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RESEARCH NOTES

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Economics of *Jatropha curcas* Under Agroforestry Systems Raised on Marginal Wastelands

J.S.Zope[1], S.S.Narkhede[2], A.J.Deshmukh[3] and S.S.Marawar[4]

ABSTRACT

The ease of cultivation of Jatropha and its importance as biofuel has given good marketability and establishment of new cropping model for the benefit of the rural communities for becoming self sufficient. Looking to the mixed evidence regarding the economic viability of growing the Jatropha on marginal lands, an attempt is made in this paper to work out the economics of the Jatropha cultivation on marginal / waste lands. The cost of establishment of *Jatropha curcas* on wastelands is estimated to be Rs. 25002. The recurring cost incurred on the maintenance of the plantations, following the standard practices was found to be Rs. 3826. The net return estimated for 20 years of rotation period from the Jatropha curcas plantation is worked out to Rs. 9502 year^{-1}, from 5th year onwards.

During last over a decade, the agroforestry has come to be recognized as a distinct discipline that is destined to play an important role in socio-economic transformation of marginal lands, into more productive agrarian economy. Agroforestry essentially means growing of economic species which yield food, fuel, fruits, fiber and other industrial raw materials to benefit rural economy. Many choice of crop com-binations are available-for rainfed and low irrigation receiving lands although efforts have been made to develop drought resistant short duration varieties. Even where physical facilities favored higher crop yields, the increase in prices of energy inputs have caused erosion in profitability demanding search of new sequences of crops in a system. (Marothia, 1989). This paper attempts to draw the economics of integrating the Jatropha as an agroforestry crop in the traditional farming system in the region.

The ease of cultivation of Jatropha and its importance as biofuel has given good marketability and establishment of new cropping model for the benefit of the rural communities for becoming self sufficient. Looking to the mixed evidence regarding the economic viability of growing the Jatropha on marginal lands, an attempt is made in this paper to work out the economics of the Jatropha cultivation on marginal / waste lands.

MATERIAL AND METHODS

The studies were conducted to know the returns from Jatropha based agroforestry system. The configuration of agricultural crop and perennial components is as given below.

Perennial component	:	*Jatropha curcas*
Spacing	:	4.5 x 2 meter
Inter crop	:	Green gram (spacing 30x10 cm)

The study was conducted at the College of Forestry Farm of Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, during the year 2002-03, where Jatropha plantation is raised on marginal uncultivated land under rainfed conditions. The green gram was grown as an intercrop following standard package of practices. The results were analysed and interpreted as per the method followed by Marawar *et. al.*, 1995.

RESULTS AND DISCUSSION

The year wise cost incurred for establishment of Jatropha plantation is as given in Table 1. The cost of establishment of Jatropha plantation is approximately around Rs. 17002/-. The green gram was grown as an intercrop in the space available between the rows of Jatropha. The cost of cultivation and returns from intercrop is given in Table 2. The results from Table 2 revealed that under the rainfed agroecosystem the minimum average yield of green gram comes out to be 5 q ha^{-1}. Taking this as the base value the returns from the intercrop i.e. green gram is around Rs.2120/-. The intercropping of agricultural component is not possible after fourth year because of closing of canopy of Jatropha plants.

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Table 1. Year wise cost of Jatropha plantation (hectare^{-1})

S.N.	Items	Rs. ha^{-1}
I Establishment cost		
First Year	Preparation of land (Ploughing & Tillage)	2000
	Digging of pits at 4.5.x 2 M spacing	1111
	Cost of FYM and filling of pits	5555
	Cost of fertilizers (20g Urea + 120g SSP + 60g Potash)	642
	Cost of seedlings @ Rs. 2 seedling^{-1}	2222
	Causality replacement	200
	Planting cost @ 10 man days (Including transport to planting site)	750
	Inter cultural operations@ 10 man days	750
	Miscellaneous charges (include rental value, land depreciation and interest on fixed capital)	1550
	Total – I	**17002**
II Recurring and maintenance cost		
Second Year	Intercultural operation, fertilizer cost	2500
Third Year	Intercultural operation, fertilizer cost	2500
Fourth Year	Intercultural operation, fertilizer cost and harvesting of fruits	3000
	Total – II	**8000**
	Grand Total (I + II)	**25002**

Table 2. Cost of cultivation of agricultural crop for initial four years (Green gram)

S. N.	Items	Rs. ha^{-1}
I	Cost of cultivation (including seed cost, sowing, fertilizers cost, intercultural operation and harvesting @ 3880 year^{-1})	15520
II	Returns (@ 5qt ha^{-1} with Rs. 1200 q^{-1} for 4 years)	24000
III	Net returns for four years	8480
IV	Net returns for one year	2120

Table 3. Returns from Jatropha plantation in agroforestry systems under rainfed conditions

S. N.	Items	Rs. ha^{-1}
I	Total gross cost incurred for 4 years	25002
II	Total cost incurred after deducting net return of inter crop from gross cost of establishment upto 4 years (25002-8480)	16552
III	Yearly net cost of establishment of jatropha plantation (for 20 years)	826 (16522/20)
IV	Cost of cultivation for 5th year (3000 + 826)	3826
V	Returns from jatropha seed* (yield @ 1666 kg ha^{-1} @ Rs. 800 q^{-1})	13328
	Net return for 5th year (13328-3826)	9502

Note : *-The seed yield will increase from 5th year onwards at the average rate of 20 per cent increase year^{-1}.

The Jatropha plants begins to produce the economic yield from 5th year onwards. The seed that can be harvested from 5th year onwards is around 1.5 kg of seeds per plant. The net returns from 5th year onwards in Jatropha –green gram model is given in Table 3.

The values given in Table 3 shows the returns from Jatropha plantation in agroforestry systems under rainfed conditions. The total gross cost incurred on the plantation is Rs. 25002. The net yearly cost of establishment cost of Jatropha

plantation on 20 years of rotation period comes out to be Rs 826, while the coast of cultivation as well as the maintenance of the plantation is Rs. 3826. Consideration the average yield of Jatropha at the rate of 1666 kg ha^{-1}, the net returns obtained will be Rs. 9502. This net returns from Jatropha plantation will increase with the increase in yield in the subsequent years.

The foregoing analysis observed in the study are based on the observations of the plantations established on the wastelands. The net returns value are not comparable with the agricultural or cash crops grown by the farmers. However, in other word it is the net returns obtained from the marginal waste lands, which are otherwise not put to any use.

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Optimization of the Length of Contour Border For Wheat Crop

R.L. Gawande[1] and S.S. Hiwase[2]

ABSTRACT

Contour borders of different lengths were tested for wheat crop during 1999 to 2002 at Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola to study the irrigation water used, crop yield and field water use efficiency for deciding the optimum length of contour border. The results indicate that 20 m contour border gave the maximum grain yield of 2684.66 kg ha^{-1} and field water use efficiency of 86.22 kg ha^{-1} -cm. Similarly, it save 21.30 per cent irrigation water over 40 m length of contour border. The minimum grain yield and field water used efficiency were observed in 40 m length of contour border while it required maximum depth of water. Hence, 20 m length of contour border is advocated for wheat crop.

When fields can be levelled to desirable land slopes economically without affecting its productivity, graded borders are easier to construct operate. But when land slope exceeds safe limit, fields are undulating and leveling is not feasible, border may be laid across the slope (Michael, 1978). For undulating topography or for higher slope (more than 0.05%), the graded borders are not much effective in terms of proper utilization of irrigation water and ultimately reduces the crop yield. For this condition contour borders are to be advocated and hence the optimum length of contour border is to be evaluated to save the irrigation water and to increase crop yield under command area specially for wheat crop. For this purpose, the experiment was carried out to study the quantity of irrigation water, crop yield and field water use efficiency for different lengths of contour border. The efforts are made to optimize the length of contour border for wheat crop under command area.

MATERIAL AND METHODS

Experiment was carried out at Shivar block, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola for three years i.e. 1999-2000, 2000-2001 and 2001-2002. Contour borders of 1.75 m width and 10 m, 15m, 20m, 25 m, 30m, 35 m and 40m lengths were prepared. The experiment was replicated thrice in Randomized Block Design. The wheat crop (var. AKW-381) was sown. The field was irrigated with 3.5 ips irrigation stream. The field soil was clay having 1.30 g cc^{-1} as bulk density, 33.50 per cent field capacity, 17.50 per cent permanent wilting point, 50.94 per cent porosity and 0.57 $t^{0.53}$ cm hr^{-1} infiltration rate. All the recommended package of practices were followed. The total advance time for each treatment was monitored to find out the depth of irrigation. The crop was harvested and the net crop yield was monitored. With the help of crop yield and depth of water applied, the water use efficiencies were determined. From these data the efforts are being taken to find out the optimum length of contour border.

RESULTS AND DISCUSSION

From the three years data (Table 1), it is revealed that minimum depth of water (27.34 cm) required in 10 m contour border and it was at par with the depth of irrigation required for 15 cm contour border (27.92 cm). The depth of irrigation recorded in 20 m and 25 m contour borders was also at par with each other (31.18 and 32.58 cm, respectively) and significantly higher over 10 m and 15 m contour borders. The maximum depth of water was recorded in 40 m contour border (39.62 cm) and significantly higher than all other treatments. The percentage saving in irrigation water by the treatments of 10m, 15m, 20 m, 25 m, 30m, and 35 m length of contour borders was observed as 30.99, 29.53, 21.30, 17.77, 12.47 and 9.24, respectively over 40 m contour border.

Table 2, revealed that the highest grain yield of wheat crop was obtained in the treatment of 20 m length of contour border (2684.66 kg ha^{-1}) and it was significantly superior over all other treatments. The

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Table 1. Total depth of water, cm and saving in irrigation water, per cent for different treatments

Length of contour border	Depth of water, cm				Saving water over 40 m contour border, %
	1999-00	2000-01	2001-02	Pooled mean	
10 m	26.64	27.20	28.20	27.34	30.99
15m	27.44	28.25	28.08	27.92	29.53
20m	30.90	31.76	30.90	31.18	21.30
25m	32.24	32.94	32.58	32.58	17.77
30m	34.40	35.15	34.48	34.68	12.47
35 m	35.25	37.30	35.33	35.96	9.24
40m	39.12	40.50	39.24	39.62	-
'F' test	Sig	Sig	Sig	Sig	-
SE (m)±	0.37	0.78	0.46	0.57	-
CD at 5%	1.06	2.21	1.30	1.61	-
CV,%	2.02	4.09	2.46	3.03	-

Table 2. Grain yield, kg ha^{-1} and per cent increase in yield for different treatments

Length of contour border	Grain yield, kg ha^{-1}				Increase in yield over 40 m contour border, %
	1999-00	2000-01	2001-02	Pooled mean	
10 m	2376	2205	2465	2348.66	13.46
15m	2540	2395	2610	2515.00	21.50
20m	2680	2538	2830	2684.66	29.69
25m	2510	2370	2492	2457.33	18.70
30m	2372	2230	2355	2319.00	12.03
35 m	2220	2110	2286	2205.33	6.54
40m	2028	1970	2212	2070.00	-
'F' test	Sig	Sig	Sig	Sig	-
SE (m)±	51.34	40.38	73.90	58.27	-
CD at 5%	144.20	113.44	207.56	163.66	-
CV,%	3.72	3.09	5.19	4.25	-

grain yield obtained in 15 m and 25 m contour borders was at par with each other (2515 & 2457.33 kg ha^{-1}, respectively) and it was significantly superior over 10m, 30m, 35 m and 40 m contour borders. It is also observed that the yield recorded in 10m, 30m, and 35m contour borders was at par with each other. The lowest yield was observed in 40m contour border (2070 kg ha^{-1}). The percentage increase in yield was observed as 29.69, 21.50, 18.70, 13.46, 12.03 and 6.54 by the treatments of 20 m, 15 m, 25 m, 10 m, 30 m and 35 m contour borders, respectively over 40 m contour border.

From the pooled data (Table 3), it is observed that maximum field water use efficiency was observed in 15 cm contour border (90.23 kg ha^{-1}-cm) and it was at par with 10 m and 20 m contour borders. The minimum field water use efficiency was recorded in 40 cm contour border (52.31 kg ha^{-1} -cm).

The results of pooled data of three years indicate that 20 m contour border gave the maximum grain yield of wheat crop with 21.30 per cent saving in irrigation water. Similarly, the maximum field water use efficiency was found in 15 m contour border treatment which was at par with 20m contour border. Therefore, contour border of 20 m length is advocated for wheat crop to obtain the higher crop yield with considerable saving in the irrigation water.

Table 3. Field water use efficiency (FWUE), kg ha^{-1}-cm as influenced by different treatments

Length of contour border	FWUE, kg ha^{-1}			
	1999-00	2000-01	2001-02	Pooled mean
10 m	89.53	81.07	87.44	86.01
15m	92.56	85.11	93.02	90.23
20m	86.91	80.03	90.76	86.22
25m	77.87	72.10	76.43	75.46
30m	68.94	63..54	68.31	66.93
35 m	62.96	56.62	64.70	61.43
40m	51.89	48.71	56.34	52.31
'F' test	Sig	Sig	Sig	Sig
SE (m)±	2.03	7.10	7.62	6.66
CD at 5%	5.71	7.10	7.62	6.66
CV,%	4.64	6.29	6.11	5.54

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Overall Effectiveness of Mechanical Grading of Kagzi Lime

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ABSTRACT

Post harvest management of citrus is of prime importance in order to sustain higher production, proper distribution with minimum losses and increasing export. The fruit grader was fabricated and tested by using kagzi lime. The overall effectiveness of grader is sensitive to feed rate and slope of the pipes (feed end to opposite end). Hence these two factors were considered for optimization for better overall effectiveness of separation. The experimental plan selected was for two variables and five levels in response surface methodology. Using optimized input factors the overall effectiveness of separation, grading efficiency and capacity was found to be 61.02 per cent, 88.20 per cent and 17.64 tonnes day^{-1} (at 75% efficiency) of eight hours

In India, citrus is grown in 482720 ha with a production of 42,58,514 tonnes with an average productivity of 80 tonnes ha^{-1}. The most important commercial citrus cultivars in India are the mandarin, followed by sweet orange and acid lime sharing 41,23 and 23 percent, respectively of all citrus fruits produced in the country (Singh et.al, 2001). Post Harvest Management of citrus is of prime importance in order to sustain higher production, proper distribution with minimum losses and increasing export. In India due to lack of proper post harvest handling system and appropriate processing technology, not only does a huge quantity of fruits go waste but also the country does not get proper distribution of fresh fruits and good market for processed products for both internal trade and export. Systematic grading is a prerequisite for efficient marketing system as a well-designed programme on grading and standardization bring about an overall improvement not only in the marketing system but also in increasing the quality consciousness.

At present the grading is done manually and only skilled persons are assigned with this job. Size grading of oranges is done in three of four grades at some places and six or seven at some places. The mechanical grading of kagzi lime is still in the infancy and the grading requirements have not been put in to large-scale commercial use in the field. This is because the graders are costly beyond the reach of rural masses. Considering the need, the grader was fabricated for grading of spherical fruits on size basis.

MATERIAL AND METHODS

The fruit grader was consisting of four pipes of PVC keeping diverging gap (spacing) between two pipes of each pair. A chain and sprocket arrangement was provided at the feed end for power transmission from pipe to pipe .The chain was linked alternately so that the pipes will rotate in opposite direction outwardly by 80 rpm. For outlet of fruits trapezoidal shaped frames of m.s. flat fitted with m.s. sheet partitions were provided as shown in Fig1. The placement of the partitions can be adjusted in the grooves as per the requirement of particular grade. For grading kagzi lime fruits , the spacing between two pipes of each pair was adjusted and the partition of the outlet were provided where the spacing between the two pipes of each pair was 25mm, 30mm, 35mm, 40mm and 45mm thereby receiving fruits of <30 mm diameter , 30-35 mm diameter , 35 to 40 mm diameter and 40 to 45 mm diameter. One horsepower single-phase electric motor was used as a prime mover. As the grader was versatile in nature for grading all types of spherical fruits; the grader was tested by using kagzi lime .The grading efficiency of grader is sensitive to feed rate and slope of the pipes (feed end to opposite end). Hence these two factors were considered for optimization for better grading efficiency by using surface response methodology.

The experimental plan selected was for two variables and five levels in response surface methodology (Cochran and Cox, 1975) for

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optimization of factors for maximum percent overall effectiveness of separation. The two independent variables, feed rate of kagzi lime, kg min^{-1} (x_1) and slope, per cent (x_2), and their levels, coded and uncoded are shown in Table 1. The centre point values were chosen as 50 kg/min feed rate and 32.5 per cent slope The two higher and two lower levels were added using equation.

Central level $\pm$ ($\sqrt{2}$ x interval) .....(1)

The second order polynomial equation of the following form can be assured to appropriate the true functions

$$Y = b_0 + b_1x_1 + b_2x_2 + b_{11}x_1^2 + b_{22}x_2^2 + b_{12}x_1x_2 \quad .....(2)$$

Where b_0, b_1, b_2,b_{11},b_{22} and b_{12} are the constant co-efficients and x_1 and x_2 are the coded independent variables. These coded variables (x_i) in any particular application are linearly related to decoded value X_i by the following equation (Khuri and Cornell, 1987).

$$x_i = \frac{2X_i - (X_{iH} + X_{iL})}{X_{iH} - X_{iL}} \quad .....(3)$$

Where,

x_i = Coded variable

X_{iH} = High level (+1) of X_i

X_{iL} = Low level (-1) of X_i

The kagzi lime were procured from the garden nearby Akola city and transported to testing unit with sufficient cushioning material in order to minimize bruising. The sample size of 12 kg of fruits was used for each test. Various feed rates were achieved by feeding the same fruit lot during different durations, and five levels of slopes were achieved by keeping required thickness of m.s. plates at the bottom of the feed end or opposite end. The major diameters of fruits before grading were measured by vernier caliper. These fruits are divided in four grades, the coding is given and weights were taken before grading (Table 2). After grading the percent overall effectiveness of separation was calculated.. Similarly the grading efficiency was calculated by dividing the weight of correctly graded fruits by total weight of fruits taken for grading.

