @ 0.05 per cent and trizophos 40 EC @ 0.12 per cent were found superior against whitefly upto 7 days after treatment. Insecticidal treatments did not show deleterious effect on predators. Highest seed cotton yield and ICBR were recorded in imidacloprid 17.8 SL @ 0.008 per cent followed by acephate 95 SG @ 0.11 per cent.

Cotton is most important commercial crop known as king of fibre and commonly referred as white gold. It provides 65 per cent raw material to textile industry and contributed 1/3rd of total foreign exchange earning for India (Mayee and Rao, 2002).

Maharashtra state occupies nearly 1/3rd of the total area of India under cotton, however, cotton productivity is less (325 kg lint ha^{-1}) as compared to national average of 454 lint kg ha^{-1} (Anonymous, 2010).

The causes for low productivity can be attributed to various problems. Menace caused by the insect pests is a major one. Indiscriminate use of chemical insecticides against cotton pests, leads to development of resistance, resurgence of pests, killing of natural enemies, environmental pollution etc. It is envisaged that the information generated through this investigation would be helpful in developing the effective, economical and eco friendly management approaches for sucking pests on Bt cotton.

Field experiment was conducted at Cotton Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, during 2010-11. The experiment was laid out in randomized block design with eleven treatments and three replications. The plot size was 6.30 m x 4.20 m with row to row and plant to plant distance was 90 and 60 cm, respectively.

All agronomic practices were followed as per recommendations, except, plant protection. Seven insecticides namely, acephate 95 SG and 75 SP, imidacloprid 17.8 SL, acetamiprid 20 SP, thiamethoxam 25 WG, diamethoate 30 EC, trizophos 40 EC, fipronil 5 SC were evaluated against sucking pests viz., aphids (*Aphis gossypii*, Glover), leaf hopper (*Amrasca biguttula biguttula* Ishida), thrips (*Thrips tabaci* Lindeman) and whitely (*Bemisia tabaci* Gennadius) on Bt cotton hybrid RCH-2. The insecticidal treatment was initiated at economic threshold level of sucking pests. The ETL for sucking insect pests aphid nymphs, 10 leaf^{-1} ; leaf hopper nymphs, 2-3 leaf^{-1}; thrips, 10 leaf^{-1} and whitefly adults, 10 leaf^{-1} was consider. Spray applications were made with hand operated knapsack sprayer. Observations were recorded on randomly selected five plants from each net plot and insect pest count was taken on top, middle and bottom leaves of each selected plant. Populations of sucking pests was recorded at three, seven and ten days after each treatment. Total four sprays at 10 days interval

Table 2. Cumulative effect of various insecticidal treatments on population of predators and yield of Bt cotton after fourth spray

S.N.	Treatments	Lady bird beetle (adult and grub) /plant				Chrysopa larvae/plant				Spiders/plant				Seed Cotton Yield Kg/ha	ICBR
		3 DAT	7 DAT	10 DAT	Mean	3 DAT	7 DAT	10 DAT	Mean	3 DAT	7 DAT	10 DAT	Mean		
l	Acephate 95 SG @0.11	1.17 (1.07)*	1.17 (0.84)*	1.83 (1.34)*	1.39 (1.18)*	0.58 (1.03)**	2.50 (1.56)*	1.67 (1.47)**	1.58 (1.24)*	0.33 (0.90)**	1.17 (1.26)**	1.33 (1.15)*	0.94 (0.97)*	589.03	1:6.41
2	Acephate 95 SG@0.15	0.42 (0.64)	1.42 (1.15)	1.00 (0.94)	0.94 (0.94)	0.17 (0.80)	2.50 (1.57)	2.00 (1.55)	1.55 (1.23)	0.58 (1.04)	2.08 (1.59)	1.17 (1.05)	1.28 (1.11)	620.87	1:5.66
3	Acephate 75 SP@0.11	0.75 (0.86)	1.25 (1.11)	1.17 (1.07)	1.05 (1.02)	0.42 (0.94)	2.42 (1.55)	1.67 (1.45)	1.49 (1.21)	0.33 (0.90)	1.33 (1.35)	0.92 (0.74)	0.83 (0.89)	544.80	1:5.26
4	Acephate 75 SP@0.15	1.00 (0.99)	1.58 (1.22)	2.17 (1.43)	1.58 (1.24)	0.00 (0.71)	3.17 (1.78)	0.33 (0.91)	1.19 (1.09)	0.08 (0.76)	1.33 (1.35)	0.83 (0.88)	0.92 (0.96)	477.69	1:3.43
5	Imidacloprid 17.8 SL @0.008	0.92 (0.94)	1.25 (1.05)	2.42 (1.52)	1.52 (1.22)	0.17 (0.81)	1.67 (1.26)	0.00 (0.71)	0.58 (0.75)	0.25 (0.86)	1.67 (1.47)	1.67 (1.26)	1.19 (1.09)	750.96	1:14.13
6	Acetamiprid 20 SP @0.004	1.42 (1.14)	1.83 (1.35)	1.00 (0.99)	1.41 (1.17)	0.50 (1.00)	1.50 (1.19)	1.58 (1.44)	1.19 (1.08)	0.92 (1.18)	2.08 (1.61)	0.92 (0.94)	1.08 (1.02)	332.91	1:3.88
7	Thiamethoxam 25 WG@0.005	1.33 (1.08)	1.92 (1.37)	1.00 (0.80)	1.41 (1.18)	0.50 (0.98)	1.25 (1.09)	1.08 (1.20)	1.08 (1.02)	0.33 (0.91)	1.00 (1.21)	1.00 (0.97)	0.77 (0.88)	314.05	1:1.86
8	Dimethoate 30 EC @0.05	1.08 (0.97)	1.50 (0.99)	0.92 (0.74)	1.16 (1.02)	0.42 (0.95)	1.58 (1.22)	1.00 (1.17)	0.94 (0.96)	1.00 (1.21)	1.25 (1.32)	0.83 (0.90)	1.03 (1.01)	455.57	1:6.13
9	Trizophos 40 EC @0.12	1.50 (1.16)	1.50 (1.17)	1.00 (0.99)	1.33 (1.14)	0.17 (0.81)	0.92 (0.93)	1.08 (1.21)	0.72 (0.80)	0.67 (1.07)	1.67 (1.46)	0.75 (0.70)	1.02 (0.99)	204.03	1:0.02
10	Fipronil 5SC @0.008	2.17 (1.44)	1.33 (1.14)	1.83 (1.32)	1.77 (1.31)	0.33 (0.90)	1.75 (1.26)	0.50 (0.94)	0.86 (0.86)	0.50 (1.00)	0.75 (1.11)	0.92 (0.91)	0.72 (0.84)	337.71	1:1.33
11	Control	2.08 (1.42)	1.58 (1.25)	2.33 (1.53)	2.00 (1.41)	0.33 (0.90)	2.00 (1.28)	1.83 (1.49)	1.39 (1.13)	0.83 (1.10)	2.17 (1.63)	1.75 (1.26)	1.58 (1.25)	202.57	
	SE (m)±	0.185	0.235	0.192	0.120	0.091	0.164	0.186	0.120	0.115	0.111	0.171	0.097	38.066	
	CD(P=0.05)	-	-	-	-	-	-	-	-	-	-	-	-	113.644	
	C.V. %	30.15	35.38	28.91	17.76	17.58	21.22	26.21	20.19	20.11	13.72	30.29	16.84	15.20	

* Square root transformation, ** Square root of X + 0.05

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Influence of Intercropping, Weed Control and Fertility Management Practices on Weed Dry Matter Production in Cotton Based Systems

In Vidarbha region of Maharashtra state, cotton is grown predominantly as a rainfed crop. Cotton is a slow growing and widely spaced crop which is heavily infested with weeds in the field it is most serious problem restricting growth of cotton. Weed species of *Kharif* season have a potential of very rapid growth and thus pose a drastic competition with the crop at early stages of crop growth (Jadhav, 995). The initial slow growth of cotton offers scope for intercrops having particularly weed suppressing ability. Intercropping is a risk covering factor, stabilizes the yield of component crops with more returns per unit area even under adverse climatic condition and therefore, intercropping is more prevalent practice in rainfed farming. Among different *Kharif* intercrops which one is most effective that is to be seen. A study was therefore undertaken to see the impact of various treatments on weed growth and weed population per unit area and to find out the most profitable, resource efficient and weed suppressing cotton based system that sustains in all respects under weeded, un-weeded and changing fertility and climatic situation. Hence, this experiment was conducted.

Two years field experiment was carried out at the Agronomy Research Farm, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (MS), during *Kharif* 2007-08 and 2008-09. The experimental site was fairely levelled and uniform in topography. The soil was medium black cotton belonging to *vertisols*. It was clayey in texture and moderately alkaline in nature (p^H 8.3). As regard nutrient status, it was medium in organic carbon (0.51 %) and available potassium (239.41 kg ha^{-1}), low in available nitrogen (169.76 kg ha^{-1}) and phosphorous (28.68 kg ha^{-1}) and slightly calcarious. AKH-8828 an American *hirsutum* variety was used for experiment. The intercrops and their varieties popular among the farmers of this area were used in replacement series of experiment and adopted spacing of 45 × 10 cm for drilling and 45 × 30 cm for dibbling by reducing the recommended spacing weed control and fertility management practices etc. 60 × 30 cm and plant population of cotton (Anonymous, 2011). Treatment combinations were 36 with 12 Main plots (A) Intercropping (6) viz., I_1- Cotton + blackgram (1:1), I_2- Cotton + soybean (1:1), I_3- Cotton + pigeonpea (6: 2), I_4- Cotton + clusterbean (1:1), I_5-Cotton + cowpea (1:1), I_6- Cotton + marigold (1:1) and (B) Weed management (2) W_1- No weeding and W_2- Normal weeding at 25 and 50 days with recommended intercultural operations after sowing and three Sub plots (C) Fertilizer management (3) F_1- 75 per cent Recommended dose of fertilizer (37.5, 18.75, 18.75 kg NPK ha^{-1}) to base crop of cotton, F_2- 100 per cent Recommended dose of fertilizer (50, 25, 25 kg NPK ha^{-1}) to base crop of cotton and F_3-125 per cent Recommended dose of fertilizer (62.5, 31.25, 31.25 kg NPK ha^{-1}) to base crop of cotton. The experiment was

laid out in a split plot design with three replications and crop was sown at the spacing of 45 × 30 cm distance. The gross plot size was 6.30 m × 3.60 m, while net plot size was 5.40 m × 3.00 m and recommended dose of fertilizers of cotton was 50, 25, 25 kg NPK ha^{-1} with no fertilizers to the intercrops.