RESULTS AND DISCUSSION

The experimental average results of three replications for per cent overall effectiveness are depicted in Table 3. The observed data were fitted in second order polynomial model equation using

Table 1. Experimental design for two variables five levels in response surface analysis

Experiment number	Levels of input variable			
	X_1	Feed rate kg min^{-1}	X_2	Slope, percent
1	-1	20	-1	27.50
2	1	30	-1	27.50
3	-1	20	1	37.50
4	1	30	1	37.50
5	-1.414	17.93	0	32.50
6	1.414	32.07	0	32.50
7	0	25	-1.414	25.43
8	0	25	1.414	39.57
10	0	25	0	32.50
11	0	25	0	32.50
12	0	25	0	32.50
13	0	25	0	32.50

Table 2. Details of kagzi limes taken for testing

Code	A	B	C	D
Diameter, mm	>40	35-40	30-35	<30
No. of fruits	114	115	94	34
Weight, kg	5.440	3.990	2.200	0.460
Average weight, Kg	0.048	0.034	0.023	0.014

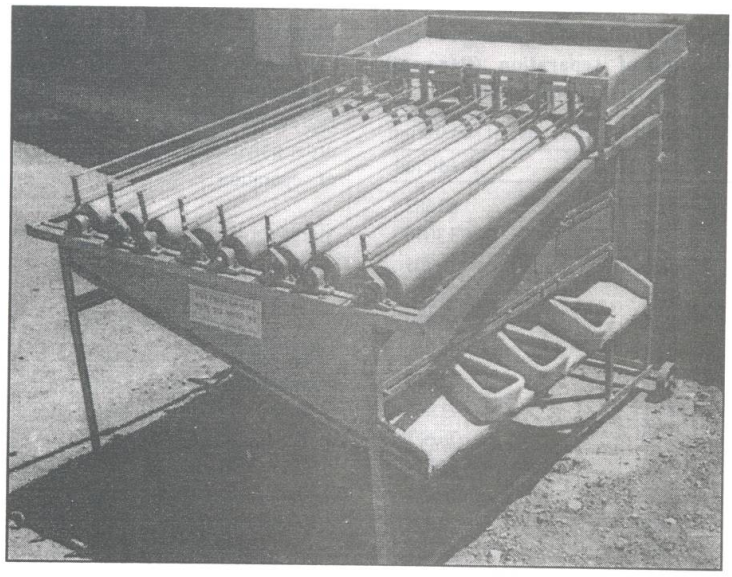

Fig. 1. PKV fruit grader developed at Akola centre

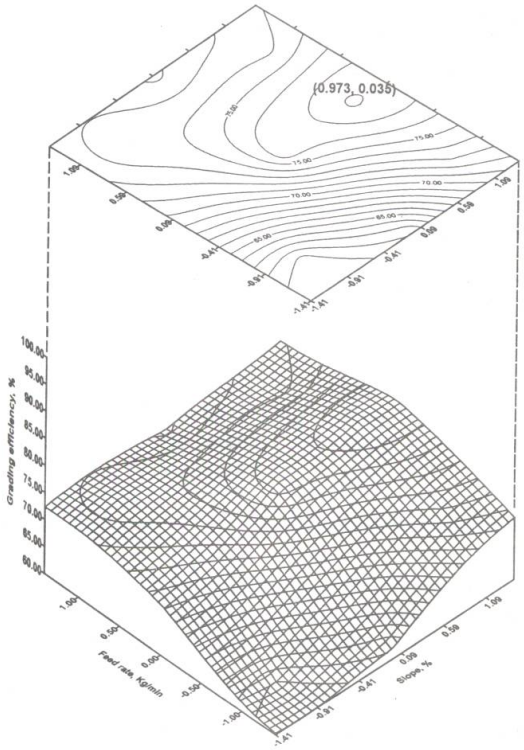

Fig. 2. Contour plot and response surface showing effect of feed rate and slope on grading efficiency of Kagzi lime

Table 3. Observed and predicted response for overall effectiveness of separation (Per cent) under various treatment conditions

Experiment number	Overall effectiveness of separation	
	Observed	Predicted
1.	61.22	60.682
2.	75.120	73.3046
3.	76.120	73.705
4.	77.50	73.550
5.	68.12	69.279
6.	74.58	79.911
7.	61.20	62.118
8.	68.11	71.682
9.	76.720	76.621
10.	76.540	76.621
11.	76.240	76.621
12.	76.820	76.621
13.	76.783	76.621

SPAR 1 programme (Doshi and Gupta, 1991). The partial regression coefficients obtained after multiple regression analysis are presented in Table 4. The regression analysis resulted the following second order polynomial equation for overall effectiveness of separation.

$$Y = 76.620 + 3.052\,x_1 + 3.382\,x_2 - 1.513x_1^2 - 4.682x_2^2 - 3.13x_1x_2 \quad (R^2=0.878) \quad \ldots\ldots (4)$$

The analysis of variance (Table 5) for the effect of factors on response indicated that the regression was highly significant ($P < 0.01$) and lack of fit was non significant and hence the mathematical model can be considered as quite adequate.

The stationary point where the slope of the curve on the first derivative is zero was located as described by Khuri and Cornell (1987). Results in Table 6 show that the stationary point for the response was laying inside the experimental region defined by $x_1 = \pm 1.414$ and $x_2 = \pm 1.414$. The model was tested whether the function has maximum or minimum prediction values. It was observed that, the function possesses maximum value. The co-ordinates ($x_1 = 0.973$ & $x_2 = 0.035$) correspond to the uncoded values as 29.86 kg min^{-1} feed rate and 32.67 per cent slope of pipe. Using these input factors the overall effectiveness of separation was calculated to be 78.16 per cent.

Table 4. Values of partial regression coefficient of second order polynomial equations for average effectiveness of separation

Response	Partial regression coefficient					
Overall effectiveness of separation	b_0 76.620	b_1 3.052	b_2 3.382	b_{11} -1.513	b_{22} -4.862	b_{12} -3.13

Table 5. Analysis of variance for the effect of input variables on overall effectiveness of separation (Y)

Sources	df	Sum of square
Model (Reg.)	5	374.999*
Residual	4	52.295
Lack of fit	3	52.068
Pure error	1	0.228
F ratio (LDF)	-	76.298
R^2	-	0.878

Table 6. Predicted levels of factors yielding optimum response

Factors	Overall effectiveness of separation Y	
	Coded	Un coded
Feed rate, Kg min^{-1}	0.973	29.86
Slope, %	0.035	32.67
Response, %	78.16	

The response surface and contour plot was generated on computer screen in order to study the pictorial form of behaviour of response variables using the prediction model equation as shown in Fig. 2. for overall effectiveness of separation.

Table 6 presents the statistical analysis of joint test on the two parameters involving one particular factor. For example test x_1 tests the hypothesis that parameters of model equation viz. x_1, x_2^2 and x_1x_2 are all zero. Similar is the case for x_2.

Table. 7 Analysis of variance for overall effect of individual factor

Factors	df	S.S.	Mean square	F ratio
X_1	3	113.737	37.912	2.156
X_2	3	258.999*	86.333	4.909

Table 7 revealed that x_2 (slope) is highly significant at 10 per cent level than x_1(feed rate) this shows that the effect of slope is much effective than the feed rate for the response.

The mathematical model was evaluated for its adequacy by testing the grader for three samples with factors constant at above level (30 kg min^{-1} feed rate and 33% slope). The grading efficiency of the grader was found to be 76.83 per cent with $\pm$ 0.71 standard deviation. The corresponding average overall effectiveness of separation was 24.65 per cent with $\pm$ 0.31 standard deviation The lower overall effectiveness of separation and lower average grading efficiency can be attributed to the difference between the major and minor diameter of fruit (fruit being not perfectly spherical) ranging from zero to 5 mm and the orientation of fruit (either major diameter/ minor diameter perpendicular to slope) while conveying within the diverging gap between two pipes of each pair, which caused the mixing of various grades of fruits.

With this optimized feed rate the capacity of grader for grading kagzi lime comes out to be 14.33 tonnes day^{-1} of eight hours and with 80 per cent efficiency, the capacity of the grader is 11.46 tonnes day^{-1} of eight hours.

CONCLUSIONS

1. For maximum response of overall effectiveness of separation and grading efficiency, the input factors, feed rate and slope of grader were optimized to 29.86 kg min^{-1} and 32.67 per cent, respectively, for grading kagzi lime.
2. For kagzi lime , the grading efficiency and capacity was found to be 76.83 per cent and 11.46 tones day^{-1} (at 80% efficiency) of eight hours , by using optimized input parameters.

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Design of Farm Pond For Yavatmal Region

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ABSTRACT

The assured agriculture production can be possible if irrigation facilities are available. Harvesting rainwater in farm ponds can increase irrigation potential. Farm pond is commonly used for protective irrigation during *Kharif* season, irrigation to *Rabi* crop and recharging ground water. Maharashtra government is encouraging the farmers by providing 95 per cent subsidies for construction of farm pond.

Average annual and rainy season rainfall of Yavatmal was found to be 906.08 and 836.10 mm, respectively. The average rainy seasonal runoff estimated by curve number technique for Yavatmal was found to be 139.93 mm. The design sizes of pond for Yavatmal were found to be 20.0 x 20.0, 26.5 x 26.5, 32.0 x 32.0 m with 3m depth and 1:1 side slope for 2, 4, and 6 ha catchment area, respectively. Area under pond ranges between 2.94 to 4.50 per cent of the total command area. From arrested water in farm pond 3 irrigations are possible to 50 per cent of the catchment area. The cost of construction of designed sizes were found to be 29.30, 54.20, 80.50 thousand rupees and storage cost per m^3 is Rs. 33.45, 32.53 and 31.79 for 2, 4 and 6 ha catchment area, respectively.

In India, irrigation is 27 per cent of the total cultivable land whereas in Maharashtra 15.21 per cent and in Vidarbha it is 12.56 per cent (Statistical information of Maharashtra, 1997-98). In Yavatmal district only 12 per cent land is presently under irrigation, which can be increased up to 41 per cent by construction of farm ponds (Nimbalkar, 2004).

The importance of farm pond is increasing greatly in recent years. Farm ponds are small tank or reservoir and are constructed to supply water for irrigation, livestock, home use and fish production. They are also used for head water flood control and to increase ground water level.

MATERIAL AND METHODS

The farm ponds were designed for Yavatmal region, which is in Central Vidarbha Zone of Maharashtra state and comes under subtropical zone.

To design the farm pond following points were considered.

Size, shape of the farm pond

The size will depend on the required storage capacity, shape of the pond, depth and side slope. For designing farm pond, we assume square shape of the pond and the depth as 3 m with side slope 1 Vertical : 1 Horizontal.

Estimation of runoff

To design the farm pond, runoff is estimated from daily rainfall data for last 10 years by curve number technique. In which, Potential maximum retention (S) is determined by using equation

$$CN = 25400/(254 + S) \qquad \text{eq. - 1}$$

Runoff Q is determined using formula

$$Q = (P-0.2S)^2 / (P + 0.8\,S) \qquad \text{eq. - 2}$$

Where, Q = runoff, mm

P = rainfall, mm

While designing, 80 per cent of the average estimated weekly runoff is considered so that farm pond is filled for at least 8 out of 10 years.

Storage losses

Pond evaporation and seepage are the two major losses. Average weekly pond evaporation was calculated from average open pan evaporation of ten years multiplied by ponded surface area and pan coefficient i.e. 0.70. Seepage rate is assumed as 10 mm day^{-1} and weekly seepage loss is estimated from total area of the pond.

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Capacity of farm pond

While designing the capacity of farm pond it is assumed that the runoff water collected in the pond will be utilized during mansoon season and pond will be nearly filled during the last runoff storm at the end of the mansoon. The volume of runoff to be stored in the pond can be calculated by using Prisomoidal formula as :

$$V = (H / 6) (A_1 + 4A_m + A_2) \qquad \text{eq. -3}$$

Where,

V = Volume of water stored, m^3

H = The height of water in pond, m

A_1 = Top area, m^2

Am = Mid area, m^2

A_2 = Bottom area, m^2

Cost estimation

Assuming soil profile consists of three layers as soil, loose murum and hard murum each of 1 m depth cost estimation of farm pond according to latest CSR rate list was done.

RESULTS AND DISCUSSION

Analysis of rainfall and evaporation data

Table 1 revealed that average annual rainfall, evaporation and *Kharif* rainfall, evaporation for Yavatmal was found to be 906, 2036 mm and 836, 578 mm respectively.

Estimation of runoff by CNT

Hydrological soil group of Yavatmal is considered, as 'c' since infiltration rate of soil is low. According to land use, treatment, hydrological condition and hydrological soil group, CN for AMC-II is found to be 80. CN and potential maximum retention for AMC-I, II and III were found. Estimated average *Kharif* runoff for Yavatmal was found to be 139.93 mm i.e. 16.73 per cent of average *Kharif* rainfall (836 mm).

Table 1. Average weekly evaporation, rainfall and estimated runoff by CNT for Yavatmal (1991-2000)

S.N.	Meteorological week	Average evaporation, mm	Average rainfall, mm	Average runoff, mm
1.	23	67.62	26.37	6.525
2.	24	55.58	36.22	2.341
3.	25	34.51	66.11	11.257
4.	26	36.05	29.86	0.432
5.	27	34.16	43.73	0.834
6.	28	27.02	74.96	10.539
7.	29	24.50	89.39	24.213
8.	30	26.37	48.76	7.310
9.	31	27.30	69.19	9.799
10.	32	27.84	50.00	6.790
11.	33	21.70	42.49	7.147
12.	34	18.82	57.07	15.886
13.	35	25.59	78.46	24.133
14.	36	25.51	33.74	2.493
15.	37	30.72	31.92	4.699
16.	38	32.9	26.93	4.734
17.	39	31.97	20.78	0.751
18	40	29.87	10.12	0.047
19	Kharif season	578.03	836.10	139.93
20.	Annual	2036.49	906.08	–

Table 2. Storage losses, area irrigated and cost of storage from farm ponds

S.N.	Catchment area, ha.	2	4	6
1.	Pond, size, m x m	20.20 x 20.20	26.5 x 26.5	32.0 x 32.0
2.	Evaporation loss, m^3	124.91	231.12	349.10
3.	Seepage loss, m^3	408.80	741.95	1109.48
4.	Total storage loss, m^3	533.71	973.07	1458.58
5.	Total runoff volume stored, m^3	2039.93	4091.53	6108.69
6.	Total storage loss/total runoff volume stored in %	26.16	23.78	23.87
7.	Area under 3 irrigation of 5 cm depth, ha.	1.01	2.05	3.05
8.	Area irrigated % of catchment area	50.50	51.25	50.83
9.	Number of irrigation to complete catchment area	1.52	1.53	1.53
10.	Area under pond % of catchment area	4.50	3.33	2.94
11.	Cost of farm pond, Rs.	29300.00	54200.00	80500.00
12.	Storage capacity, m^3	876	1666	2532
13.	Cost of storage/m^3, Rs.	33.45	32.53	31.79

Calculation of storage losses from the farm pond

Pond evaporation during *Kharif* season at Yavatmal was found to be 543.83 mm. From Table 2 it reveals that, the ratio of storage loss to the total runoff volume stored varies from 23.78 to 26.16 per cent.

Design of farm pond

Design of pond for 2 ha. catchment area is presented in Table 3. Cumulative runoff volume from beginning of rainy season to end of the 29th meteorological week is estimated to be 848.26m^3, out of that 700.00 m^3 stored water is proposed to be applied as protective irrigation to 1.05 ha. area of 5 cm depth considering 75 per cent irrigation efficiency, then 148.26 m^3 volume remain in the pond. Similarly, one more irrigation is possible in 34th meteorological week to 1.05 ha area. At the end of rainy season i.e. in 40th meteorological week runoff volume balance in the pond is calculated to be 639.93 m^3, which can irrigate 0.96 ha. area of 5 cm depth. Considering 80 per cent of runoff volume from 2 ha. catchment plus rainfall in the pond after deducting storage losses during rainy season total arrested water is estimated to be, 2039.93 m^3. Thus the design size of pond for 2 ha. is found to be 20.0 x 20.0 m with 3 m depth and 1:1 side slope.

Similarly the ponds were designed for 4 and 6 ha. catchment area. The design capacity and sizes of pond for 4 and 6 ha. were found to be 1666, 2532 m^3 and 26.5 x 26.5, 32.0 x 32.0 m with 3m depth and 1:1 side slope.

Area irrigated by farm pond

Area irrigated by pond is presented in Table 2. It revealed that total volume of water stored in the pond is found to be 2039.93, 4091.53 and 6108.69 m^3 for 2, 4 and 6 ha. catchment area, respectively, from which three irrigation's are possible to about 1.01, 2.05 and 3.05 ha. area respectively, which is approximately 51 per cent of catchment area. The total area under pond ranged from 2.94 to 4.50 per cent of catchment area considering 2 m berm and bund with 3 m bottom width. From stored water in pond, one irrigation to complete catchment area and second irrigation to 52 to 53 per cent of catchment area is possible.

Cost of farm pond

Table 2 reveals that the cost of construction

Table 3. Design of farm pond for 2 ha catchment area for Yavatmal (Side slope-1 : 1, Size - 20.0 m x 20.0 m)

Meteo-rological week	Rain-fall, mm	Runoff, mm	Runoff, volume, m^3	80% of runoff volume, m^3	Rainfall in pond, m^3	Total runoff volume, m^3	Storage losses		Runoff volume at end of period, m^3	Cumulative runoff volume, m^3	Remarks
							pond Evaporation, m^3	seepage m^3			
23	26.37	6.525	130.50	104.40	10.55	114.95	10.72	15.85	88.38	88.38	
24	36.22	2.341	46.48	37.46	14.48	51.94	9.04	18.83	24.07	112.45	
25	66.11	11.257	225.14	180.11	26.44	206.55	6.77	19.63	180.15	292.60	
26	29.86	0.432	8.64	6.91	11.94	18.85	7.00	19.41	-7.56	285.84	
27	43.73	0.834	16.68	13.34	17.49	30.83	6.62	19.49	4.80	289.84	
28	74.96	10.539	210.78	168.62	29.98	198.60	6.06	22.42	170.12	459.96	
29	89.39	24.213	484.26	387.41	35.75	423.16	6.86	28.00	388.30	848.26-700.00=148.26	Irrigation of 5
30	48.76	7.310	146.20	116.96	19.50	136.46	5.00	18.94	112.52	260.80	cn deopth to
31	69.19	9.799	195.98	156.78	27.67	184.45	5.88	21.56	157.01	417.81	1.05 ha. area
32	50.00	6.970	135.80	108.64	20.00	128.64	6.45	23.18	99.01	516.82	
33	42.49	7.147	142.94	114.34	16.99	131.33	5.39	24.87	101.07	617.89	
34	57.07	15.886	317.72	254.10	22.82	276.92	5.27	28.00	243.65	861.54-700.00=161.54	Irrigation of 5
35	78.46	24.133	482.66	386.13	31.38	417.51	6.06	23.69	387.76	549.30	cm depth to
36	33.74	2.493	49.86	39.89	13.49	53.88	6.14	24.08	23.66	572.96	1.05 ga, area
37	31.92	4.699	93.98	75.18	12.76	87.94	7.68	25.00	55.26	628.22	
38	26.93	4.734	94.68	75.74	10.77	86.51	8.40	25.53	52.58	680.80	
39	20.78	0.751	15.02	12.02	8.29	20.31	8.07	25.27	-13.03	667.77	
40	10.12	0.047	0.94	0.75	4.04	4.79	7.50	25.13	-27.84	639.93	

of farm pond for 2, 4 and 6 ha. catchment area were estimated to be Rs. 29300, 54200 and 80500 for sizes 20.0 x 20.0, 26.5 x 26.5 and 32.0 x 32.0 m respectively. The cost of storage of runoff water per m^3 ranges from Rs. 31.79to 33.45 for 6 to 2 ha. catchment area.