Dry matter production of weed

Data recorded on total dry matter production of weeds per sq. m area as influenced by different treatments at various stages of growth are shown in Table 1. Total dry matter production per sq. m area of weed increased progressively up to 60 DAS during 2007-08 and up to 90 DAS during 2008-09. Total dry matter production of weeds per sq. m area was greater during 2007-08 (96.26 g) as compared to the year 2008-09 (86.40 g).

Effect of intercropping

During 2007-08 at 30 DAS, intercropping of cotton + blackgram recorded significantly greater weed dry matter production over other treatments. Treatment of cotton + marigold and cotton + pigeonpea being par shown significantly higher dry matter production of weeds over the treatments of cotton + clusterbean, cotton + cowpea and cotton + soybean. At 60 DAS, cotton + marigold recorded significantly greater weed dry matter production over other treatments. Treatments of cotton + clusterbean and cotton + cowpea being par recorded significantly more weed dry matter over cotton + soybean, cotton + blackgram and cotton + pigeonpea. However, these treatments were equally effective in producing weed dry matter of weeds. At 90 DAS, treatments of cotton + cowpea and cotton + clusterbean being par shown significantly greater dry matter production of weeds over other treatments. At 120 DAS, treatments of cotton + pigeonpea and cotton + clusterbean being par recorded higher dry matter production of weeds over other treatments. Treatment of cotton + pigeonpea stood at second position followed by treatments of cotton + marigold, cotton + soybean and cotton + blackgram. At 150 DAS, treatments of cotton + clusterbean and cotton + cowpea being par recorded higher dry matter production of weeds over other treatments. Treatment of cotton + pigeonpea recorded more dry matter of weeds over the treatments of cotton + blackgram, cotton + marigold and cotton + soybean. At harvest, treatments of cotton + cowpea, cotton + marigold and cotton + blackgram being par recorded significantly higher dry matter production of weeds over other treatments. Treatments of cotton + pigeonpea and cotton + marigold being par recorded greater dry matter of weeds than cotton + soybean. During 2008-09 at 60 DAS, treatment of cotton + clusterbean recorded significantly greater dry matter production of weeds over other treatments. Treatment of cotton + marigold recorded second position as regards dry matter production of weeds followed by the treatments of cotton + pigeonpea, cotton + cowpea, cotton + soybean and cotton + blackgram. At 90 DAS, treatments of cotton + clusterbean, cotton + pigeonpea and cotton + cowpea being par resulted in production of higher dry matter of weeds over other treatments. At 120 DAS, treatment of cotton + blackgram recorded significantly higher production of weed dry matter over other treatments. Treatment of cotton + clusterbean showed second position followed by treatments of cotton + pigeonpea, cotton + cowpea, cotton + marigold and cotton + soybean. At 150 DAS, treatment of cotton + clusterbean gave significantly higher dry matter production of weeds over other treatments. Treatments of cotton + cowpea, cotton + blackgram and cotton + pigeonpea being par recorded higher dry matter production of weeds over cotton + soybean and cotton + marigold. At harvest, treatment of cotton + cowpea registered greater dry matter production of weeds over other treatments. Treatment of cotton + blackgram, cotton + pigeonpea and cotton + clusterbean being par registered significantly greater dry matter production of weeds over cotton + soybean and cotton + marigold. Increased dry matter in cotton + clusterbean and cotton + marigold might be due to vertical growth of intercrops facilitate to grow the weeds below space. While, other intercrops having spreading and horizontal growth habbit might have suppressed the weed growth (Pal *et al.*, 2005).

Effect of weed management

During 2007-08 and 2008-09 at every stage of crop growth, no weeding treatment recorded significantly higher dry matter production of weeds sq. $m.^{-1}$ area except at 90 DAS during 2008-09 as treatment differences between no weeding and normal weeding were not significant.

Effect of fertility management

Every increased dose of RDF increased weed dry matter production sq. $m.^{-1}$ area over its lower dose of RDF during both the years of experimentation and at all the dates of observation. It might be due to the utilization of nutrients applied by weeds and produced more weight of

the application of 30 kg S ha^{-1}. Similarly, the significantly highest grain and stover yield of soybean (20.38 and 25.54 q ha^{-1}) was recorded with zinc @ 3 kg ha^{-1}. The nutrient uptake was also highest in the treatment of 30 kg S ha^{-1} and 3 kg Zn ha^{-1}. Singh *et al*. 2001 also reported similar response of soybean to sulphur up to 30 kg ha^{-1}. The grain and stover yield of soybean increased with increasing levels of zinc which could be attributed to the deficient status of zinc (0.58 mg kg $^{-1}$) in the soil and therefore addition of zinc, might be useful in increasing growth hormones such as auxin, which promotes starch formation and seed maturation. Malewar *et al.*(1982) and Jadhao *et al*. (2002) also reported significant increase in dry matter and grain yield of groundnut increased significantly with increased levels of zinc in zinc deficient black soil of Maharashtra. The interaction effect between sulphur and zinc in respect of grain and straw yield of soybean was found non significant.

Table 1. Effect of sulphur and zinc on grain and straw yield of soybean

Sulphur levels (Factor A)	Yield of soybean (q ha^{-1})	
	Grain	Straw
S0 - 0 kg	15.97	22.50
S1 - 15 kg	17.67	23.06
S2 - 20 kg	19.64	25.07
S3 - 45 kg	18.20	24.56
SE (m) ±	0.48	0.47
CD at 5%	1.40	1.35
Zinc Levels (Factor B)		
Zn0 - 0 kg	15.82	22.23
Zn1 - 1 kg	17.73	23.44
Zn2 - 2 kg	18.97	23.97
Zn3 - 3 kg	20.38	25.54
SE (m) ±	0.48	0.47
CD at 5%	1.40	1.35

The highest uptake of nitrogen (116.7 kg ha^{-1}) was recorded with the application of 30 kg S ha^{-1}. The increase in the nitrogen uptake with increased levels of sulphur may be due to role of sulphur in synthesizing sulphur containing amino acids and formation of chlorophyll. The significantly highest uptake of nitrogen (123.7 kg ha^{-1}) was also recorded with the application of 3 kg Zn ha^{-1}. The interactive effect of application of sulphur @ 30 kg ha^{-1} and zinc @ 3 kg ha^{-1} was found beneficial in increasing uptake of nitrogen upto 128.60 kg ha^{-1}. Similar findings were reported by Wasmatkar *et al.* (2002) in soybean in black soils of Maharashtra with combined effect of sulphur and zinc.

Table 3. Effect of sulphur and zinc on uptake of phosphorus by soybean

Sulphur Levels (Factor A)	Phosphorus uptake (kg ha^{-1})
S0	11.1
S1	11.2
S2	12.5
S3	12.8
SE (m) ±	0.09
CD at 5%	0.27
Zinc Levels (Factor B)	
Zn0	11.0
Zn1	12.1
Zn2	12.1
Zn3	12.3
SE (m) ±	0.09
CD at 5%	0.27

Table 4. Effect of sulphur and zinc on quality of Soybean

Sulphur Levels (Factor A)	Quality	
	Oil (%)	Protein (%)
S0	17.2	35.1
S1	18.4	36.4
S2	19.2	38.0
S3	20.6	38.3
SE (m) ±	0.18	0.37
CD at 5%	0.53	1.08
Zinc Levels (Factor B)		
Zn0	18.4	34.8
Zn1	18.7	35.9
Zn2	18.9	36.0
Zn3	19.3	37.3
SE (m) ±	0.18	0.37
CD at 5%	0.53	1.08

The total uptake of phosphorus was increased with increasing levels of sulphur and zinc. The results are in the conformity with the findings of Bansal (1991) and Mujumdar, *et al*. (2001). The application of sulphur @ 30 kg ha^{-1} and zinc @ 3 kg ha^{-1} recorded significantly

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Effect of Long Term Integrated Nutrient Management on Humic Substances under Paddy-Wheat Cropping System in Vertisol

Organic matter is the central element of soil fertility, productivity and quality. It is a substance that has many desirable characteristics, which influence the soil physical, chemical and biological properties. The labile and humified organic matter will have a strong impact on soil fertility and may need to be taken in to consideration in the development of fertilizer recommendations.The microbial carbon, the unused resistant compounds from the crop residues and native organic matter in soil are classified in to different fractions of organic matter (Schnitzer and Khan, 1978). Added nitrogen increases the assimilation power of soil microbes (Alaxander, 1977). The combined use of residues and nitrogen are likely to increase the organic matter fractions differently.

The organic matter forming humus, includes the most specific humic compounds and their organo mineral derivatives. Their use is most effective for generalized characterisation of the humus status of soils (Orlov and Grishina, 1982; Orlov 1992).Optimum level of soil organic matter can be managed through combined use of farm yard manure and mineral fertilizers. Hence this investigation was taken up to evaluate the effect of long term integrated nutrient management on humic substances under paddy-wheat cropping system in Vertisol.

A long term experiment was initiated during 2000 in All India Coordinated long term fertilizer experiment at research farm, Indira Gandhi Agricultural University, Raipur (C. G.). This region is sub-humid with mean annual rainfall 1171 mm. The soil of experimental site was clay loam belongs to order *Vertisol* having, neutral pH, normal EC, medium available nitrogen and available phosphorus, whereas high available potassium.

Initial samples were collected after wheat crop in 2000 and on completion of seven cropping seasons final samples were collected after harvest of paddy in 2003 (after 7th cropping cycle) from All India Coordinated long term fertilizer experiment located at research farm, Indira Gandhi Agricultural University, Raipur (C. G.) to assess the effect of long term integrated nutrient management on humic substances under paddy-wheat cropping system in *Vertisol*. The ten treatments namely control, 50 per cent

Table 2 . Effect of long term integrated nutrient management on Fulvic acid (%) and humin + nonhumic matter (%)

Treatments	Fulvic acid (%)		Humin + nonhumic matter (%)	
	2000 Initial	2003After 7 cycle	2000Initial	2003After 7 cycle
T_1 – Control	0.058	0.064	0.607	0.620
T_2 – 50% NPK	0.064	0.071	0.625	0.642
T_3 – 100% NPK	0.069	0.086	0.635	0.662
T_4 – 150% NPK	0.072	0.114	0.642	0.685
T_5 – 100% NPK + $ZnSO_4$ @ 10 kg ha^{-1}	0.070	0.097	0.632	0.660
T_6 – 100% NP	0.069	0.077	0.615	0.637
T_7 – 100% N	0.067	0.074	0.605	0.630
T_8 – 100% NPK+FYM @ 5 ton ha^{-1} (Kharif) 100% NPK (Rabi)	0.080	0.126	0.620	0.697
T_9 – 50% NPK + BGA (Kharif) 50% NPK (Rabi)	0.071	0.104	0.625	0.670
T_{10} – 50% NPK + GM (Kharif) 50% NPK (Rabi)	0.077	0.110	0.625	0.680
	Year	Treatment	Year	Treatment
SE (m) $\pm$	0.00085	0.0019	0.0045	0.01
C.D. (5%)	0.0017	0.01	0.01	0.03

Humic acid

Humic acid content of the soil (Table 2) increased significantly with the conjunctive use of fertilizers over long-term experiment (after 7th cropping cycle).