From this study it is concluded that the design sizes of pond for Yavatmal were found to be 20.0 x 20.0, 26.5 x 26.5, 32.0 x 32.0 m and storage capacities 876, 1666, 2532 m^3 with 3m depth and 1:1 side slope for 2, 4 and 6 ha. catchment area respectively. The storage losses vary between 23.78 to 26.16 per cent of total runoff volume stored. Also, one irrigation to complete catchment area and second irrigation to 52 to 53 per cent of catchment area of 5 cm depth considering 75 per cent irrigation efficiency is possible from pond water with area under pond ranging between 2.94 to 4.50 per cent of the total catchment area. The cost/m^3 of storage runoff water is found to be Rs. 33.45, 32.53 and 31.79 for 2, 4 and 6 ha. catchment area, respectively. The cost of storage/ m^3 of runoff volume decreases as catchment area or size of pond increses.

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Effect of Land Grading and Smoothening on the Yield of Wheat Crop Under Border Irrigation

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ABSTRACT

A study was conducted for wheat crop during 1996 to 1999 at Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola to test the effect of different implements for land grading and smoothing on depth of irrigation water, crop yield and field water use efficiency. From the study, it is revealed that the land grading and smoothening by Terracer blade before sowing of wheat crop required lesser depth of irrigation water and gave higher crop yield along with more field water use efficiency over Tropicultor, Wooden float and Buck scraper treatments. The land treated with Terracer blade saved 12.88 per cent irrigation water and increased 15.36 per cent crop yield over control.

Land grading is reshaping of the field surface to a planned grade. It is necessary in making a suitable field surface to control the flow of water and to check soil erosion. Land grading is equally beneficial in un-irrigated areas so as to conserve moisture, reduce soil erosion and facilitate surface drainage (Michael, 1978). Criteria for land grading is influenced by the characteristics of the soil profile, prevailing land slope, rainfall characteristics, cropping pattern, method of irrigation and other special features of the site including the preference of the farmer.

The major factors affecting the infiltration of water into the soil are initial moisture content, condition of soil surface, hydraulic conductivity of soil profile, texture, porosity, degree of swelling of soil colloides and organic matter, vegetation cover, duration of irrigation or rainfall and viscosity of water. Due to precise smoothening, infiltration rate increases at early stages of irrigation. The increased infiltration rate increases the availability of water in the root zone. This good status of available moisture increases the yield of wheat crop along with saving in irrigation water. The water thus saved could be utilized for increasing crop areas, yields and overall crop production (Khattak, *et. al.*, 1981). Land grading is done by tractor drawn and bullock drawn equipments. Land smoothening is done by tractor drawn land planes or bullock drawn wooden floats.

Usually the agricultural field is not graded to a truly levelled surface, but a gentle uniform slope is maintained to meet the requirement of irrigation. Therefore, land grading smoothens the field to eliminate uneven surface to get uniform advance of flow and permits uniform distribution of water in the root zone. In general, farmers do not consider the soil and site conditions of their fields and use any of the land grading implement easily available for them. Due to this, their effort in achieving proper soil condition goes waste. Increased irrigation potential and consolidation of land have compelled the farmers to reshape their fields (Pradhan, *et. al.*, 1988). The information regarding effect of land grading on irrigation depth, field water use efficiency and crop yield is not largely available. Hence a study was conducted for wheat crop to test the effect of different land grading and smoothening implements on depth of irrigation water, crop yield and field water use efficiency.

MATERIAL AND METHODS

The experiment was conducted during 1996-97, 1997-98 and 1998-99 at National Agricultural Research Project, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The locally available implements like Tropicultor (T_1), Wooden float (T_2), Buck scraper (T_3) and Terracer blade (T_4) were used for land grading and smoothening before sowing of wheat crop. The one plot was kept as control (T_5). With all treatments, the experiment was replicated for four times. The wheat crop (var. AKW-381) was sown. The field was irrigated with 3.5 lps irrigation stream.

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Table 1. Depth of water, cm and saving in irrigation water, per cent for different treatments

Treatments	Depth of irrigation water, cm				Saving in irrigation water over control, %
	1996-97	1997-98	1998-99	Pooled mean	
T_1- Tropicular	27.45	25.96	28.13	27.18	10.24
T_2- Wooden float	27.59	26.61	28.88	27.69	8.55
T_3 - Buck scraper	28.46	28.48	30.08	29.00	4.23
T_4-Terracer blade	26.93	25.02	27.20	26.38	12.88
T_5- Control	30.23	29.83	30.80	30.28	-
'F' test	Sig.	Sig.	Sig.	Sig.	
SE (m)±	0.30	0.162	0.421	0.185	
CD at 5%	0.93	0.47	1.29	0.57	
CV%	2.14	1.19	2.90	2.29	

Table 2. Crop yield, kg ha^{-1} and per cent increase in yield for different treatments

Treatments	Growth yield, kg ha^{-1}				Increase in yield over control,%
	1996-97	1997-98	1998-99	Pooled mean	
T_1- Tropicular	3201.22	863.41	3174.06	2412.89	9.82
T_2- Wooden float	3170.73	853.66	3123.11	2382.50	8.44
T_3 - Buck scraper	2987.81	834.14	3074.17	2298.70	4.62
T_4-Terracer blade	3445.12	902.44	3256.26	2534.60	15.36
T_5- Control	2804.88	790.24	2996.10	2197.07	-
'F' test	Sig	Sig	Sig	Sig	-
SE (m)±	123.06	25.81	84.06	44.19	-
CD at 5%	379.00	74.77	–	135.60	-
CV%	7.88	6.08	5.38	6.47	-

Table 3. Field water use efficicney (FWUE), kg ha^{-1} -cm as influenced by different treatments

Treatments	FWUE, kg ha^{-1}-cm				% increase over control
	1996-97	1997-98	1998-99	Pooled mean	
T_1- Tropicular	116.65	33.25	112.83	87.57	21.08
T_2- Wooden float	114.97	32.09	108.54	85.06	17.61
T_3 - Buck scraper	104.80	29.29	102.28	78.79	8.94
T_4-Terracer blade	128.17	36.07	119.75	94.66	30.89
T_5- Control	92.83	26.49	97.64	72.32	-
'F' test	Sig	Sig	Sig	Sig	-
SE (m)±	4.80	1.02	3.33	1.73	-
CD at 5%	14.78	2.96	10.23	5.30	-
CV%	8.60	6.50	6.16	7.16	-

The length and width of the border were 20 m and 1.75 m respectively and laid on 0.5 per cent slope. The field soil was clay soil having 1.32 g cc^{-1} bulk density, 31.50 per cent field capacity, 16.50 per cent permanent wilting point, 50.18 per cent porosity and 0.6 t^{05} cm hr^{-1} infiltration rate. The depth of irrigation water is calculated by recording the advance time of water front. The crop yield is recorded and field water use efficiency is determined.

RESULTS AND DISCUSSION

Table 1 revealed that the maximum depth of water was required in the control (30.28 cm) and significantly higher over all treatments. The minimum depth of water was observed in Terracer blade (26.38 cm). The Buck scraper (29.00cm) was required significantly more depth of water than Tropicultor (27.18 cm), Wooden float (27.69 cm) and Terracer blade treatments. The Tropicultor was required significantly more depth than Terracer blade but was at par with the Wooden float treatment. The saving in irrigation water over control was maximum (12.88%) in the treatment of Terracer blade. The Tropicultor was recorded 10.24 per cent saving in irrigation water over control. The saving in water by Wooden float and Buck scraper treatments was observed as 8.55 and 4.23 per cent over control, respectively.

From the pooled data, it is observed (Table 2),that the highest grain yield of wheat crop was obtained in the Terrace blade treatment (2534.60 kg ha^{-1}) and was significantly superior over the yield obtained in Wooden float (2382.50 kg ha^{-1}), Buck scraper (2298.70 kg ha^{-1}) and control (2197.07 kg ha^{-1}) treatments. The yield recorded in Terracer blade and Tropicultor treatments was at par with each other. The yield obtained in the treatments of Tropicultor, Wooden float and Buck scraper was at par with each other. The minimum yield was recorded in control (2197.07 kg ha-1).

From the pooled data presented in Table 3, it is observed that the maximum field water use efficiency was obtained in the Terracer blade treatment (94.66 kg ha^{-1} cm) and it was significantly superior over all other treatments i.e. Tropicultor (87.57 kg ha^{-1}-cm), Wooden float (85.06 kg ha^{-1}-cm), Buck scraper (78.79 kg ha^{-1} -cm) and control (72.32 kg ha^{-1}-cm), respectively. The field water use efficiency recorded in the treatments of Tropicultor and Wooden float was at par with each other but significantly higher over Buck scraper and control. The Buck scraper treatment gave significantly more field water use efficiency than control. The minimum field water use efficiency was observed in control (72.32 kg ha^{-1}-cm). It is concluded from the pooled data of three years that the land grading and smoothening by Terracer blade before sowing of wheat crop saved 12.88 per cent irrigation water and increased 15.36 per cent crop yield. Terracer blade required lesser depth of irrigation water and gave higher yield of wheat crop along with more field water use efficiency over Tropicultor, Wooden float and Buck scraper treatments.

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Effect of Water Frequency on Physiological Functions in Lactating Crossbred Cows

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ABSTRACT

To access, the influence of water frequency on physiological reactions in lactating crossbred cows, 18 animals were randomly divided in to three groups T_1 (ad libitum), T_2 (9.00 and 21.00 hours) and T_3 (9.00, 15.00 and 21.00 hours) comprising 6 animals in each. Significant and positive correlation with respiration rate was observed at 8.30 hours in all groups. There was significant and positive correlation of pulse rate with watering frequency at 14.30 and 19.00 hours in T_1. whereas, significant and positive correlation was observed for T_2 and T_3 at 8.30 hours. Rectal temperature established significant and positive correlation in T_1 at 8.30, 14.30 and 19.00 hours. However, no significant correlation was found for rectal temperature at any interval in T_3. The physiological reactions showed no significant correlation with relative humidity at 8.30 hours in all groups. However, the negative significant correlation was found for ambient temperature and relative humidity with physiological reactions. It was observed that, physiological reactions during summer months are more dependents on climatic conditions.

Water is the most abundient of the animal body at every stage in development. For maximum efficiency the water content of the animal tissue must be maintained within normal limits. Water is lost continuously in the urine and faeces and by evaporation from the body surface. In order to maintain the normal body function at least total water made available to the animal must equal to the output of water. The present study was conducted to know effect of drinking water frequency on body function of crossbred cows.

MATERIAL AND METHODS

Eighteen crossbred cows were selected for the study and divided randomly in to three groups (T_1, T_2 and T_3) comprising of 6 cows in each group. The animals in T_1 were allowed to drink water ad libitum and in T_2 at 9.00 and 21.00 hours. Whereas, animals in T_3 were allowed to drink water for three times at 9.00, 15.00 and 21.00 hours. The water intake by individual animal was recorded daily. During the experimental period (15th March to May 15th), the lactating crossbred cows were fed with known quantity of chaffed green maize, wheat straw twice daily whereas, amount of concentrate mixture fed was based on milk production of individual cow (ICAR, 1985). Daily observation on rectal temperature (clinical veterinary thermometer), pulse rate min^{-1} (feeling coccygeal artery) and respiration rate min^{-1} (flank movement) were recorded for individual cow at 8.30, 14.30 and 19.00 hours. Dry and wet bulb thermometer was hung in the shed to record minimum and maximum ambient temperature and relative humidity. All the experimental crossbred cows were kept under shed with asbestos roofing and sides open for 62 days.

The data was analyzed as per the procedure recommended by Snedecor and Cochran (1967).

RESULTS AND DISCUSSION

The water intake showed significant and positive correlation with respiration rate at 8.30 hours in all groups. Whereas, positive and significant correlation was observed in T_2 and T_3 at 14.30 hours, but had no significant correlation with T_1 (Pyane and Hancock, 1957).

Pulse rate had no significant correlation with T_1 at 8.30 hours whereas, positive and significant correlation was observed for T_2 and T_3. However, pulse rate had no significant correlation with frequency in T_1 and T_3 at 14.30 and 19.00 hours. Pal *et. al.*, (1975) and Little *et. al.*, (1976) reported the similar findings that the pulse rate was not significantly affected due to the frequency of watering.

There was no significant correlation with rectal temperature at any interval in T_3. However, the significant positive correlation was observed

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Table 1. Correlation of physiological reactions with water frequency

	T_1	T_2	T_3
	Correlation values		
Respiration rate			
8.30	0.181*	0.273**	0.348**
14.30	0.094	0.134*	0.334**
19.00	0.026	0.134*	0.340**
Pulse rate			
8.30	0.005	0.158**	0.119*
14.30	0.202**	0.027	0.021
19.00	0.192*	0.046	0.063
Rectal temperature			
8.30	0.139*	0.255**	0.058
14.30	0.249**	0.165**	0.101
19.00	0.173**	0.228**	0.089
Respiration rate x Ambient Temp.			
8.30 hrs	0.065	-0.152**	0.084
19.00 hrs	0.101*	0.028	-0.026
Respiration rate x relative humidity			
8.30 hrs	0.03	0.008	0.013
19.00 hrs	0.070	0.076	-0.281**
Pulse rate x ambient temperature			
8.30 hrs	0.026	0.07	0.047
19.00 hrs	0.064	-0.126*	0.034
Pulse rate x relative humidity			
8.30 hrs	0.064	0.054	0.028
19.00 hrs	-0.176**	-0.149**	0.058
Rectal temperature x Ambient temperature			
8.30 hrs	0.026	0.093	0.012
19.00 hrs	0.011	0.007	0.023
Rectal temperature x relative humidity			
8.30 hrs	0.032	0.015	0.089
19.00 hrs	-0.157	-0.155**	-0.251**

* Significant at 5 per cent level, ** Significant at 1 per cent level

for T_1 and T_2. This indicates that frequency of watering had no role in maintaining the rectal temperature of cows during stress period of the day.

The physiological reactions of the cows had no correlation with ambient temperature and relative humidity at 8.30 hours in different watering frequency. Whereas, negative and significant correlation were observed for ambient temperature and relative humidity at 19.00 hours. The negative and significant correlation of humidity with physiological reactions at 19.00 hours indicates that there was rise in physiological reactions at 19 hours indicates that there was rise in physiological reaction with decreased humidity levels. It was observed that physiological reactions viz. rectal temperature, respiration rate and pulse rate were dependent on

atmospheric conditions as a strong relationship exist between air temperature and humidity with that of physiological reactions (Kundu and Bhatnagar, 1980, Singh, 1980, Patel *et. al.*, 1985 and Mishra *et. al.*, 1995).

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Growth and Development of Dairy Cooperative Societies in Akola District

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ABSTRACT

The growth rate of number of societies, animals and milk production during the year 1985-2002 was studied. Development of milk cooperative over 17 years span (1985-2002) was not encouraging for cooperative movement. Milk cooperative societies increased from 250 in 1985 to 318 in 2002-2003 leading to a growth of 21.38 per cent in societies. On the other hand the number of society members did not increase proportionately. The number of functional societies registered a reducing trend 52.43 per cent. Membership of working societies decreased by 66.79 per cent from 1985-87 to 2000-2002. The growth rate of milk collection by the milk co-operative registered decline trend year^{-1} (-1.30%) during experimental period. Milch cow and buffalo increased significantly at the rate of 4.22 and 5.99 per cent.

The dairy cooperative has a four level structure which consists of National Dairy Development Board (NDDB), state federations, milk unions and dairy cooperative societies operating at the national level, state level, district level and village level, respectively. In India, during the year 1995 total number of dairy cooperative societies were 69,868 and total members were 8992 (Dairy India, 1997)

In Maharashtra, during the year 1961 the total cooperatives were 431 and total members were 155. These figures increased upto 20084 and 1580600 during the year 1997, respectively.

In Akola district, the milk producer's cooperative societies were also established. The societies flourished and collected maximum possible milk from rural areas of Akola district. The total number of milk cooperative societies registered in Akola district was 189. However, at present only 33 milk cooperative societies are functioning properly.

MATERIAL AND METHODS

In Akola district, three tahsils were selected on the basis of working more number of dairy co-operative societies and their higher milk production as compared to other tahsils. Out of 33 societies, which are, functioning, nine co-operative societies were selected randomly comprising 3, 1 and 5 from Akola, Barshitakli and Akot tahsils, respectively.

The compound growth rate was estimated for total number of societies, working co-operative societies, total number of member of society, member of working co-operative societies, milk collection by the milk co-operative in Akola district for 17 years i.e. from year 1985 to 2002 and growth rate of milch cows and buffaloes for six census i.e. from year 1872-1997. About 84 trends were fitted to study the behaviours performance of data amongst all exponential trend.

RESULTS AND DISCUSSION

The examination of data from Table 1 indicated that milk cooperative societies increased from 250 in 1985-87 to 318 in 2000-2002, leading to a growth of 21.3 per cent in societies. But, the number of members did not increase proportionately. There was marginal decline to 14010 members in 2000-2002 from the member number of 14895 in 1985-87. These results are in agreement with Rao (1994), Rao and Singh (1993) and Duhan and Singh (1982). However, Jain *et. al.*, (1987) noted contradictory trend.

Inspite of the growth in milk cooperatives, the number of functional or working societies, reduced from 122 in 85-86 to 58 in 2001-2002 (52.45%). Similarly the members of working societies had also decreased by 66.79 per cent i.e. from 7274 in 1985-87 to 2415 members in 2000-2002. These situations together had influenced on the annual collection of milk by the co-operative societies in the district.