The content of humic acid in the soil increased with increasing levels of fertilizer application from 50 to 150 per cent and the highest concentration was recorded due to addition of 100 per cent NPK + FYM @ 5 ton ha^{-1}. This may be due to the improved soil physical parameters and a conducive environment for the formation of root residue consequent to higher biomass yield, which might have produced more amount of humic acid. Higher humic acid content was recorded in 100 per cent NPK + FYM @ 5 ton ha^{-1} (T_8) followed by 50 per cent NPK + GM (T_{10}), 150 per cent NPK (T_4) and 50 per cent NPK + BGA (T_9). Similar trend was reported by Bharadwaj and Omanwar (1994) and Santhy *et al.* (2001).

According to Mitusova (1986) a general tendency towards increase in carbon content and humic acids of soils receiving manure and fertilizer application was observed. This effect is more pronounced in humic acid of heavy loam soils in which the proportion of carbon in humic acid rise by 2-3 per cent over control.

Fulvic acid

Continuous application of organic and inorganic fertilization with different levels significantly influenced on fulvic acid (Table 2).

The highest content of fulvic acid was observed in 100 per cent NPK + FYM @ 5 ton ha^{-1} (T_8) and which could be due to improved soil physical parameters due to FYM for the formation of fulvic acids in this treatment. The content of fulvic acid in the soil increased with increasing levels of fertilizer application from 50 to 150 per cent. In 150 per cent treatment addition of root residues consequent to higher biomass yield might have produced more amount of fulvic acid. Similar trend was reported by Bharadwaj and Omanwar (1994).

Humin + Non Humic matter content in soil

The amount of humin + non humic matter in soil was significantly influenced by the organic and inorganic additions over long run (Table 2).

The content of humin + non humic matter in the soil increased with increasing levels of fertilizer application from 50 to 150 per cent. The highest concentration of humin + non humic was recorded under 100 per cent NPK + FYM @ 5 ton ha^{-1} followed by 150 per cent NPK, 50 per cent NPK + GM and 50 per cent NPK + BGA which were at par with each others. The increase in humin + non humic concentration in these treatments might be due to direct addition organic matter

Georeferenced Status of Boron in Soils of Yavatmal District of Maharashtra

In India widespread deficiencies of boron are associated with specific soil properties and cropping system. Boron deficiencies are becoming increasingly important in Indian soils primarily because of decline in soil fertility, loss of soil organic matter and non-application of deficient nutrient based on soil test. Boron is essential for plants growth and it is useful in various physiological processes like transfer of sugar and nutrients from leaves to reproductive organs, increase pollination and seed development. Boron is also helpful for cell wall strength, cell division and synthesis of amino acid, proteins and nodule formation in legumes. The predominantly black swell-shrink soils occurring in Vidarbha are mostly calcareous and have higher soil pH. Although clayey, the medium textured shallow soils are most prone to deficiency of boron. The commonly grown oilseed crops like groundnut, sunflower, soybean etc. need boron and are sensitive to boron deficiency.

In this context the present study was conducted at Dept. of Soil Science and Agricultural Chemistry, Dr. PDKV, Akola, during 2012 -2013. Most of the soils in Yavatmal district are Vertisols, Inceptisols and Entisols, clay textured and formed from basalt rock. From each tehsil minimum of twenty four surface (0-20 cm) soil samples were selected based on soil pH and $CaCO_3$ for the study. The latitude, longitude and altitude of the sampling were recorded using Geographical positioning system (GPS). The pH 1:2.5 soil:water suspension was determined using pH meter. Organic carbon was determined by Walkley and Black's method (1934) of wet oxidation using diphenylamine as indicator. Calcium carbonate content was determined by rapid titration method (Piper, 1966). The available boron was determined by 0.01M $CaCl_2$ extract with Azo-methine method given by Berger and Truog (1939). Nutrient index for soils was calculated as per formula NI= [(% Low samples x 1) + (% Medium samples x 2) + (% High samples x 3)] / 100.

The soil pH in Yavatmal district (Table 1) ranged from 6.88 to 8.56 indicating neutral to moderately alkaline in reaction. The calcium carbonate varied from the 1.00 to 15.00 per cent of soil indicating calcareous nature of soils. The organic carbon content varied from 1.35 to 9.73 g kg^{-1} soil.

The available boron ranged from 0.22 to 1.78 mg kg^{-1} (Table 2). The highest boron deficiency was recorded in Arni and Yavatmal tehsils (25%) followed by Darva (20.83%) and Wani (20.83%). Shirale *et al*. (2011) reported that the $CaCl_2$-boron ranges from 0.04-0.71 mg kg^{-1} in calcareous soils of Research Farm of College of Agriculture, Nagpur. The fertility indices in Yavatmal district were medium to high and ranged from 2.00 to 2.45.