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Table 1. Number of milk co-operative societies, their membership in Akola district

Year	Milk co-operative indicators			
	Total societies	Members	Working	Members
1985-87	250	14895	122	7274
1988-90	266	1654	73	4513
1991-93	285	16062	83	4572
1994-96	299	14506	81	3745
1997-99	317	14868	72	3345
2000-02	318	14010	58	2415

Table 2 Number of milch animals as per census

Census	Milch animals		Per cent change	
	Cows	Buffaloes	Cows	Buffaloes
72	75312	30804	-	-
78	78989	36519	4.88	18.55
82	79529	26923	0.68	-26.27
87	82457	34623	3.68	28.60
92	85927	42318	4.208	22.22

Table 3. Growth rate of co-operative society, members, animals and milk collection

S.N.	Particulars	Compound growth rate (CGR) (%)
1.	Total number of societies	1.542819*
2.	Working co-operative societies	-3.707606*
3.	Total number of members of societies	-0.6192625
4.	Members of working co-operative societies	-5.809045*
5.	Milk collection by the milk cooperative	-1.392281
6.	Total number of milch cows	4.240096*
7.	Total number of milch buffaloes	5.990756*

*Significant at 5 per cent level of significance

However, the number of milch cows and buffaloes had shown an increasing trend over a period of experimental study (Table 2). These encouraging growth rate in bovine milch population does not mean the boost to dairying in reference to production of milk because there were significant inter and intra regional differences in the productivity of cows and buffaloes (Patel *et al.*, 1998). Therefore, it is necessary to develop potential animals in the district rather than numerical increase in population.

Results regarding growth rate of cooperative society, members, animals and milk collection are presented in Table 3. Important feature of the development is that the milch animals (cows and buffaloes) increased significantly at the rate of 4.24 and 5.99 per cent year^{-1} in the district, respectively. The growth rate of buffaloes was higher than that of cows, which is an indication of inclination towards buffalo for dairying. Emphasis on buffalo rearing was also noticed by Dorston (1990) for Gujarat, Mattigatti *et.al.*, (1990) for Dharwad district and Shiyani (1996) for Saurashtra. Milk cooperative societies in the district increased at the rate 1.54 per cent annum^{-1}. This growth was found significant. This incidates that the farmers realized the importance and pivotal role of milk co-operatives in raising their socio-economic status. The overall growth in member of societies exhibited a negative rate of -0.61 per cent

year^{-1}. However, their negative growth rate was found non-significant, indicating practically no remarkable change in the membership of societies. Growth rate was negative (-3.70 % and -5.88 %) but significant between working societies and members of society. This might be due to the fact that the societies were closed down either on account of non-collection of milk or irregular payments and collection of inadequate quantity of milk from the members. (Shah 2000) observed that out of 1174 registered societies in Jalgaon district, 50 societies were under liquidation and 494 were dormant.

With regards to growth rate of milk collection by the milk co-operatives, it was noticed that rate of milk collection decreased by -1.39 per cent year^{-1}, though this growth rate was found non significant. This means that the rate of collection was more or less similar over the period of study. The tendency of members for diversion of milk to private sector might have reflected on the milk supply to co-operatives. This might be due to more prices, regular payment irrespective of quality of milk.

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Stability and Economics of Need Based, Legume Incorporated Crop Sequences Under Vidarbha Condition

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ABSTRACT

A field trial to study the stability and economics of crop sequences was conducted from 1992-93 to 1994-95 at AICRP on Cropping Systems Research, Dr. PDKV, Akola. The treatments consisted of six crop sequences viz. chilli (green)- groundnut, cotton - groundnut, pigeonpea-chickpea-groundnut, soybean-wheat-clusterbean, sorghum-wheat-cowpea and sorghum-chickpea-groundnut arranged in randomized block design with four replications. Pooled results indicated that the chilli (green)-groundnut recorded the highest productivity, monetary returns and B:C ratio. Next remunerative sequence was observed to be cotton-groundnut. However, fertility status of the soil in respect of net gain in N and K was improved in sorghum-chickpea-groundnut sequence.

Under irrigated conditions, multiple cropping is a common practice. Inclusion of legumes in such crop sequences is beneficial in order to maintain the sustainability in yields. Legumes benefits the succeeding crop is a well known fact. The residues and the root nodules releases N during decomposition for the use of succeeding crop. It is also known that the legumes absorb soil phosphorus more efficiently and part of this mobilized in organic form is available to the succeeding crop. As a result, inclusion of legumes in intensive cropping systems has become imperative (Palaniappan, 1984). A field trial was undertaken to study the comparative performance of legumes inclusive crop sequences under irrigated conditions.

MATERIAL AND METHODS

A field experiment was conducted on a vertisol during 1992-93 to 1994-95 at AICRP on Cropping Systems Research, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The experimental field was low in total nitrogen (0.038 %), available N (195 kg ha^{-1}) and available P (18.0 kg ha^{-1}) while rich in available K (320 kg ha^{-1}) with pH 7.6 and EC 0.18 dSm^{-1}. Six crop sequences (Table 1) were tried in RBD with four replications on a plot size of 7.2 x 5.4 m^2. The crops included in the sequences were raised with recommended package of practices. The soil samples were taken before sowing and after harvesting of individual crop included in the study in order to assess the fertility status. While calculating monetary returns, the prices of the commodities prevailed during last year were considered for all the three years. Recommended plant protection schedule for each crop was adopted. Irrigations were given as and when required to the crops included in the sequence. The total annual rainfall received during 1992-93, 1993-94 and 1994-95 was 905.0, 956.9 and 907.4 mm, respectively.

RESULTS AND DISCUSSION

Crop productivity

During 1992-93 and 1993-94, chilli-groundnut sequence has recorded the highest total productivity (Table 1). However, the data of 1994-95 showed the highest productivity in case of soybean-wheat-clusterbean sequence. Average over three years proved the superiority of chilli-groundnut sequence while next best sequence was soybean-wheat-clusterbean. The lowest productivity was recorded by cotton-groundnut crop sequence.

Gross and net monetary returns

Chilli-groundnut crop sequence has recorded significantly highest GMR during all the three years as well as after pooling (Table 2). Pooled data further revealed that the cotton-groundnut was the next best profitable sequence although it was at par with sorghum-chickpea-groundnut but

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Table 1. Productivity (kg ha^{-1}) as influenced by various crop sequences

Treat-ments	Crop sequence	Variety	Crop yield kg ha^{-1}			
			1992-93	1993-94	1994-95	Mean
T_1	K Chilli (green)	Jwala	9103	9546	7375	8665
	R continued	-	-	-	-	-
	S Groundnut	TAG-24	2418	1799	2696	2304
	Total		11521	11345	10071	10979
T_2	K Cotton	AHH-468	1847	2738	1675	2087
	R Continued	-	-	-	-	-
	S Groundnut	TAG-24	2329	2130	2685	2381
	Total		4176	4868	4360	4468
T_3	K Pigeonpea	ICPL 85012	900	1062	869	944
	R Chickpea	ICCV-2	1741	2063	1435	1746
	S Groundnut	TAG-24	2100	1737	1874	1904
	Total		4741	4862	4178	4594
T_4	K Soybean	PK 472	1565	2671	1485	1907
	R Wheat	AKW-381	4006	3115	4088	3736
	S Clusterbean (v)	Pusa Sadabahar	5057	4744	6157	5319
	Total		10628	10530	11730	10962
T_5	K Sorghum	SPH-468	4758	3870	2276	3635
	R Wheat	AKW-381	3884	3430	3815	3710
	S Cowpea (v)	Pusa Dofasli	2010	2198	3058	2421
	Total		10652	9498	9147	9766
T_6	K Sorghum	SPH-468	4242	3984	2495	3574
	R Chickpea	ICCV-2	1578	1705	1348	1544
	S Groundnut	TAG-24	1687	1703	2223	1871
	Total		7507	7392	6066	6989

Table 2. Gross monetary returns, net monetary returns and B:C ratio as influenced by various crop sequences

Treat-ments	Crop sequence	Gross monetary returns (Rs.ha^{-1})				Net monetary returns (Rs. ha^{-1})				B:C ratio
		1992-93	1993-94	1994-95	Pool mean	1992-93	1993-94	1994-95	Pool mean	
T_1	K Chilli (green)	72821	76368	58997	69395	60321	63868	46497	56895	
	R continued	-	-	-	-	-	-	-		
	S Groundnut	33697	25167	37097	31988	25427	16897	28827	23718	
	Total	10618	101535	96094	101383	85748	80765	75324	80613	3.88
T_2	K Cotton	37038	54676	33887	41867	26487	44105	23316	31296	
	R Continued	-	-	-	-	-	-	-	-	
	S Groundnut	31943	30263	36937	33048	23725	22045	28719	24830	
	Total	68981	84939	70824	74915	50192	66150	52036	56126	2.99
T_3	K Pigeonpea	17704	18271	14917	16964	11288	11855	8501	10548	
	R Chickpea	23918	27490	19375	23594	17142	20714	12599	16818	
	S Groundnut	28857	24378	25887	26374	20589	16110	17619	18106	
	Total	70779	70139	60179	66932	49019	48679	42329	45472	2.12
T_4	K Soybean	15445	26031	15172	18883	8005	18591	7732	11443	
	R Wheat	24426	18790	25385	22867	16666	11030	17625	15107	
	S Clusterbean (v)	20226	18976	24627	21277	12570	11320	16971	13621	
	Total	60097	63797	65184	63027	37241	40941	42328	40171	1.76
T_5	K Sorghum	32719	24972	15820	24504	25049	17302	8150	16834	
	R Wheat	23534	20623	23811	22656	25774	12863	18051	14896	
	S Cowpea (v)	10050	10989	15278	12105	3735	4674	8983	5790	
	Total	66303	56584	54909	59265	44558	34839	43504	37520	1.73
T_6	K Sorghum	29865	25672	17152	24230	22195	18002	9482	16560	
	R Chickpea	21408	22352	18159	20640	14632	15576	11383	13864	
	S Groundnut	23570	23903	30908	26126	15302	15835	22640	17858	
	Total	74843	71927	66219	70996	52129	49243	43505	48282	2.13
	SE (m) ±	1316	3617	2257	2095	1316	3617	2257	2095	
	CD at 5%	3907	10742	6703	6314	3907	10742	6703	6314	

Table 3. Balance sheet of available NPK (kg ha^{-1}) as influenced by various crop sequences at the end of 1994-95

Treat-ments	Crop sequence			Initial soil fertility status			Status of the soil at the end of three years			Net gain (+) or loss (-) over initial status		
	Kharif	Rabi	Summer	N	P	K	N	P	K	N	P	K
T_1	Chilli (green)	-	Groundnut	267	48	305	339	38	323	72	(-)10	18
T_2	Cotton	-	Groundnut	250	50	307	313	37	330	63	(-) 13	23
T_3	Pigeonpea	Chickpea	Groundnut	290	48	299	376	38	320	86	(-)10	21
T_4	Soybean	wheat	Clusterbean	266	53	305	326	35	327	60	(-)18	22
T_5	Sorghum	Wheat	Cowpea	272	44	318	306	36	330	34	(-)8	12
T_6	Sorghum	Chickpea	Groundnut	248	49	307	338	38	336	90	(-) 11	29

significantly superior over rest of the sequences. More or less similar results were recorded in case of net monetary returns. Similar results in respect of productivity, GMR and NMR were also recorded by Dhoble *et. al.*, 1987.

Benefit : Cost Ratio

The highest benefit cost ratio (3.88) was recorded by chilli-groundnut, followed by cotton-groundnut (2.99) (Table 2). The lowest benefit-cost ratio of 1.73 was noted in case of sorghum-wheat-cowpea.

Balance sheet of available NPK

The data on balance sheet (Table 3) of NPK revealed that in general, there is net gain in case of nitrogen and potash while loss in case of available phosphorus at the end of three years of cropping. Amongst the treatments of crop sequences, the data further revealed that the highest net gain in available nitrogen and potash was recorded in sorghum-chickpea-groundnut wherein two legumes were included. The lowest gain in nitrogen and potassium was observed in case of sorghum-wheat-cowpea wherein only one legume was incorporated in crop sequence. As regards net loss in available phosphorus, the lowest loss is observed in sorghum-wheat-cowpea crop sequence while highest in case of soybean-wheat-clusterbean sequence. This conform the findings of Kharkar *et. al.*, 1999.

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Varietal Response of Mustard (*Brassica juncea* L.) in Relation to Sowing Dates, Irrigation, Growth, Yield and Water Use

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ABSTRACT

A field trial was conducted in clay soils at Akoal, India, during the winter (*Rabi*) seasons of 1999-2000 and 2000-20001 with the object to compare the performance of new mustard variety ACN-9 with Pusa Bold under sowing dates irrigation regimes and mulching. Growth and yield components and seed and oil yield varied significantly because of various treatments. Significantly higher growth parameters resuted in significant increase in dry matter, yield attributes and seed yield in 15 Nov. sown crop. late sowing on 30th November caused considerable reduction in water use efficiency (WUE), relative water use rate (RWR) and absolute water use rate (AWR) that ultimately increased the consumptive use (CU). Significantly increase in growth and yield parameters as in 0.6 IW/CPE ratio also had pronounced effect on seed yield, oil content and oil yield, availment of more irrigation and caused increase in CU, because of more branches and siliquae the variety ACN-9 over yielded Pusa bold. Judicious water use was achieved due to 5 t ha^{-1} of mulch application which resulted in lowering CU, their increased RWR and AWR values.

Indian mustard is coming up as substitute to safflower in Vidarbha, because of its simple cultivation, suitability to wide agro-climatic conditions, usefulness as edible oil, less water need and still better production. Proper sowing date, judicious wate use, availability of suitable variety can make the mustard cultivation more economic. With this view, thepresent investigation was undertaken to findout the proper irrigation schedule and appropriate sowing date for newly released variety ACN-9 in comparison with Pusa Bold.

MATERIAL AND METHODS

A field study was carried out during winter season of 1999-2000 and 2000-2001 on clayey soils of Agronomy Farm of Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (Maharashtra). The available N, P and K in soil was 170.5, 24.6 and 242.9 kg ha^{-1} respectively, with 7.9 pH. The value of FC, PWP, BD, EC were 32.58 per cent, 17.25 per cent , 13.5 g cm^3 and 0.62 d sm^{-1}. The experiment was laid out in split -split-plot design with four replications. Sowing dates (15 and 30 Nov.) and irrigation levels (0.4 and 0.6 IW/CPE ratio) were allotted combinely to main plots and varieties (ACN-9 and Pusa Bold) represented as subplots and mulch (0 and 5 t ha^{-1}) treatments were allotted in sub-sub-plot. Sub-sub-plot size was 4 x 3.6 m^2. Five kg seed ha^{-1} was hand drilled at 45 x 20 cm^2 spacing. Wheat straw mulch was applied at 21 days after sowing. A common pre-sowing irrigation of 6 cm depth was applied. Phosphorus through SSP and N through urea @ 40 and 25 kg ha^{-1}, respectively were applied as basal dose and 25 kg N was top dressed 30 days after sowing. Irrigation of 60 mm depth were applied by using 90°'V' notch. Ancillary observations were recorded at 15 days interval. Two sprayings at 1 week interval of mixture of endosulfan (35 EC) @ 715 ml and wettable sulphur powder @ 1250 g ha^{-1} were done for crop protection. Weed control was done by 2 hoeings and 2 weedings. Shelling percentage (SP), CU (Misra and Ahmed 1987), harvest index (HI) & WUE (Reddy and Reddi, 1997) were worked out by using following formulae.

$$SP = \frac{\text{Weight of seed obtained from 100 g siliquae}}{\text{100 g siliquae}} \times 100$$

$$HI = \frac{\text{Seed yield}}{\text{Biological yield}} \times 100$$

$$CU = \sum_{K=1}^{N} (Ek \times 0.8) + \sum_{i=1}^{n} \frac{M_1^i - M_2^i}{100} \times Asi \times Di + ER$$

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$$Cu = \Sigma Cu$$

CU = Water used in two successive sampling periods in mm
Cu = Seasonal consumptive use (mm)
Ek = Actual evaporation for the period of 1 to 2 days immediately after k^{th} irrigation from USWB pan evaporimeter
N = Number of times
M1i = Soil moisture after irrigation (%)
M2i = Soil moisture before next irrigation (%)
n = Number of soil layers
Asi = Bulk density of with layer (g cm-3) of dry soil
Di = Soil depth of with layer (mm)
Σ = Sum of
ER = Effective rainfall

$$WUE = \frac{\text{Seed yield (kg)}}{\text{Consumptive use (mm)}}$$

RESULTS AND DISCUSSION

Effect of sowing dates

The plant height, leaves, branches, dry matter production and duration for 50 per cent flowering and maturity of Indian mustard were significantly influenced by sowing dates. Significantly higher values of all above growth parameters were obtained when mustard crop was sown on 15 November and length of Siliqua, Seeds per Siliqua and 1000 - seed weight were found significantly higher in 15th Nov. date over succeeding date. Lad *et. al.*, (1993) also reported such results and suggested that late planted crop is subjected to relatively lesser times span available for growth which results in less growth and yield attributes in 30th Nov., crop. This improvement coupled with SP, seed to stover ratio and HI resulted in significant increase in seed and oil yield (Table 3). Fifteen days delay in sowing from 15th Nov. caused increase in CU by 17.8 m and 9.8 mm, respectively in first and second year. And also increased the daily water consumption in the form of AWR. Sowing on 15th Nov. also favourably increased the RWR. Average WUE of 7.9 and 5.3 kg ha^{-1} mm for 15 and 30 November sowing dates indicated 54 per cent increase in yield obtained per mm water use. Early sowing appreciably lowered the CU and increased the seed yield due to less daily water use.

Effect of irrigation levels

Increased in siliqua number and its length, seeds per siliquae and 1000 seed weight also resulted in significant increase in seed and oil yield in 0.6 IW/CPE ratio over its lower level. Such increase was due to more water supply that resulted in increasing cell turgidity, opening of stomata and lastly partitioning of photosynthates efficiently to the sink. These results are in corroboration with Patel *et. al.*, (1999).

Increase in soil wetness through more irrigation increased the consumptive use and thereby increasing the WUE due to higher seed yield obtained in 0.6 IW/CPE ratio over 0.4 IW/CPE. The values of AWR and RWR were also found considerably higher with higher number of irrigation. Increase in CU and water use rates was also reported by Thakral *et. al.*, (997). It was observed that the mustard crop availed significantly more number of days to attain 50 per cent flowering and maturity with 0.6 IW/CPE ratio that helped the crop to get more time for growth and development.