Boron deficiency may be caused due to large amount of calcium carbonate in the soils. Increase in the organic carbon content of soils generally increases the

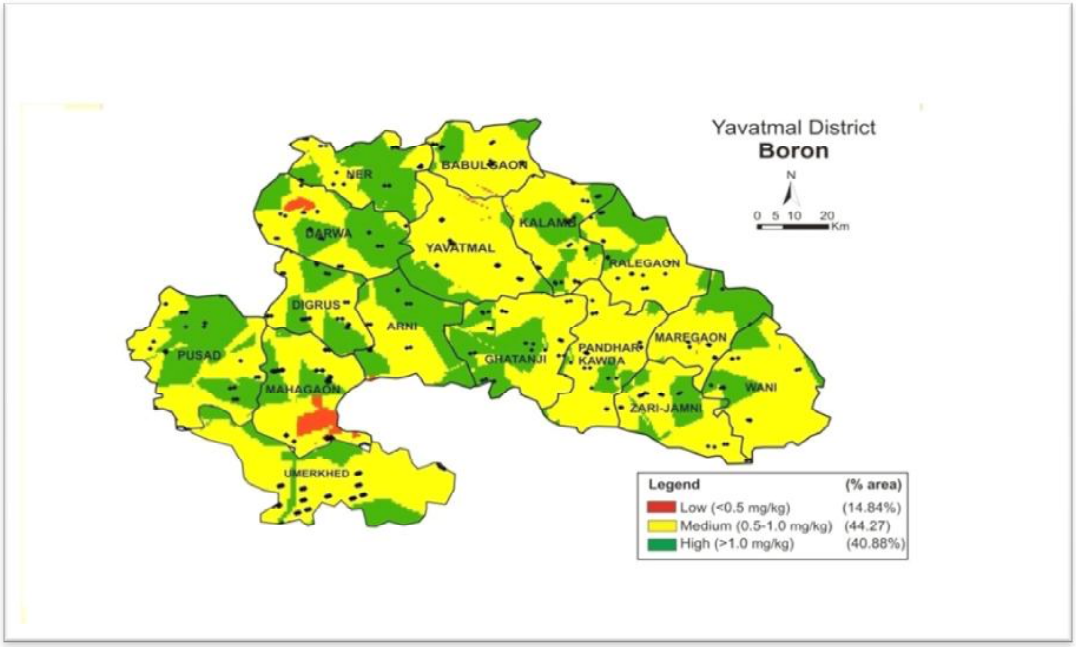

Fig. 1 Status of $CaCl_2$-boron in Yavatmal district

available boron content, although a soil of high organic matter content fixes more boron as the pH is raised. Mathur *et al.* (1964) reported factors such as pH, $CaCO_3$ which normally affect the boron availability in soils.

It is thus inferred that the soils in Yavatmal district representing swell-shrink soils of Deccan Plateau in semi-agro eco regions of Central India under intensive cultivation are showing emerging deficiency of boron and 18.48 per cent of soils showed marginal status indicating necessity of regular corrective measures. The deficiency of boron in soils of Yavatmal district was 14.84 per cent and the nutrient index was 2.26.

Therefore, it essential to use organic manures regularly to prevent the deficiency of boron and to use boron on the basis of deficiency soil application or foliar spray as per the need of crop.

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Effect of Organic and Inorganic Nutrient Sources on Nutrient Status and Fruit Yield of Sapota Orchard

Sapota (*Achras sapota* L.) is widely cultivated throughout the tropics. It is extensively grown in the moist tracts of peninsular India. Nutrient management affects both productivity and quality of produce. Like other fruit crops, in sapota too, efficient nutrient management is the key for achieving higher yield per unit area and improved produce quality (Dalal *et al*. 2004). The crop responses to fertilizer is declining, affecting the farmers profitability and sustainability of agriculture. This situation, therefore, precludes rational application of nutrients for ensuring efficient use of the external input in production systems for optimizing productivity besides addressing issues of pollution. Adoption of organic manures and biofertilizers in plant nutrition holds a good potential to overcome some of soil physical constraints. Organic manures applied to soil, improve the soil physical properties and add important nutrients to the soil, thus increase the nutrient availability and its ultimate absorption by plant. Besides this, organic manures and biofertilizers help in better utilization of added inorganic fertilizers, thus reduce its level of application as well as reduce the deleterious effect of harsh chemical fertilizers. Therefore, keeping this fact in view, an attempt was made to find out effect of organic and inorganic sources of nutrient on soil nutrient availability, leaf nutrient composition and fruit yield of sapota.

An experiment was laid out in Randomized Block Design with eleven treatments and three replications during 2010-11 at Main Garden, Department of Horticulture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The treatments consisting two levels of NPK fertilizers (75 and 100% of recommended dose), biofertilizers (*Azotobacter*, *Azospirillium* and PSB), vermicompost and FYM in different conjoint combinations. The treatment details are given under the Table 1. The soil samples were analyzed for available nutrient status using standard methods. For leaf nutrient analysis, (tenth leaf from apex), thirty leaf samples were collected from all sides of plant in the month of September. Total macronutrients viz., N, P, and K were analyzed as per standard procedures. Total micronutrients viz., Fe, Cu, Mn and Zn were estimated by using atomic absorption spectrophotometer (Wolf, 1982).