Response of varieties

Variety pusa bold recorded significantly more height, number of leaves, dry matter production and also availed higher time span for 50 per cent flowering and maturity than ACN-9. Because of higher secondary or fruiting branches, siliquae $plant^{-1}$, seeds per siliqua and also due to higher shelling percentage and HI, variety ACN-9 over yielded than pusa bold. Increased seed yield also resulted in significant increase in oil yield of ACN-9. Water use parameters viz. CU and AWR and values of WUE and RWR were favourable in ACN-9. Higher WUE in ACN-9 was due to higher seed yield and less CU. These results conform the findings of Lad *et. al.*, (1993).

Effect of mulching

The growth components viz. plant height, branches and dry matter accumulation as well as the yield attributes like length and number of silique, seeds $silique^{-1}$ and 1000 seed weight were found significantly higher in mulched plots. These results support the work of Sadhu *et. al.*, (1996). The crop availed slightly but significantly more days to attain

Table 1. Effect of various treatments on growth components of Indian mustard

Treatments	Plant height (cm)		Leaves plant^{-1}		Secondary branches plant^{-1}		Dry matter (g)		Days for 50 % flowering		Days for maturity	
	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2
Sowing dates												
15th Nov.	145.7	160.5	19.23	22.22	21.93	23.40	38.4	42.14	50.2	51.2	109.1	110.1
30th Nov.	137.4	150.4	16.28	20.44	15.46	16.71	30.07	32.62	47.0	48.0	104.2	105.2
SE (m)±	0.67	0.49	0.31	0.28	0.19	0.14	0.85	0.55	0.013	0.031	0.26	0.26
CD at 0.05%	2.14	1.57	1.00	0.63	0.62	0.45	2.72	1.76	0.041	0.10	0.82	0.82
Irrigation levels (IW/CPE ratio)												
0.4	136.7	148.7	16.22	19.72	15.87	17.04	28.00	31.90	48.2	49.2	105.4	106.4
0.6	146.4	162.3	19.19	22.94	21.52	23.07	40.47	42.86	49.0	50.0	107.8	108.8
SE (m)±	0.67	0.49	0.31	0.28	0.19	0.14	0.85	0.55	0.013	0.031	0.26	0.26
CD at 0.05%	2.14	1.57	1.00	0.63	0.62	0.45	2.72	1.76	0.041	0.10	0.82	0.82
Variety												
Pusa bold	146.5	158.4	18.56	21.94	16.41	17.49	35.42	38.30	54.3	55.3	110.5	111.5
ACN-9	136.5	152.5	15.84	20.72	20.98	22.62	33.04	36.46	42.9	43.9	102.8	103.8
SE (m)±	0.91	0.39	0.23	0.21	0.26	0.28	0.28	0.32	0.012	0.03	0.11	0.11
CD at 0.05%	2.81	1.20	0.72	0.66	0.79	0.87	0.85	0.99	0.036	0.09	0.33	0.35
Mulching (t ha^{-1})												
0	138.4	152.6	16.47	19.94	17.69	18.97	30.62	34.04	48.3	49.3	105.7	106.7
5	144.7	158.4	18.94	22.72	19.70	21.14	37.84	40.72	48.9	49.9	107.6	108.6
SE (m)±	0.87	0.38	0.21	0.20	0.18	0.15	0.22	0.39	0.017	0.04	0.09	0.09
CD at 0.05%	2.53	1.10	0.72	0.57	0.54	0.44	0.61	1.12	0.049	0.12	0.25	0.25

Table 2. Yield attributes of mustard genotypes as affected by different treatments

Treatments	Siliquae plant^{-1}		Length of siliquae (cm)		Seeds siliquae^{-1}		1000-seed weight(g)		Shelling percentage		Seed to stover ratio	
	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2
Sowing dates												
15th Nov.	321.3	412.9	6.30	6.48	13.7	15.7	3.56	3.65	56.3	57.2	0.66	0.83
30th Nov.	233.7	320.5	6.08	6.30	11.0	14.3	3.21	3.29	50.6	50.7	0.51	0.70
SE (m)±	7.65	4.2	0.02	0.02	0.21	0.07	0.01	0.01	0.74	0.35	0.01	0.01
CD at 0.05%	24.47	13.3	0.08	0.06	0.67	0.24	0.05	0.03	2.36	1.13	0.026	0.027
Irrigation levels (IW/CPE ratio)												
0.4	241.2	328.6	6.03	6.34	10.6	14.6	3.20	3.31	50.7	51.2	0.53	0.72
0.6	313.8	404.8	6.35	6.44	13.5	15.5	3.56	3.62	56.1	56.6	0.64	0.81
SE (m)±	7.65	4.2	0.02	0.02	0.21	0.07	0.01	0.01	0.74	0.35	0.01	0.01
CD at 0.05%	24.47	13.3	0.08	0.06	0.67	0.24	0.05	0.03	2.36	1.13	0.026	0.027
Variety												
Pusa bold	229.5	319.6	6.48	6.67	11.5	14.5	3.80	3.82	49.5	50.2	0.48	0.64
ACN-9	325.5	413.8	5.90	6.11	12.5	15.5	2.96	3.11	57.3	57.6	0.69	0.89
SE (m)±	4.37	1.97	0.03	0.02	0.07	0.03	0.03	0.03	0.41	0.24	0.01	0.01
CD at 0.05%	13.39	6.08	0.09	0.06	0.21	0.09	0.08	0.11	1.26	0.74	0.025	0.026
Mulching (t ha^{-1})												
0	250.7	343.2	6.07	6.24	11.6	14.5	3.20	3.29	50.1	50.9	0.55	0.71
5	304.4	390.2	6.31	6.54	12.4	15.6	3.57	3.64	56.8	56.9	0.62	0.82
SE (m)±	5.63	2.59	0.02	0.02	0.03	0.13	0.01	0.02	0.56	0.33	0.01	0.01
CD at 0.05%	16.42	7.56	0.05	0.06	0.09	0.39	0.04	0.06	1.62	0.96	0.026	0.026

Table 3. Yield attributes of mustard genotypes as affected by different treatments

Treatments	Seed yield (q ha^{-1})			Oil content (%)		Oil yield (q ha^{-1})		Harvest index (%)	
	Y_1	Y_2	Y_3	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2
Sowing dates									
15th Nov.	16.48	24.34	20.41	35.74	35.86	5.93	8.73	39.11	44.5
30th Nov.	10.53	17.06	13.80	33.35	33.45	3.52	5.70	33.49	41.0
SE (m)±	0.16	0.08	0.09	0.09	0.10	0.07	0.03	0.26	0.35
CD at 0.05%	0.51	0.24	0.26	0.29	0.32	0.21	0.09	0.84	1.13
Irrigation levels (IW/CPE ratio)									
0.4	10.48	17.82	14.15	34.11	34.24	3.60	6.11	34.14	41.5
0.6	16.54	23.59	20.06	34.98	35.07	5.85	8.32	38.46	44.1
SE (m)±	0.16	0.08	0.09	0.09	0.10	0.07	0.03	0.26	0.35
CD at 0.05%	0.51	0.24	0.26	0.29	0.32	0.21	0.09	0.84	1.13
Variety									
Pusa bold	12.25	19.27	15.76	34.35	34.48	4.25	6.67	32.13	38.8
ACN-9	14.76	22.14	18.45	34.74	34.83	5.19	7.76	40.47	46.4
SE (m)±	0.11	0.09	0.05	0.06	0.08	0.04	0.03	0.29	0.17
CD at 0.05%	0.34	0.28	0.14	0.20	0.24	0.12	0.11	0.89	0.54
Mulching (t ha^{-1})									
0	11.92	18.13	15.02	34.40	34.51	4.14	6.29	34.82	41.0
5	15.09	23.28	19.18	34.70	34.80	5.30	8.14	37.7	44.6
SE (m)±	0.16	0.13	0.07	0.05	0.06	0.05	0.04	0.32	0.22
CD at 0.05%	0.46	0.37	0.20	0.15	0.18	0.15	0.13	0.92	0.64

Table 4. Consumptive use (mm) and water use efficiency (kg ha^{-1}-mm) as influenced by various tratments

Treatments	Consumptive use (mm)		Water use efficiency kg ha^{-1} - mm		Relative water use rate (Et/EO)		Absolute water use rate (mm day^{-1})	
	1999-2000	2000-01	1999-2000	2000-01	1999-2000	2000-01	1999-2000	2000-01
Sowing dates								
15th Nov.	229.3	281.0	7.2	8.7	0.60	1.02	2.19	2.56
30th Nov.	247.1	290.8	4.3	5.9	0.55	0.72	2.45	2.88
Irrigation levels (IW/CPE ratio)								
0.4	215.4	260.5	4.9	6.8	0.45	0.77	2.14	2.54
0.6	261.0	311.4	6.3	7.6	0.70	0.97	2.50	2.90
Variety								
Pusa bold	242.2	290.0	5.1	6.6	0.55	0.85	2.41	2.80
ACN-9	234.2	281.8	6.3	7.9	0.59	0.90	2.23	2.64
Mulching (t ha^{-1})								
0	244.5	290.2	4.9	6.2	0.56	0.84	2.44	2.83
5	231.9	281.6	6.5	8.3	0.59	0.90	2.20	2.61

50 per cent flowering stage and maturity with 5 t ha^{-1} of mulching in both the seasons. This indicated that mulch application extended the growth period and flowering and maturity to get more life time for higher yield. These results are in line with Selveraju (1999). Moisture conservation due to mulch application also significantly increased the values of HI, shelling percentage and seed to stover ratio. Significantly higher yield attributes also increased the seed and oil yield in mulched treatments. Seasonal CU and AWR values were less in mulching condition, indicating judicious water use. Similar results were reported by Jadhav *et. al.*, (1999). Mulch application also increased the RWR and WUE due to significant higher seed yield.

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Correlation and Regression Analysis Studies Between Yield and Morphological Characters of Dhaincha (*Sesbania aculeata* L.)

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ABSTRACT

Number of functional leaves, branches, nodules, total dry matter and number of developed pods plant^{-1}, number of seeds pod^{-1} and thousand seed weight found to be significant and correlated with yield. The regression coefficient were found with characters viz. height, leaves, dry matter and developed pods plant^{-1}. Correlates under study had very higher predictability with regards to yield of dhaincha. Monitoring of these variables is substantially importance in increasing seed yield ha^{-1}.

Dhaincha (*Sesbania aculeata* L.) is an ideal green manure crop, as it is quick growing, succulent, easily decomposable with low moisture requirements and produces maximum amount of organic matter and nitrogen. It is also grown as cover crop to prevent soil erosion and supress growth. When green manured with dhaincha, rice yield has been reported to be 12-15 per cent more than that when conventional manures are used, (Khan, 1952).

Inclusion of green manures like dhaincha for nutrient supply is gaining momentum in the context of sustainable agriculture. But so far no serious attempt has been made to grow this as a seed crop with proper management practices. Therefore, present study was carried out with various variables for higher predictability with regards to yield of dhaincha.

MATERIAL AND METHODS

Field experiments were carried out in *Kharif* season of 1999-2000 and 2000-2001 at Department of Agronomy Farm, Dr. PDKV, Akola. The soil of the experiment field was clayey in nature, low in available nitrogen (241 kg ha^{-1}), available phosphorus (22.42 kg ha^{-1}) and high in potassium (342.5 kg ha^{-1}). The soil reaction was slightly alkaline (pH 7.7). The experiment was laid out on new sites in each season in a split-plot design with three replications. The treatment comprised of nine combinations of three seed rates and three row spacing alloted to main plot and three phosphate levels to sub-plots.

A) Main plots (Nine combinations of three seed rates and three row spacings)

Seed rate (kg ha^{-1})	Row spacing (cm)
S_1 - 15 kg ha^{-1}	R_1 - 30 cm
S_2 - 25 kg ha^{-1}	R_2 - 45 cm
S_3 - 35 kg ha^{-1}	R_3 - 60 cm

B) Sub plots (Three phosphate levels)

P_0 - control
P_1 - 25 kg P_2O_5 ha^{-1}
P_2 - 50 kg P_2O_5 ha^{-1}

The gross and net plot sizes were 6.0 m x 5.4 m and 5.4 m x 3.6 m, respectively.

Simple correlation studies : Simple correlation coefficients (r) were computed between weight of dhaincha seed (Y) in g plant^{-1} and different morphological characters (X) for both the years of experimentation. The procedure and formula described by Snedecor and Cochran (1968) was followed and the significance was tested.

Simple regression studies (R^2) : Simple regression coefficient (b) values were computed between weight of dhaincha seed (Y) in g plant^{-1} and those morphological characters (X) studied for simple correlation for both the years of experimentation. The 'b' values were computed and tested for their significance as per the procedure and formula described by Snedecor and Cochran (1968).

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Table 2. Morphological characters and yield attributes as influenced by different treatments during 1999-2000 and 2000-2001

Treatments	1999-2000								2000-2001							
	PL.Ht	Leaves plant^{-1}	Branch plant^{-1}	Nodules plant^{-1}	DM plant^{-1}	No. of pods plant^{-1}	Seeds plant^{-1}	1000 seed wt.	PL.Ht	Leaves plant^{-1}	Branch plant^{-1}	Nodules plant^{-1}	DM plant^{-1}	No. of pods plant^{-1}	Seeds plant^{-1}	1000 seed wt.
Seed rate																
S1-15 kg ha^{-1}	290.25	52.09	17.71	42.48	21.81	48.88	30.25	15.65	293.02	44.11	17.74	40.85	22.57	35.60	29.40	15.38
S2-25 kg ha^{-1}	313.29	50.80	17.63	38.40	20.64	43.12	29.56	15.39	304.85	43.14	17.23	36.56	21.48	35.19	28.70	15.22
S3-35 kg ha^{-1}	314.59	48.01	16.98	34.85	20.24	37.05	28.29	14.87	312.09	40.89	15.40	33.56	20.96	32.61	27.11	14.72
SE (m) ±	1.23	0.48	0.07	0.52	0.14	0.21	0.30	0.13	0.35	0.68	0.090	0.58	0.10	0.35	0.20	0.07
CD at 5%	3.71	1.45	0.23	1.56	0.42	0.65	0.91	0.41	1.07	0.26	0.290	1.74	0.30	1.07	0.61	0.23
Row spacing																
R1-30 cm	315.40	49.18	17.01	34.96	19.56	40.09	29.14	15.13	307.04	41.45	16.10	33.44	20.61	33.91	28.37	14.97
R2-45 cm	306.70	50.82	17.50	39.37	20.89	44.06	29.44	15.27	304.33	43.33	16.85	37.78	21.67	34.35	28.40	15.15
R3-60 cm	296.03	50.90	17.80	41.40	22.25	44.09	29.51	15.47	298.59	43.36	17.42	39.74	22.74	35.12	28.44	15.20
SE (m) ±	1.23	0.48	0.07	0.52	0.14	0.21	0.30	0.13	0.35	0.08	0.09	0.58	0.10	0.35	0.20	0.07
CD at 5%	3.71	1.45	0.23	1.56	0.42	0.65	NS	NS	1.07	0.26	0.29	1.74	0.30	1.07	NS	NS
Phosphate levels																
P0-control	304.74	47.60	12.96	25.59	16.25	31.22	27.40	14.72	292.17	37.07	13.23	24.29	16.78	27.13	26.70	14.59
P1-25 kg ha^{-1}	304.92	50.67	18.97	39.62	21.39	40.38	29.62	15.31	306.73	42.26	17.75	38.03	22.14	36.65	28.56	15.21
P2-50 kg ha^{-1}	307.48	52.64	20.38	50.51	25.06	57.45	31.07	15.84	311.07	48.19	19.38	48.62	26.09	39.60	29.96	15.52
SE (m) ±	1.00	0.46	0.10	0.59	0.17	0.26	0.21	0.09	0.44	0.13	0.13	0.72	0.12	0.35	0.17	0.06
CD at 5%	NS	1.33	0.30	1.71	0.48	0.76	0.62	0.27	1.26	0.39	0.40	2.09	0.35	1.00	0.51	0.19

Table 1. Correlation and regression studies in dhaincha

S.N.	Morphological characters	Correlation coefficient 'r' values	Regression coefficient 'b' values	S.E. (b)	't' value
1.	Height of plant	-0.0517	-0.146*	0.0085	-1.7356
2..	Leaves plant^{-1}	0.7279**	0.0929**	0.0149	4.7945
3.	Branches plant^{-1}	0.4340**	-0.0809	0.1071	0.7554
4.	Nodules plant^{-1}	0.4374**	-0.0138	0.0247	0.5606
5.	Dry matter plant^{-1}	0.3236**	-0.2836**	0.0843	3.3637
6.	Developed pods plant^{-1}	0.7604**	0.2359**	0.0232	10.1793
7.	Seeds pod^{-1}	0.5641**	0.1525	0.1049	1.4532
8.	Thousand seed weight (g)	0.489**	0.2767	0.2535	1.0914
9.	Harvest index	-0.1689	0.0894	0.0614	1.4573

R2 = -0.773, t values = 1.99 %, * - Significant at 0.1 probability level ** - Significant at 0.01 probability level
r - values at 5 % - 0.217*, r values at 1% - 0.283 **

RESULTS AND DISCUSSION

Simple correlation coefficient ('r') :

An analysis of the correlates of the yield of dhaincha presented in (Table 1 and 2), showed that the number of leaves, branches, nodules, total dry matter and number of developed pods plant^{-1}, number of seeds pod^{-1} and thousand seed weight were found to be significantly correlated with yield. It indicated that positive change in these variables appeared to enhance the yield plant^{-1}. The values of correlation coefficient were observed in the range of 0.0517 to 0.7604. Height of plant and harvest index were found to be negatively correlated with yield. These results are corroborated with the work of Antil *et. al.*, (1998) and Kaith *et. al.*, (1997).

Regression analysis ('b') :

The regression analysis of correlates of the yield plant^{-1} of dhaincha shown in Table 1, revealed that the production values of height, leaves, dry matter and developed pod plant^{-1} were observed to be significant.

The regression coefficient were -0.0146, 0.0809, -0.2836 and -0.2359, respectively. The overall contribution of various correlates under study in predicting the yield ha^{-1} of dhaincha was moderately high i.e. 77 per cent (R^2=0.773). These results are coincide with the work of Antil *et. al.*, (1988) and Kaith *et. al.*, (1997).

Effects of treatment on the morphological characters and yield attributes shown in Table 2.

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On Farm Response of N, P and K on Cotton -Summer Groundnut in Central Vidarbha Region

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ABSTRACT

On-farm trials to study the response of recommended doses of N, P and K alone and in combination, on cotton-summer groundnut cropping system, were conducted at three, four and six locations during 1999-2000, 2000-2001 and 2001-2002, respectively in Nagpur and Wardha districts of Central Vidarbha zone. The highest yields of both cotton and groundnut were recorded with the application of recommended doses of NPK in combination to both the crops. The highest total as well as increased benefits were also obtained with combined application of NPK at recommended levels.

The Central Vidarbha zone is characterized by semi-arid ecosystem with hot and dry summer and mild to cool winter an average rainfall is 1133 mm received in 43 rainy days. The soils are vertisols and associated ones derived from basalt rock, black in colour with varying depth, predominantly rich in montmorillonite type of clay. On an average the zone has 17.4 per cent heavy, 33.0 per cent medium and 49.7 per cent soils. Average fertilizer consumption is 45.60 kg N, 16.19 kg P_2O_5 and 3.43 kg K_2O ha^{-1}, which is quite inadequate considering requirement of mono or double crop in a year. Farmers hesitate to supply recommended dose to the crops because of varied problems and therefore imbalance application of NPK is also commonly observed. Keeping this in view, the present investigation entitled "On farm response of cotton-summer groundnut cropping sequence to N, P and K" was conducted.

MATERIAL AND METHODS

Field experiments were conducted at three, four and six locations (Village) during 1999-00, 00-01 and 01-02 respectively with five treatments, treating locations as replications. Villages were selected in Hingna block of Nagpur and Selu block of Wardha districts. Treatments consisted of no NPK (control), recommended dose of N alone, NP alone, NK alone and NPK (50:25:25 and 25:50:00 kg NPK ha^{-1} for cotton and groundnut, respectively) applied to both the crops on a plot size of 20 m x 5 m. The soils of the experimental sites were medium to heavy in texture, fairly high in clay content, high in lime reserve and slightly alkaline in reaction with high base saturation of exchange complexes (Table 1). Well-distributed rainfall ranged between 980 to 1150 mm was received during the crop growth period. Cotton (PKV Hy. 4) was sown from 15th to 30th June and groundnut (TAG 24) from 28th January to 7th February. Both the crops were raised with recommended package of practices except fertilization. NPK were supplied through straight fertilizers at recommended timings. Life saving irrigation was given to cotton and groundnut was irrigated as per the recommended practice.

RESULTS AND DISCUSSION

Grain yield

Data on yield of cotton and succeeding groundnut (Table 2 and Fig. 1) indicated that the application of recommended dose of NPK to cotton was at par with NP and NK alone during first two years but significantly superior over all other treatments during third year. Application of NP and NK, both alone, being at par had increased the yields significantly over control and recommended dose of N alone. In case of groundnut application of recommended dose of NPK was found at par with NP alone during last two years but significantly superior over recommended dose alone and control

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Table 1. Initial soil fertility status of experimental sites

Parameters	1999-2000		2000-2001		2001-2002	
	Max.	Min.	Max.	Min.	Max.	Min.
Available N (kg ha^{-1})	232.1	112.9	247.5	234.5	311.4	220.6
Available P (kg ha^{-1})	20.1	11.2	20.1	11.5	20.2	10.1
Available K (kg ha^{-1})	526.7	504.0	397.2	368.5	416.6	243.0
O.C. (%)	0.69	0.61	0.44	0.32	0.65	0.38
pH	8.0	7.9	7.6	7.1	8.0	7.2
EC (dSm^{-1})	0.22	0.15	0.19	0.14	0.23	0.16

Table 2. Effect of NPK on yield (q ha^{-1}) of cotton and groundnut

Treatments	1999-2000		2000-2001		2001-2002		Pooled	
	Cotton	Groundnut	Cotton	Groundnut	Cotton	Groundnut	Cotton	Groundnut
No. NPK	10.03	12.20	13.27	13.16	11.85	12.00	11.82	12.40
Rec. N	13.25	13.43	15.56	15.15	15.48	13.83	15.05	14.19
Rec. NP	16.78	16.33	18.67	19.55	17.42	18.72	17.75	18.43
Rec. NK	17.15	14.25	16.87	15.41	17.83	15.15	17.58	15.12
Rec. NPK	20.02	18.37	21.12	20.44	21.42	18.42	21.21	18.98
SE (m)±	1.53	0.22	1.54	0.79	0.35	0.56	1.32	1.58
CD at 0.05%	4.45	0.65	4.63	2.37	1.02	1.65	3.65	4.37

Table 3. Economic analysis of the treatment effect

Treatments	Increase yield due to treatment (q ha^{-1})		Value of increased yield (Rs. ha^{-1})	Expenditure due to treatment (Rs. ha^{-1}) for both crops	Total benefit due to treatment (Rs. ha^{-1})
	Cotton	Groundnut			
No. NPK	–	–	–	–	–
Rec. N	3.04	1.69	8541	1363	7178
Rec. NP	5.91	5.75	21059	3080	17079
Rec. NK	5.57	2.49	14776	1680	13096
Rec. NPK	913	659	27836	3347	24489

during all the three years. Tiwari and Dhakar (1997) and Patel *et. al.*, (1983) also recorded significant increase in the pod yield of groundnut due to application of recommended dose of NPK i.e. 30:60:0 and 25:50:0 kg NPK ha^{-1}. Pooled data indicated that the yield of cotton was highest with recommended dose of NPK but was at par with NP and NK and significantly superior than control and N application. More or less of yield of cotton, similar trend was observed in case of succeeding groundnut. Niranjan and Arya (1995) and Malawar *et. al.*, (1999) corroborate the present findings.

Economic analysis

Data on economics of cotton - summer groundnut sequence as affected by fertilizer application (Table 3) indicates that the total ha^{-1} monetary benefit was augmented by Rs. 7178, 17079, 13096 and Rs. 24,489 due to fertilization with only N, NP, NK and NPK, respectively over control. The increased total benefit due to NPK application was 241 per cent higher than N application alone, 43 per cent higher than NP application alone and 87 per cent higher than NK application alone. This conforms the findings of Patel *et. al.*, (1996).

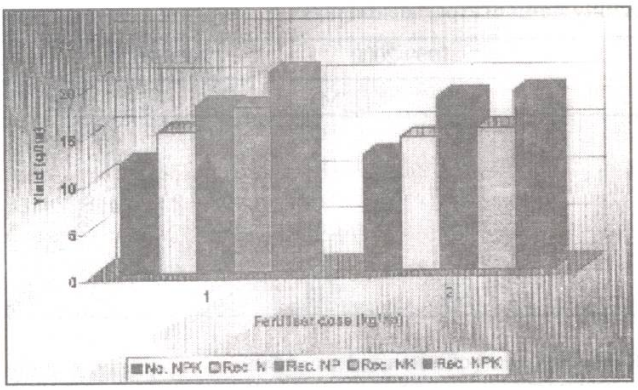

Fig. 1. Effect of NPK on yield of cotton and groundnut (pooled)

Table 4. Crop response to applied N, P and K (kg cotton equivalent yield kg^{-1} nutrient)

Nutrient	1999-2000		2000-2001		20001-2002	
	Max.	Min.	Max.	Min.	Max.	Min.
N	7.73	3.11	6.11	3.32	9.40	5.72
P	8.65	6.69	14.45	7.21	9.80	6.37
K	22.48	14.16	23.84	6.00	21.44	9.88

Response to N, P and K

The data on response to N, P and K in terms of cotton equivalent yield (Table 4) indicates that the response to N was within the range of 4.83 to 5.72, for P_2O_5 it was 7.77 to 10.15 while that for K_2O, the same was between 12.16 to 18.80. Therefore, it is concluded that cotton and summer groundnut, in a sequence cropping should be fertilized with 50:25:25 and 25:50:0 kg NPK ha^{-1} respectively, for maximum production.

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Growth, Yield and Quality of Acid Lime (*Citrus aurantifolia* Swingle) as Influenced By Neem Cake and Fertilizer

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ABSTRACT

The present investigation was undertaken to study the effect of organic and inorganic fertilizers on growth, yield and quality of acid lime. The results indicated that plant height, spread and canopy volume of acid lime trees were noted but could not reached the level of significance with the application of organic and inorganic fertilizers. The fruit yield of acid lime was significantly increased with the application of neem cake @ 7.5 kg + 100 per cent recommended dose of NPK plant^{-1}. Combined use of neem cake along with inorganic fertilizer was found significantly superior as compared to application of neem cake and 100 per cent recommended dose of NPK alone. Studies on physico-chemical properties of acid lime fruits revealed that average fruit volume and weight, juice percentage, total soluble solids (TSS) were significantly influenced due to the combined application of neem cake @ 7.5 kg + 100 per cent NPK plant^{-1}. Acidity and ascorbic acid content were not significantly affected due to application of various treatments.

Citrus is a nutrient responsive plant and it requires adequate nutrients for proper growth and development. Many research workers (Hernandez, 1981, Harishkumar and Sandhu, 1990, Ghosh, 1990) reported beneficial effects of nitrogen, phosphorus and potassium application on growth, yield and quality in increasing citrus production. But the information regarding the influence of organic manure along with or without inorganic fertilizer on citrus production is scanty. Hence, the present investigation was undertaken to study the effect of organic material in the form of neem cake in combination with inorganic fertilizers on growth, yield and physico-chemical properties of acid lime (*Citrus aurantifolia* Swingle).

MATERIAL AND METHODS

The present investigation was undertaken on ten years old acid lime trees of uniform growth and vigour at Central Research Station, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola from 1998 to 2000. The soil of the experimental plot was deep and moderately well drained and taxonomically belongs to fine, montmorillonitic, hyperthermic family of Typic Haplusterts. Seven treatments each replicated four times in randomized block design consisted neem cake @ 7.5 and 15 kg plant^{-1}, 100 per cent NPK alone through fertilizer plant^{-1}, 50, 75 and 100 per cent NPK with 7.5 kg neem cake plant^{-1}, 100 per cent RD of NPK with 15 kg neem cake plant^{-1}. As per the treatments half dose of nitrogen along with full dose of P_2O_5 , K_2O and finely ground neem cake was applied at the time of release of water stress near the feeding root zone and mixed thoroughly with the soils. Remaining half dose of nitrogen was applied one month after fruit set.

The vegetative growth observations of acid lime plants were recorded in the month of October. Number and weight of fruits per plant were recorded at maturity and statistically analysed. Physico-chemical characteristics of fruits were measured by following standard techniques.

RESULTS AND DISCUSSION

Growth parameters

It is evident from the data presented in Table 1 that the growth of the acid lime trees in terms of plant height, spread and canopy volume could not be influenced significantly by various treatments. However, the maximum height, spread and canopy volumes were recorded with the treatment received neem cake @ 7.5 kg +75 per cent RD of NPK plant^{-1}

Yield

Yield of acid lime in terms of number and weight of fruits plant^{-1} were significantly influenced by the application of organic and inorganic fertilizers (Table 2). An application of 100 per cent

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Table 1. Growth parameters, number and weight of fruits plant^{-1} as influenced by organic and inorganic fertilizers

Treatments	Height Meter	Spread meter	Canopy Vol. (m^3)	Fruit yield tree^{-1} in	
				Number	kg
Neem cake @ 7.5 kg plant^{-1}	3.44	3.93	22.543	661	21.350
Neem cake @ 7.5kg + 50 % RD of NPK plamt^{-1}	3.52	4.00	24.033	802	25.303
Neem cake @ 7.5kg + 75% RD of NPK plant^{-1}	3.71	4.09	26.588	932	29.453
Neem cake @ 7.5 kg + 100% RD of NPK plant^{-1}	3.70	4.35	32.308	1005	33.470
Neem cake @ 15 kg plant^{-1}	3.53	3.85	22.398	752	21.925
Neem cake @ 15 kg + 100% RD of NPK plant^{-1}	3.77	4.25	29.258	948	31.308
100% Recommended dose of NPK *	3.65	4.19	27.333	821	25.840
S.E (m) $\pm$	0.21	0.16	2.99	35.09	0.690
CD at 5%	-	-	-	98.56	1.940

* Recommended dose of NPK : 600 g N, 300 g P_2O_5 and 300 g K_2O plant^{-1}

Table 2. Physico-chemical properties of acid lime fruit as influenced by organic and inorganic fertilizers

Treatments	Fruit Vol. (cc)	Fruit wt. (g)	Juice (%)	TSS (%)	Acidity (%)	Ascorbic Acid (mg 100ml^{-1})
Neem cake @ 7.5 kg plant^{-1}	27.033	29.010	49.80	7.100	7.820	30.720
Neem cake @ 7.5 kg + 50 % RD of NPK plant^{-1}	29.638	31.650	51.00	7.980	7.960	31.475
Neem cake @ 7.5 kg + 75 % RD of NPK plant^{-1}	29.588	31.600	51.40	7.820	8.000	31.220
Neem cake @ 7.5 kg + 100 % RD of NPK plant^{-1}	31.088	33.300	53.50	8.100	7.900	30.900
Neem cake @ 15 kg plant^{-1}	27.168	29.155	50.60	7.210	7.670	30.863
Neem cake @15 kg + 100% RD of NPK plant^{-1}	31.040	33.060	52.25	7.950	7.900	31.800
100 % Recommended dose of NPK plant^{-1}	29.500	31.250	52.50	7.200	8.040	31.850
S.E (m) $\pm$	0.530	0.457	0.256	0.050	0.116	0.837
C.D at 5% level	1.491	1.285	0.720	0.145	-	-

recommended dose of NPK plant^{-1} significantly increased the fruit yields by 21.03 and 17.86 per cent as compared to the treatments receiving 7.5 and 15 kg neem cake plant^{-1} respectively. The results of the present investigation are also consistent with the findings of Ingle *et.al.* (2000). Maximum yield, i.e. 1005 fruits plant^{-1} and 33.47 kg fruit plant^{-1} were recorded with the application of neem cake @ 7.5 kg + 100 per cent recommended dose of NPK plant^{-1}, which were significantly higher over all other treatments. Beneficial effect of combined application of neem cake and NPK fertilizers in improving the citrus production has been reported earlier by Srivastava *et.al.* (1974) and Tiwari *et.al.* (1999). Amongst all the treatments, an application of neem cake @ 7.5 kg or 15 kg plant^{-1} gave lowest number and weight of fruits indicating that sole application of organic manure (neem cake) could do no better unless they are supplemented with inorganic fertilizers. These results corroborated the findings of Rokba *et.al.* (1975) and Tiwari *et.al.* (1999).

Fruit quality parameters

Data presented in Table 2, reveal that the combined use of organic and inorganic fertilizers is increasing the quality of fruits. Beneficial effects of organic and inorganic fertilizer were also reported earlier by Hernandez (1981). Maximum total soluble solids (8.100 %) and juice content (53.50%) in acid lime fruits were observed with 7.5 kg Neem cake + 100 per cent RD of NPK plant^{-1}, which were significantly higher over all other treatments. Ghosh and Besra (1997) also observed significant improvement in TSS and juice percentage due to application of organic matter +inorganic fertilizers. Acidity and Ascorbic acid content in acid lime fruits were not significantly affected due to application of organic and inorganic fertilizer alone and their combinations.

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Direct and Residual Effect of FYM and Inorganic Nutrients on Rice-Wheat Cropping System in Vertisol

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ABSTRACT

A field experiment was carried out in Vertisol at the Research Farm, College of Agriculture, Raipur (Chhattisgarh) during *Kharif* and *Rabi* season 2001-2002 to assess the direct and residual effect of FYM and inorganic nutrients on rice-wheat cropping system. (The treatments were consisting of inorganic nutrients in combinations with and without FYM (8 t ha^{-1}). The FYM was applied to rice only and seven inorganic nutrient combinations were tested with rice followed by wheat differently. The results showed that the productivity of rice and wheat was significantly increased with the application of inorganic fertilizers with FYM (8 t ha^{-1}). The experimental results indicated that application of 100 per cent recommended dose of NPK to either of the crops produced significantly highest yield followed by 100 per cent recommended dose of NP and 100 per cent N + 100 per cent PK. Combined application of FYM with inorganic fertilizers was more effective as compared to inorganic fertilizers alone in building up fertility status of soil and increasing the productivity of rice and wheat. The uptake of N, P and K by rice as well as wheat followed. The residual effect of FYM applied to rice was conspicuous in significantly increasing the productivity of wheat and improving the NPK and organic carbon status of soil.

Integrated nutrient supply system seek to maintain or improve soil fertility for sustaining the desired levels of crop production and productivity through optimization of the benefits from all possible sources of plant nutrients in integrated manner. A judicious combination of chemical fertilizers, organic manures and biofertilizers should be incorporated for a cropping system within the ecological, social and economic possibilities. The integrated nutrient management approach has perhaps greater scope in rice based than in any other cropping systems. Rice is grown predominantly under submerged anaerobic soil conditions that offer wider scope for harvesting different nutrient sources. Besides servings as a source of plant nutrients to crops the farm yard manure (FYM) helps to improve all physical as well as biological properties of soil thereby enhancing the fertilizer use efficiency (Kundu and Pillai, 1992). Even the application of recommended NPK fertilizers devoid of organics has not been able to sustain productivity (Rattan and Singh 1997). With this in view the present investigation was carried out to study direct and residual effect of FYM and inorganic nutrients on rice-wheat cropping system in Vertisol.

MATERIAL AND METHODS

A field experiment was conducted at Research Farm, Indira Gandhi Agricultural University, Raipur in 2001-02. The experimental soil contained sand 20 per cent, silt 35 per cent, clay 44 per cent, pH 7.2, EC 0.22 dSm^{-1} organic carbon 0.45, available N 188 kg ha^{-1}, available P 14.6 kg ha^{-1} and available K_2O 503 kg ha^{-1}. The experiment was conducted in factorial randomized block design with two treatments of Farm yard manure viz. F_0 : No FYM application, F_1 : application of 8 t FYM ha^{-1} to rice and seven treatment combinations of inorganic NPK fertilizers applied differently to rice and wheat are given in Table 1.