The application of organic, inorganic manures and biofertilizers had significant influence on soil available nutrient status and fruit yield (Table 1). The available soil nitrogen (213.15 kg ha^{-1}), phosphorus (16.73 kg ha^{-1}) and potassium (349.43 kg ha^{-1}) was found maximum under treatment T_9 (1125:750:375 g NPK + 15 kg vermicompost + 250 g *Azotobacter* + 250g PSB $plant^{-1}$) while, minimum available nitrogen, available phosphorus and available potassium content were recorded in treatment T_{11} (Control) The increased in available soil nutrient status might be due to the addition of inorganic fertilizers and further improvement due to addition of organic manures, which resulted in solubilization of native nitrogen, increase in soil micro flora and biological nitrogen fixation. The application of organic manures significantly reduced the fixation of added as well as native phosphorus making them more available to plants. These findings are in close conformity with findings of Deshmukh *et al*. (2014) in acid lime.

Leaf nutrient status in sapota was enhanced significantly with application of inorganic fertilizers along with organic manures and biofertililzers as compared to control (Table 1). Among macronutrients, nitrogen, phosphorus and potassium content were recorded maximum in treatment T_9 (1125:750:375 g NPK + 15 kg vermicompost + 250 g *Azotobacter* + 250 g PSB $plant^{-1}$) followed by T_5. The minimum content of macronutrients was recorded in T_{11} (Control). Among, micronutrients, iron, manganese, zinc and copper contents were estimated in leaf samples. The treatment T_9 followed by T_4 showed the superiority in micronutrients contents in leaves. The least micronutrient content was recorded with control (Table 1). Application of different nutrients increased the soil nitrogen, phosphorus and potassium content. The higher nutrient status of soil due to organic manure might be due to slow release of nutrients from organic manures and better uptake of nutrients by the plant which in turn increase the leaf mineral content. The increased plant nutrient content might be due to the biological nitrogen fixation and production of enzyme complex, which solubilize the unavailable form of nutrient element and render them available. Further, the values of nutrient contents in leaves obtained by the use of organic manures and biofertilizers with chemical fertilizers in present study are in the optimum range according to DRIS norm developed for sapota (Annapurna *et al*. 1988) suggesting the beneficial use of these sources of plant nutrients in sustainable production.

The data (Table 1) further revealed that application of 1125:750:375 g NPK + 15 kg vermicompost + 250 g *Azotobacter* + 250g PSB $plant^{-1}$ (T_9) recorded the highest number of fruits $plant^{-1}$ (1569.33), which was significantly superior over recommended dose of fertilizers (T_1) and control (T_{11}). Highest yield per plant (197.53 kg ha^{-1}) was observed in the same treatment which was superior to the control (T_{11}). The above results are in conformity with the findings of Dalal *et al.* (2004) in sapota, Barne *et al.* (2011) in guava.

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Maximum pollen viability (76.54%) was observed at 10.00 am, where the temperature and humidity percentage was 27.5^{0}C and 90 per cent, respectively.

The pollination behaviour of the herb was also monitored and it was observed that it is a cross pollinated crop. Four types of insect were observed, as pollinating agent. The insect activity was found to be maximum during 7.30 to 9.00 am.

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Effect of Varieties, Spacing and Fertilizer on Seed Cotton Yield and Quality of *Hirsutum* Cotton Under Rainfed Condition

Cotton the word is derived from the Arabic word 'Quntun'. Cotton (Gossypium Spp.) popularly known as 'White gold' or king of fiber. Being a cash crop cotton plays a vital role in Indian economy. Near about 116.1 lakh ha area is under cotton cultivation in india with average productivity 489 kg ha^{-1}, whereas cotton occupies about 41.03 lakh ha area in Maharashtra but productivity is too low (329 kg ha^{-1}) as compared to national average (Anonymous 2013). Among different species of cotton major area is under *Gossypium hirsutum* which is commonly called as 'American cotton'. Under this group of cotton number of varieties and hybrids are released and doing well on farmers field. Recently some of the varieties having better yield potential than the existing are released or at pre released stage. It is essential to study the agronomic requirement of new genotype particularly spacing and fertilizer levels. The real yield potential of any genotypes could be only exploited if it is grown with suitable plant density and optimum dose of fertilizer. In view of these objectives the present investigation was undertaken to find out suitable genotypes, spacing and fertilizer under rainfed condition

A field experiment was conducted at Cotton Research Unit, Dr. PDKV Akola (M.S) during kharif season 2012-2013. The experiment was laid out in a split plot design consisting four *hirsutum* cotton genotypes namely NDLH- 1938, BS- 79, AKH- 8828 and AKH-9916, two spacings (60 x 30 cm and 60 x 45 cm) and two levels of fertilizer i.e 100 per cent RDF (50:25:25 kg NPK kg ha^{-1}) and 125 per cent RDF(61.5:31.25:31.25 kg NPK kg ha^{-1}) and replicated thrice. The soil of experimental field was medium deep black low in available nitrogen (193.3 kg ha^{-1}), low in available phosphorus (14.5 kg ha^{-1}) and high in available potassium (334.50 kg ha^{-1}) with 0.570 per cent organic carbon content. The seed of hirsutum cotton genotypes was sown by dibbling 2 to 3 seed hill^{-1} on 9th July 2012. Plant population as per treatment was maintained by gap filling. Fifty percent nitrogen and full dose of phosphours and potassium fertilizers were applied at the time of sowing. Remaining fifty percent nitrogen was applied after 30 DAE. Only one plant per hill was kept by thinning.