Table 1. Inorganic NPK combinations for rice and wheat

Treatments	*Kharif*–Rice	*Rabi* – Wheat
T_1	100% N	100% N
T_2	100% N K	100% N P
T_3	100% N + 150 % K	100% N + 150 % P
T_4	100% N + 50 % P K	100% N + 50 % P K
T_5	100% N + 50 % P	100% N + 50 % K
T_6	100% N P K	100% N P K
T_7	100% N P	100% N K

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Table 1 : Effect of FYM and inorganic nutrients on yield an yield attributing characters of rice and wheat crops

Treatments	Rice					Wheat				
	Grain yield (Kg ha^{-1})	Straw yield (Kg ha^{-1})	Length of ear head (cm)	Effective plant tillers (m^2)$^{-1}$	Plant height (cm)	Grain yield (Kg ha^{-1})	Straw yield (Kg ha^{-1})	Length of ear head (cm)	Effective plant tillers (m^2)$^{-1}$	Plant height (cm)
F_0	4390	7060	18.2	256	80.2	1944	3442	6.3	276	50.1
Fl	4586	7808	20.1	267	84.0	2080	4008	6.7	307	53.1
SE (m)±	20	46	0.43	1.90	0.31	28	518	0.04	9.1	0.12
CD at 5%	60	136	125	5.53	0.91	82	1508	0.12	27.1	0.36
Inorganic fertilizer combinations										
T_1	4146	7315	17.5	231	75.5	1630	3030	6.1	260	46.1
T_2	4159	7097	17.9	241	77.9	1940	3578	6.2	268	48.1
T_3	4219	6990	18.5	251	80.1	2115	3970	6.4	278	50.3
T_4	4610	7373	19.3	271	84.2	1889	3512	6.6	297	52.8
T_5	4638	7453	18.7	261	82.2	2288	4156	6.4	288	51.7
T_6	4888	7934	21.8	296	88.3	2442	4576	7.0	334	57.3
T_7	4755	7879	20.3	281	86.3	1780	3253	6.9	325	54.8
SE (m)±	39	87	0.80	3.56	0.58	52	97	0.08	17	0.23
CD at 5%	114	255	2.33	10.36	1.70	153	282	0.23	51	0.67
Interaction (F x T)										
F_0T_1	4145	7001	16.6	226	74.1	1575	2665	6.0	250	44.6
F_0T_2	4099	6566	16.9	236	76.4	1962	3407	6.0	258	46.8
F_0T_3	4162	6758	17.7	246	78.1	2099	3276	6.1	268	48.8
F_0T_4	4406	6785	18.3	266	82.2	1774	3181	6.3	287	51.3
F_0T_5	4573	7277	17.7	256	80.2	2188	3270	6.1	278	50.2
T_0T_6	4703	7499	208	286	86.1	2313	4186	6.8	322	55.8
T_0T_7	4643	7536	193	276	84.2	1698	3106	6.6	302	53.3
F_1T_1	4147	7629	185	236	77.0	1685	3395	6.2	270	47.6
F_1T_2	4218	7629	189	246	79.4	1917	3750	6.4	278	49.8
F_1T_3	4277	7221	193	256	82.1	2131	4263	6.6	288	51.8
F_1T_4	4814	7962	203	276	86.4	2004	3843	6.8	307	54.3
F_1T_5	4703	7629	197	266	84.2	2388	4443	6.6	298	53.2
F_1T_6	5073	8370	228	306	90.3	2575	4966	7.2	345	58.8
F_1T_7	4866	8221	213	286	88.4	1862	4000	7.1	327	56.33
SE (m)±	55	124	1.1	5.0	0.27	74	137	0.11	24	0.32
CD at 5%	161	360	3.3	14.6	2.40	223	415	N.S.	70	0.95

Table 2. Effect of FYM and inorganic nutrients on nutrient uptake by rice and wheat crops

Treatments	Rice			Wheat		
	Nitrogen (Kg ha^{-1})	Phosphorus (Kg ha^{-1})	Potassium (Kg ha^{-1})	Nitrogen (Kg ha^{-1})	Phosphorus (Kg ha^{-1})	Potassium (Kg ha^{-1})
FYM levels to rice						
F_0	88	17.4	151	53.7	15.9	60.7
F1	112	20.3	1.70	63.2	19.3	71.7
SE (m)±	0.47	0.18	1.0	0.96	0.33	0.99
CD at 5%	1.38	0.52	3.0	2.81	0.97	2.88
Fertilizer combinations						
T_1	83	15.1	129	44.5	10.9	48.9
T_2	87	15.5	150	54.5	17.7	59.9
T_3	91	16.8	150	63.0	20.1	67.8
T_4	102	19.3	165	53.4	15.6	64.5
T_5	105	19.4	164	69.6	21.3	78.5
T_6	120	23.5	185	75.1	24.6	87.1
T_7	114	22.4	181	48.2	13.0	56.9
SE (m)±	0.89	0.34	1.9	1.81	0.62	1.85
CD at 5%	2.58	0.98	5.6	2.81	1.81	5.38
Interaction (F x T)						
F_0T_1	76	14.5	118	40.7	9.5	42.8
F_0T_2	76	14.4	137	52.5	16.8	56.7
F_0T_3	81	15.8	145	59.1	18.4	62.7
F_0T_4	86	16.8	149	48.1	14.1	58.5
F_0T_5	95	19.0	161	63.8	18.6	77.2
T_0T_6	103	21.1	174	66.1	22.4	78.7
T_0T_7	100	19.8	172	46.0	11.5	53.3
F_1T_1	91	15.6	140	48.4	12.2	55.1
F_1T_2	97	16.6	162	56.5	18.5	63.1
F_1T_3	101	17.6	155	67.0	21.7	73.0
F_1T_4	118	21.7	180	58.8	17.2	70.5
F_1T_5	115	19.7	168	75.4	24.0	84.7
F_1T_6	137	25.8	197	84.0	26.9	95.4
F_1T_7	128	25.1	189	50.3	14.5	60.5
SE (m) ±	0.47	0.48	2.7	2.55	0.88	2.62
CD at 5%	1.38	1.39	2.9	7.43	2.57	7.62

The treatments were replicated three times. The Farm yard manure was applied 8 days before transplanting of rice. The transplanting of the seedings of rice (variety Mahamaya) was done on 25th July 2001 with 50 per cent recommended dose of N and complete dose of Pand K. Remaining 50 per cent dose of N was applied in two splits, 1st split on 29.08.2001 and 2nd split on 17.9.2001. The recommended doses of N,P and K were 100 kg N, 60 kg P_2O_5 and 40 kg K_2O ha^{-1} for rice as well as wheat crops. The rice was harvested on November 12, 2001. After harvest of rice wheat (variety GW-193) was sown on the same plots with fixed randomization as that used for rice crop with 50 per cent N and complete dose of P and k applied as basal on 1.12.2001 and remaining 50 per cent N was applied in the splits. The observations on yield and yield contributing characters of both the crops were recorded at harvest. The soil, plant samples collected at harvest-were analysed for N, P and K content.

RESULTS AND DISCUSSION

Yield of rice and wheat

Data in Table 2 revealed that application of FYM (8 t ha^{-1}) along with different fertilizer combinations resulted significant increase in the grain yield of rice over no FYM application. Highest grain yield of rice was obtained with T_6 (100% NPK) treatment and it was significantly superior over the

Table 3: Effect of FYM and inorganic nutrients on soil fertility under rice and wheat cropping systems.

Treatment	After harvest of Rice						After harvest of Wheat					
	pH	E.C. (dSm^{-1})	Org. Carbon (%)	Available nutrients (kg ha^{-1})			pH	E.C. (dSm^{-1})	Org. Carbon (%)	Available nutrients (kg ha^{-1})		
				Nitrogen	Phosphorus	Potassium				Nitrogen	Phosphorus	Potassium
FYM levels to rice												
F_0	7.19	0.22	0.46	2.11	13.4	459	7.19	0.22	0.43	208	14.8	450
F1	7.17	0.22	0.50	2.24	16.3	477	7.18	0.21	0.48	219	14.9	467
SE (m) ±	0.006	0.002	0.003	0.52	0.178	1.1	0.005	0.002	0.003	1.00	0.135	1.39
CD at 5%	N.S	N.S.	0.011	1.52	0.519	3.3	N.S.	N.S.	0.103	3.00	0.394	4.05
Inorganic fertilizer combinations												
T_1	7.19	0.22	0.47	208	11.7	450	7.17	0.21	0.45	208	13.2	441
T_2	7.19	0.22	0.47	211	12.6	464	7.18	0.21	0.47	210	14.2	449
T_3	7.22	0.22	0.49	213	13.7	474	7.20	0.21	0.45	209	13.9	465
T_4	7.20	0.22	0.46	219	14.6	469	7.18	0.21	0.44	216	14.9	462
T_5	7.20	0.23	0.48	215	15.3	475	7.18	0.22	0.45	214	15.5	465
T_6	7.21	0.22	0.52	235	18.5	487	7.20	0.22	0.48	223	17.0	476
T_7	7.20	0.22	0.49	225	17.3	457	7.18	0.22	0.45	216	14.3	451
SE (m) ±	0.011	0.004	0.007	0.98	0.334	2.15	0.01	0.004	0.006	1.87	0.254	2.61
CD at 5%	N.S.	N.S.	0.021	2.85	0.971	6.25	N.S.	N.S.	0.019	5.43	0.738	7.59
Interaction (F x T)												
F_0T_1	7.20	0.22	0.45	205	10.2	440	7.19	0.21	0.42	203	12.9	433
F_0T_2	7.19	0.22	0.45	207	11.2	464	7.18	0.22	0.44	205	14.2	444
F_0T_3	7.22	0.21	0.47	207	12.2	464	7.20	0.21	0.43	204	13.7	453
F_0T_4	7.19	0.22	0.45	217	13.6	459	7.20	0.21	0.42	211	14.7	453
F_0T_5	7.19	0.22	0.47	220	14.2	465	7.18	0.23	0.44	208	15.2	458
T_0T_6	7.22	0.22	0.50	223	16.7	476	7.18	0.22	0.47	218	16.6	466
T_0T_7	7.19	0.22	0.46	218	15.8	447	7.21	0.22	0.43	210	13.8	445
F_1T_1	7.17	0.22	0.49	210	14.2	460	7.17	0.21	0.48	212	13.4	450
F_1T_2	7.17	0.22	0.50	211	14.1	462	7.15	0.20	0.49	215	14.2	455
F_1T_3	7.21	0.23	0.51	217	15.2	484	7.17	0.21	0.47	214	14.2	478
F_1T_4	7.19	0.23	0.47	231	16.6	479	7.21	0.21	0.46	222	15.1	471
F_1T_5	7.19	0.23	0.49	232	17.4	485	7.16	0.22	0.46	219	15.7	473
F_1T_6	7.20	0.22	0.55	248	21.4	498	7.18	0.21	0.49	228	17.3	485
F_1T_7	7.18	0.21	0.51	236	20.1	467	7.19	0.21	0.48	223	14.8	456
SE (m) ±	0.016	0.006	0.01	1.39	0.47	3.04	0.014	0.006	0.009	2.64	0.359	3.69
CD at 5%	N.S.	N.S.	0.03	1.14	1.54	8.84	N.S.	N.S.	0.027	7.94	1.078	N.S.

preceeding treatments (T_1 to T_5) and at par with succeeding treatment T_7 (100% NP). The interaction effect of fertilizer combinations with FYM influenced the rice yield significantly. Highest grain yield was obtained with F_1 T_6 (100% NPK + FYM) followed by F_1 T_7 (100% NP+ FYM). Both the treatments were found at par and significantly superior over rest of the treatments. Straw yield also followed similar trend as that of grain yields of rice.

The residual effect of FYM applied to rice was studied on wheat crop. Data in Table 1 revealed that the residual effect of farm yard manure application (F1) with different doses of fertilizer combinations gave significantly more grain yield of Wheat over treatment F_0 without (without FYM). The grain yield of wheat was significantly highest under treatment T_6 (100% NPK) followed by T_5 (100% NK +50% P) both being at par with each other and significantly superior to rest of the fertilizer combinations. Highest grain yield was obtained with F_1 T_6 (100% NPK+FYM application to rice) followed by F_1 T_5 treatment. The next best combination came out was F_0 T_6 followed by treatment F_0 T_5 and F_1 T_3, they being at par with each other. The straw yield followed similar trend as that of grain yield of wheat.

Fertilizer doses in combination with FYM (F_1) produced significantly more length of the ear head, effective number of tillers and increased the plant height under both the crops. Treatment F_1 T_6 (FYM +100% NPK) produced better results followed by F_1 T_7 (FYM+100%NP) in respect of all the three yield attributing characters (Table 2). Similar findings were reported earlier by Rathore *et.al.* (1993) in low land rice crop. Organic manuring helps in making better soil environment and enhancing nutrient supply and consequently result in improving crop growth and over all crop productivity. Bharadwaj and Tyagi (1994) in a rice-wheat-cowpea cropping system observed that the highest yields were obtained with the application of recommended NPK fertilizers along with 15t FYM ha^{-1} and lowest in control plots.

Nutrient uptake

Data presented in Table 3 showed that uptake of N,P and K were significantly increased with the application of FYM to rice. Application of 100 per cent recommended dose of NPK (T_6) recorded highest uptake of nutrients followed by 100 per cent NP (T_7) in rice. Application of 100 per cent recommended dose of NPK with 8t FYM ha^{-1} (F_1 T_6) recorded significantly highest uptake of N,P and K followed by 100 per cent NP+8t FYM ha^{-1} (F_1 T_7) under rice crop.

The residual effect of FYM application also resulted the significant increase in NPK uptake by wheat crop subsequently grown after rice (Table 3). The fertilizer treatments showed that N, P and K uptake were significantly highest in wheat with 100 per cent NPK (T_6) followed by T_5 (100% NP+50% K) and T_3 (100%N+150%P). The treatment combination F_1 T_6 recorded significantly highest N,P and K followed by F_1T_5 and F_3 T_5. Similar results were reported by Bharadwaj and Tyagi (1994). Santhy *et.al.* (1998) reported that total uptake of N,P and K increased with progressively supply of NPK to the crop, because of higher availability of these nutrients. Application of NPK at 100 per cent optimum level along with FYM @10t ha^{-1} increased the uptake over the application of 100 percent optimum level of NPK alone.

Fertility status of soil

The pH, EC, organic carbon and available N, P and K status of soil was evaluated after the harvest of rice as well as wheat crops. The results (Table 4) showed that there was no significant change in pH and electrical conductivity with the application of various fertilizer combinations with and without FYM. However, the comparison of their values with the initial soil analysis data indicated that application of FYM marginally decreased the pH and EC of the soil. Decrease of pH and EC of soil due to application of various organic resources with in organic fertilizers was reported by Ghuman (1997). The different treatment combinations of NPK fertilizers with FYM significantly increased the organic carbon content of the soil. Application of 100 per cent NPK with FYM recorded significantly higher organic carbon content followed by 100 per cent NP+FYM@ 8t ha^{-1}. The increase in organic carbon content of the soil with application of fertilizers and manures has also been reported by Banwari (1999). The increase in organic carbon content of the soil in a adequately fertilized plot may be due to the enhanced root growth leading to accumulation of more organic residues in the soil, while its increase in the manurial treatment combination may be attributed to direct incorporation of the organic matter in the soil.

Application of NPK fertilizers with FYM significantly increased the available Nitrogen,

Phosphorus and Potassium contents in soil as compare to the treatment receiving NPK fertilizers without FYM (Table 3) and the treatment combination $F_1 T_6$ (100%NPK+FYM) was found to be optimum for increasing available N,P and K content followed by $F_1 T_7$ and $F_1 T_5$. The available nutrient content at harvest of wheat was decreased as compared to the values obtained at harvest of rice.

The build up of available N and P in the soil due to 100 per cent NPK or 100 per cent NP or 100 per cent NK +50 per cent P with or without FYM application may be ascribed to the residual effect of applied fertilizers and the mineralization of FYM. Dudhat *et. al* (1997) reported that application of FYM and chemical fertilizers alone and in combination with each other significantly increased the residual N and P in the soil.

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Effect of Integrated Nutrient Management on Soil and Crop Productivity and Nutrient Uptake of Rice Grown on Vertisol

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ABSTRACT

A field experiment was conducted during 2001-2002 to study the effect of inorganic fertilizers with and without farm yard manure (FYM) application on yields, nutrient uptake of transplanted rice and residual fertility status of Vertisol. The results indicated that the combined application of 100 per cent recommended dose of NPK fertilizers (100: 60: 40 kg NPK ha^{-1}) with FYM @ 8 t ha^{-1} found significantly superior in increasing the grain and straw yields of rice variety Mahamaya. Similar trend was observed in respect of N, P & K uptake by rice. Combined application of FYM with inorganic fertilizers was found more effective as compared to inorganic fertilizers alone in building up the fertility status of soil.

To maintain and to improve the soil fertility for sustaining the desired levels of crop production and productivity through optimizing the benefits from all possible sources of plant nutrient in an important aspects in farming system. A judicious application of organics and inorganics with biofertilizers should be incorporated for a cropping system within the ecological, social and economic possibilities. The integrated nutrient management approach has perhaps greater scope in rice based than in any other cropping systems. Rice is grown predominantly under submerged anaerobic soil conditions that offer wider scope for harvesting different nutrient sources. Besides servings as a source of plant nutrients to crops the farm yard manure (FYM) helps to improve all physical as well as biological properties of soil thereby enhancing the fertilizer use efficiency (Kundu and Pillai, 1992). Even the application of recommended NPK fertilizers devoid of organics has not been able to sustain productivity (Rattan and Singh 1997). With this in view the present investigation was carried out to study the effect of FYM with chemical fertilizers on productivity of transplanted rice, its nutrient uptake and fertility status of soil.

MATERIAL AND METHODS

A field experiment was conducted on Vertisol of Indira Gandhi Agril. University Research Farm, Raipur in 2001-2002. The experimental soil belongs to fine, montmorillonite, hyperthermic, Typic Haplusterts and contained sand 20 per cent, silt 35 per cent, clay 44 per cent, pH 7.2, EC 0.22 dSm^{-1}, Organic carbon 0.45 per cent, , available N 188 kg ha^{-1} available P 14.6 kg ha^{-1} and available K_2O 503 kg ha^{-1}. The experiment was conducted in factorial randomised block design with two treatments of farm yard manure viz. F0: no FYM application, F_1 : application of 8 t FYM ha^{-1} and seven treatment combination of inorganic fartilizer viz., T_1 : 100 per cent N, T_2 : 100 per cent NK, T_3 : 100 per cent NK + 150 per cent K, T_4 : 100 per cent N + 50 per cent PK, T_5 : 100 per cent NK + 50 per cent P, T_6 : 100 per cent NPK, T_7 : 100 per cent NP. The treatments were replicated three times. The farm yard manure applied 8 days before transplanting of rice. The transplanting of the seedlings of rice variety Mahamaya was done on 25th July, 2001 with 50 per cent recommended rate of N and complete dose of P and K as base application and remaining half dose of N was applied in two splits, 1st split on 29th August 2001 and 2nd split on September 17, 2001. The recommended dose of N, P and k were 100 kg N, 60 kg P_2O_5 and 40 kg K_2O. The paddy was harvested on November 12, 2001.