Effect of varieties

Plant height was recordper cented maximum in variety NDLH-1938, Sympodial branches, number of bolls picked plant^{-1}, seed cotton weight plant^{-1} and seed cotton yield kg ha^{-1} was recorded highest in variety AKH-9916, whereas boll weight was recorded higher in variety BS- 79 than the other varieties.The quality parameter such as ginning percentage and bundle strength was

Effect of fertilizer

The fertilizer level of 125 per cent RDF i.e 61.5:31.25:31.25 kg NPK ha^{-1} recorded significantly higher number of bolls picked $plant^{-1}$ and seed cotton weight $plant^{-1}$ over the 100 per cent RDF i.e 50:25:25 kg NPK ha^{-1}. However the seed cotton yield per hectar was at par in respect of 100 per cent RDF and 125 per cent RDF. Similar results were obtained by Katkar *et. al.*, 2002. Fertilizer levels was found to be non significant in respect of quality parameters.

Hirsutum cotton genotype AKH- 9916, crop spacing of 60 x 30 cm and recommended dose of fertilizer (50:25:25 kg NPK ha^{-1}) recorded higher yield of seed cotton under rainfed condition.

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Effect of Bypass Protein Supplementation on Growth Performance of Cross-bred Calves

The present investigation was undertaken to assess the effect of formaldehyde treated soybean meal on the growth performance of cross-bred calves. Six Sahiwal x Jersey cross-bred (CB) calves having similar LBW were procured from Dairy Farm of Animal Husbandry and Dairying section, College of Agriculture, Nagpur .They were randomly distributed into three groups viz. T_0 - CB in this treatment group were fed with concentrate mixture+ chaffed green sorghum stalks *ad lib.*; T_1 - CB calves in this treatment group were fed with soybean meal treated with formaldehyde @ 0.5 per cent 100^{-1} g CP + chaffed green sorghum stalks *ad lib.*and T_2 - CB calves in this treatment group were fed with soybean meal treated with formaldehyde @ 1.0 per cent 100^{-1} g CP + chaffed green sorghum stalks *ad lib.*Formaldehyde treated soybean meal was mixed with concentrate mixture and fed to the calves in T_1 and T_2. As per suggestion of statistician, each calf received each treatment in switch over design for a period of 63 days. The total duration of the study was 63 days followed by a digestion trial of 7 days. The calves were fed with equal quantities of ration twice daily. Their net feed intakes, water intake were calculated for 24 hours. The estimation of DMI, moisture, crude protein content of feed and forage ,analysis of faeces samples were done as per AOAC (1995). Various observations pertaining to growth such as LBW, body length, Chest girth, height ar withers were recorded at weekly intervals. The data were tabulated and analyzed as per Snedechor and Cochran (1994).

During present study the CP and EE contents of chaffed sorghum were found to be lower whereas, CF,NFE and ash contents were higher as compared to the treated and untreated soybean meal. The chemical composition of treated and untreated soybean meal did not differ significantly ($P > 0.05$). Whereas, Bhargava *et al.*(1979) reported that CP and NFE increased whereas the EE and CF decreased in the concentrate mixture treated with formaldehyde. The findings of present study are in agreement with Mathur and Mathur (1974) .The mean DMI of CB calves in the three treatment groups T_0, T_1

The treatment T_2 was found to be significantly superior ($P < 0.05$) as compared to T_1 and T_0. The average weekly gain in height at withers were 2.88,3.25 and 3.92 inches, respectively. The variation among various treatment groups was found to be significant ($P < 0.05$). The DMI of calves in T_0 was higher (10.87 kg) followed by T_1 (8.32 kg) and T_2 (7.78 kg). The variation among various treatment groups was found to be significant ($P < 0.05$). The treatment T_2 was found to be significantly superior ($P < 0.05$) as compared to T_0 and T_1. The FCE was significantly higher in T_2 (12.85 %) followed by T_1 (12.02 %) and least in T_0 (9.20 %).

These results show that the protection of highly degradable soybean meal was achieved by treatment with formaldehyde. Higher supply of undegradable protein (UDP) by treatment of soybean meal with formaldehyde might have enhanced the protein and essentail amino acid content(s) and thus caused an increase in the efficiency of protein utilization.It might have reduced the energy loss, which is generally caused by excessive microbial protein turnover and through urea synthesis in the liver.The excess amount of amino acids provided through the feeding of protected soy-protein might have contributed to glucose synthesis and might have caused balance of energy and protein resulting in enhanced growth of CB calves.The average DCP and TDN intake/kg of body weight gain for experimental calves also showed similar trend.

The total expenditure of feeding in various treatment groups was estimated to be Rs. 3221.29, 3226.29 and 3228.85 respectively. The average feed cost per kg live weight gain in various treatment groups was worked out to be Rs. 76.22. 49.70 and 46.73 respectively.Thus from the above investigation it can be concluded that bypass protein supplementation through the treatment of soybean meal with formaldehyde at 1 percent level in the ration of crossbred calves resulted in efficient nutrient utilization,faster growth and lowered cost of raising.Thus this is a very promising technology which will help livestock owners and farmers for rearing the calves economically and will lead to profitable dairying.

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