The observations on grain and straw yields plant height, effective tillers and length of earhead were recorded at harvest. Similarly the plant samples collected at harvest were analysed for N, P, and K content. Similarly soil samples were collected from 0-15 cm layer and different physico-chemical properties were determined by using the standard methods.

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RESULTS AND DISCUSSION

Data presented in Table 1 revealed that application of FYM @ 8 t ha^{-1} along with inorganic fertilizers resulted significant increase in the yields of rice. Highest grain yield was obtained with T_6 (100% NPK) treatment and it was significantly superior over the preceeding treatments (T_1 to T_5) and was at par with the succeeding treatment T_7 (100% NP). The interaction effect between fertilizer combinations and FYM, influenced the rice yield significantly. Highest grain yield was obtained with F1 T_6 (100% NPK + FYM) followed by F_1 T_7 (100 % NP + FYM), however, both the treatments were found at par and significantly superior over rest of the treatments. Straw yield followed similar trend as that of grain yield of rice (Table 1). Application of 100 per cent fertilizer doses in combination with FYM (F_1 treatment) produced significantly more length of the earhead, effective number of tillers and increased the plant height. (FYM + 100% NPK) produced better results followed by F_1T_7 (FYM+100 % NP) inrespect

Table1: Effect of FYM and inorganic nutrients on yield and yield characters of rice

Treatments	Yield q ha^{-1}		Yield attributing characters		
	Grain	Straw	Length of ear head (cm)	Effective tillers $(m^2)^{-1}$	Plant height (cm)
FYM levels to rice only					
F_O	43.90	70.60	18.2	256	80.2
F_1	45.86	78.08	20.1	267	84.0
S.E. (m) ±	0.209	0.468	4.31	1.905	0.31
C.D. at 5%	0.609	1.363	0.12	5.539	0.90
Fertilizer combinations					
T_1	41.46	73.15	17.5	231	75.5
T_2	41.59	70.97	17.9	241	77.9
T_3	42.19	69.9	18.5	251	80.1
T_4	46.10	73.73	19.3	271	84.2
T_5	46.38	74.53	18.7	261	82.2
T_6	48.88	79.34	21.8	296	88.2
T_7	47.55	78.79	20.3	281	86.3
S.E (m) ±	0.391	0.877	8.06	3.564	0.58
C.D. at 5%	1.139	2.550	0.23	10.364	1.70
Interaction (FXT)					
F_0T_1	41.45	70.01	16.6	226	74.0
F_0T_2	40.99	65.66	16.9	236	76.4
F_0T_3	41.62	67.58	17.7	246	78.1
F_0T_4	44.06	67.85	18.3	266	82.1
F_0T_5	45.73	72.77	17.7	256	80.2
F_0T_6	47.03	74.99	20.8	286	86.1
F_0T_7	46.43	75.36	19.3	276	84.2
F_1T_1	41.47	76.29	18.5	236	77.0
F_1T_2	42.18	76.29	18.9	246	79.4
F_1T_3	42.77	72.21	19.3	256	82.1
F_1T_4	48.14	79.62	20.3	276	86.4
F_1T_5	47.03	76.29	19.7	266	84.2
F_1T_6	50.73	83.70	22.8	306	90.3
F_1T_7	48.66	82.21	21.3	286	88.4
S.E (m) ±	0.554	1.240	0.11	5.040	0.27
C.D. at 5%	1.611	3.607	0.33	14.656	2.40

of all the three attributing characters. Similar findings were reported by Rathore *et.al.* (1993) in low land rice. Organic manuring helps in making better soil environment and enhancing nutrient supply and consequently result in improving crop growth and over all crop productivity. Bharadwaj and Tyagi (1994) in a rice wheat – cowpea cropping system observed that the highest yields were obtained with the application of recommended NPK fertilizers along with 15 t FYM ha^{-1} and lowest in control plots.

Nutrient uptake

Data presented in Table 2 showed that uptake of N, P and K were significantly increased with the application of FYM. Application of 100 per cent recommended dose of NPK (T_6) recorded highest uptake of nutrients followed by 100 per cent NP (T_7) in rice. Application of 100 per cent recommended dose of NPK with 8 t FYM ha-1 (F_1 T_6) recorded significantly highest uptake of N, P and K followed by 100 per cent NP + 8 t FYM ha^{-1} (F_1 T_7). Similar result were reported, by Bharadwaj and Tyagi (1994). Santhy *et. al.* (1998) reported that total uptake of N, P and K increased with progressive supply of NPK to the crops because of higher availability of these nutrients. Application NPK at 100 per cent optimum level along with FYM @ 10 t ha^{-1} incrased the uptake

Table 2. Effect of FYM and inorganic nutrients on nitrogen, phosphorus & potassium uptake (kg ha^{-1}) by rice

Treatments	Nitrogen			Phosphorus			Potassium		
	Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total
FYM levels to rice only									
F_0	46.1	42.4	88.5	11.6	5.8	17.4	10.2	141.1	151.4
F_1	55.5	57.4	112.9	13.4	6.9	20.3	12.5	158.0	170.5
S.E (m) ±	0.23	0.41	0.47	0.20	0.05	0.18	0.17	1.00	1.03
C.D. at 5%	0.67	1.20	1.38	0.58	0.14	0.52	0.50	2.91	3.00
Fertilizer combinations									
T_1	43.5	40.2	83.7	9.5	5.4	15.0	8.3	121.0	129.3
T_2	45.5	41.6	87.1	9.9	5.5	15.5	9.6	140.5	150.1
T_3	46.9	44.5	91.4	11.0	5.7	16.7	9.8	140.3	150.1
T_4	52.5	49.7	102.4	12.8	6.5	19.3	11.8	153.5	165.3
T_5	52.5	52.6	105.1	12.9	6.4	19.3	11.9	153.1	164.9
T_6	58.3	62.2	120.6	15.8	7.6	23.5	14.8	171.0	185.8
T_7	55.8	58.6	114.4	15.3	7.1	22.4	13.4	167.8	181.2
S.E (m) ±	0.43	0.77	0.88	0.37	0.09	0.33	0.32	1.87	1.93
C.D. at 5%	1.25	2.24	2.58	1.08	0.27	0.98	0.94	5.46	5.62
Interaction (FXT)									
F_0T_1	42.1	34.0	76.1	9.40	5.1	14.5	6.3	112.3	118.6
F_0T_2	42.0	34.5	76.5	9.56	4.9	14.4	8.7	129.0	137.7
F_0T_3	42.7	38.2	81.0	10.4	5.4	15.8	8.9	136.3	145.2
F_0T_4	45.3	41.1	86.4	11.1	5.7	16.8	10.2	139.6	149.9
F_0T_5	48.2	47.1	95.3	12.7	6.2	19.0	11.3	150.0	161.3
F_0T_6	51.7	52.1	103.8	14.7	6.6	21.1	13.6	160.6	174.3
F_0T_7	49.9	50.2	100.1	13.2	6.5	19.8	12.6	160.3	172.9
F_1T_1	44.9	46.4	91.4	9.7	5.8	15.6	10.3	129.6	140.0
F_1T_2	49.0	48.8	97.8	10.3	6.2	16.6	10.5	152.0	162.5
F_1T_3	51.1	50.7	101.9	11.6	6.0	17.6	10.7	144.3	155.1
F_1T_4	59.8	58.3	118.3	14.4	7.2	21.7	13.5	167.3	180.8
F_1T_5	56.8	58.1	115.0	13.1	6.5	19.7	12.3	156.3	168.6
F_1T_6	65.0	72.3	137.3	17.2	8.6	25.8	15.9	181.3	197.3
F_1T_7	61.7	67.0	128.7	17.3	7.7	25.0	14.2	175.3	189.5
S.E (m) ±	0.61	1.09	0.47	0.53	0.13	0.48	0.45	2.656	2.73
C.D. at 5%	1.78	3.17	1.38	1.54	0.38	1.39	1.33	7.724	7.96

over the application of 100 per cent optimum level of NPK alone.

Fertility status of soil

The pH, EC, Organic carbon and available N, P and K status of soil were evaluated after the harvest of rice crop. The results (Table 3) showed that there was no significant change in pH and electrical conductivity with the application of various fertilizer combinations with and without FYM. However, when compare with the initial soil analysis it was observed that application of FYM marginally decreased the pH and EC of the soil. Decrease in pH and EC of soil due to application of various organic sources with inorganic fertilizers was reported by Ghuman (1997). The different treatment combinations of NPK fertilizers with FYM significantly increased the organic carbon content of the soil. 100 per cent NPK with FYM recorded significantly higher organic carbon content followed by 100 per cent NP + FYM.

The increase in organic carbon content of soil with the application of fertilizers and manures has alse been reported by Banwasi (1999). The crease in organic carbon content of the soil in a

Table 3 : Effect of FYM and integrated nutrients on residual fertility status of the soil after harvest of rice

Treatments	pH	E.C.dSm^{-1}	O.C.%	Available nutrients (kg ha^{-1})		
				Nitrogen	Phosphorus	Potassium
FYM levels to rice only						
F_0	7.19	0.22	0.46	211	13.44	459
F_1	7.17	0.22	0.50	224	16.27	477
S.E (m) $\pm$	0.006	0.002	0.003	0.525	0.178	1.14
C.D. at 5%	NS	NS	0.011	1.526	0.519	3.34
Fertilizer combinations						
T_1	7.19	0.22	0.47	208	11.76	450
T_2	7.19	0.22	0.47	211	12.66	464
T_3	7.22	0.22	0.49	213	13.73	474
T_4	7.20	0.22	0.46	219	14.63	469
T_5	7.20	0.23	0.48	215	15.36	475
T_6	7.21	0.22	0.52	235	18.56	487
T_7	7.20	0.22	0.49	225	17.30	457
S.E (m) $\pm$	0.011	0.004	0.007	0.98	0.334	2.14
C.D. at 5%	NS	NS	0.021	2.85	0.971	6.25
Interaction (FXT)						
F_0T_1	7.20	0.22	0.45	205	10.26	440
F_0T_2	7.19	0.22	0.45	207	11.16	464
F_0T_3	7.22	0.21	0.47	207	12.23	464
F_0T_4	7.19	0.22	0.45	217	13.66	459
F_0T_5	7.19	0.22	0.47	220	14.26	465
F_0T_6	7.22	0.22	0.50	223	16.73	476
F_0T_7	7.19	0.22	0.46	218	15.80	447
F_1T_1	7.17	0.22	0.49	210	14.26	460
F_1T_2	7.17	0.22	0.50	211	14.16	465
F_1T_3	7.21	0.23	0.51	217	15.23	484
F_1T_4	7.19	0.23	0.47	231	16.60	479
F_1T_5	7.19	0.23	0.49	232	17.46	485
F_1T_6	7.20	0.22	0.55	248	21.40	498
F_1T_7	7.18	0.21	0.51	236	20.10	467
S.E. (m) $\pm$	0.016	0.006	0.010	1.38	0.472	3.04
C.D. at 5%	NS	NS	0.030	4.14	1.54	8.84

adequately fertilized plot may be due to the enhanced root growth leading to accumulation of more organic residues in the soil, while its increase in the manurial treatment combination may be attributed to direct incorporation of the organic matter in the soil.

Application of NPK fertilizers with FYM significantly increased the available nitrogen, phosphorus and potassium contents in soil over that of without FYM (Table 3) and the treatment combination F_1T_6 (100% NPK + FYM) was found as the optimum for increasing available N, P and K contents followed by F_1 T_7 and F_1 T_5.

The build up of available N and P in the soil with different fertilizer combination with or without FYM application may be ascribed to the residual effect of applied fertilizers and the mineralization of FYM. Dudhat *et. al.* (1997) reported that application of FYM and chemical fertilizers alone and in combination with each other significantly increased the residual N and P in soil.

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Influence of *Rhizobium japonicum* and Chemical Herbicides on Weed Count, Nitrogen Fixation and Grain Yield of Soybean

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ABSTRACT

Seed inoculation with *R. japonicum* alone increase N content in shoot (0.62 % N), grain (6.84 % N), soil (0.063 % N) and also increased N uptake (188.03 Kg ha^{-1}) and grain yield (2862 Kg ha^{-1}) over all other treatments. Among herbicide application treatments, minimum weed count was noticed with *R. japonicum* + Alachlor treatment (24 $m^2)^{-1}$ followed by *R. japonicum* + Pendimethalin (25 $m^2)^{-1}$. In respect of yield all herbicidal treatments were at par with *Rhizobium japonicum* seed inoculation alone.

Soybean [*Glycine max* (L.) Merrill] is leguminous crop, that stands at number one position amongst the oil seed crops in the world. It is a reach source of protein (contain 43 %), which is greater than cereal and vegetable crops. As a legume crop, biological nitrogen fixation makes it self- sustaining for N nutrition. In addition inoculation of seed with *Rhizobium* not only increase crop yield but also improve the quality of the crop and soil fertility (SubbaRao and Balsundram, 1977). In soybean production, weed management is one of the constraints, and if not controlled properly at critical stages, weeds reduce the yield to the greater extent. Previous evidence is conflicting; however, it appears that the possibility exists for some herbicides to adversely affect soybean nodulation, N_2 fixation and yield (Behran *et al.*, 1979). There is also disagreement concerning whether herbicides affect adversely *Rhizobium* sp., the host plant or both (Baltazar and Brotenegro,1979 and Kust and Struckmeyer, 1971). Hence the present investigation was undertaken to compare the potential effect of chemical herbicides and to determine their influence on the soybean *Rhizobium japonicum* symbiosis and seed yield under field conditions.

MATERIAL AND METHODS

The experiment was laid out in Randomised Block Design with four replications and seven treatments with a variety of soybean J S – 335 at spacing of 30 x 8 cm. Gross and net plot size was 2.4 x 3.2 m^2 and 1.8 x 3.04 m^2 respectively. Seeds treated with *Rhizobium japonicum* culture @ 25g Kg^{-1} seed obtained from APDRC, Dr. PDKV, Akola. Fertilizer was applied @ 30 Kg N; 75 Kg P_2O_5 ha^{-1}. Herbicides were applied as pre-emergence i.e. after one day of sowing and before emergence of plant. The herbicides were alachlor @1 Kg a. i. ha^{-1}, Pendimethalin @ 1 Kg a. i. ha^{-1}, Fluchloralin @ 1 Kg a. i. ha^{-1}, Chorimuron ethyl @ 30 g a. i. ha^{-1}, Trifluralin @ 1 Kg a. i. ha^{-1}. Weed count were taken at 45 DAS from each plots by drawing 1 m^2 quadrat in the net plot and weeds were collected to count number of weeds, then were over dried at 60° C temperature for taking weed, dry weight. Soil, plant and grain analysis of N content were done as per method of analysis by Jackson, (1967).

RESULTS AND DISCUSSION

The predominant weed flora found in the experimental plot included *Cyperus rotundus*, *Eragrostis cilianesis*, *Cynodon dactylon*, *Ageratum conyzoides*, *Dactyloctenium aegyptium*, *Agremone mexicana* and *Axanthospermum hispidium*. Total weed population and dry matter production of weeds differed significantly due to various treatments. Minimum weed count was noticed with *R. japonicum* + Alachlor treatment (24 $m^2)^{-1}$ followed by *R. japonicum* + Pendimethalin (25 $m^2)^{-1}$ (Table 1). With regard to weed dry weight, lowest weed dry weight recorded in treatment *R. japonicum* + alachlor (32 g $m^2)^{-1}$ followed by *R. japonicum* + fluchloralin (34 g $m^2)^{-1}$. These observations are in conformity with those reported by Singh and Singh (1987) and Prabaraj and Dhingra (1995). Maximum N content in

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Table 1. Effect of various treatments on weeds and weed dry biomass.

Treatments		Dose	Total no. of weeds/m^2	Weed dry biomass (g/m^2)
1)	Uninoculated control	-	39	47
2)	*R. japonicum* (ST)	25 g kg^{-1}	32	40
3)	*R. japonicum* + Alachlor	1 kg a.i. ha^{-1}	24	32
4)	*R. japonicum* + Pendimethalin	1 kg a.i. ha^{-1}	25	38
5)	*R. japonicum* + Fluchloralin	1 kg a.i. ha^{-1}	26	34
6)	*R. japonicum* + Chlorimuron ethyl	30 g a.i. ha^{-1}	28	38
7)	*R. japonicum* + Trifluralin	1 kg a.i. ha^{-1}	29	34
	SE (m) ±		1.69	2.45
	CD at 5 %		4.74	6.90

Table 2. Effect of *R. japonicum* and herbicides application on per cent N content, N uptake and grain yield of soybean.

Treatments	Dose	Percent N content			N uptake (Kg ha^{-1})	Grain yield (Kg ha^{-1})
		Shoot	Grain	Soil		
Uninoculated control	-	0.40	5.45	0.040	130.90	2402
R. japonicum (ST)	25 g kg^{-1}	0.62	6.84	0.063	188.03	2862
R. japonicum + Alachlor	1 kg a.i. ha^{-1}	0.51	6.08	0.045	161.97	2662
R. japonicum + Pendimethalin	1 kg a.i. ha^{-1}	0.48	6.34	0.050	175.35	2763
R. japonicum + Fluchloralin	1 kg a.i. ha^{-1}	0.46	6.27	0.050	169.56	2700
R. japonicum + Chlorimuron ethyl	30 g a.i. ha^{-1}	0.46	6.12	0.049	148.24	2419
R. japonicum + Trifluralin	1 kg a.i. ha^{-1}	0.55	6.25	0.051	161.14	2583
SE (m) ±		0.248	0.019	0.001	6.40	83.98
CD at 5 %		0.696	0.040	0.005	17.98	235.88

shoot (0.62 % N), grain (6.84 % N), soil (0.063 % N) and N uptake (188.03 Kg ha^{-1}) was found in seed treatment with *R. japonicum* alone (Table 2). This may be due to more nitrogen fixation, phosphoprotein and phospholipids in the plants. Similar results were reported by Chore and Shastri (1991). Among weedicide treatments *R. japonicum* + Trifluralin gave the higher N content in shoot (0.55 % N), *R. japonicum* + Pendimethalin in grain (6.34 % N) and *R. japonicum* + Trifluralin increased the residual soil N (0.051 % N) and *R. japonicum* + Pendimethalin increases N uptake. This is accordance with the results observed by Behran *et al.* (1979) and Bollich *et al.*, (1988).

With regard to grain yield, seed treatment with *R. japonicum* alone registered the highest grain yield (2862 Kg ha^{-1}) over all treatments (Table 2). This agrees with researches conducted by Kurundkar *et al.*, (1991) and Dahatonde and Shava (1992). Among herbicidal treatment *R. japonicum* + Pendimethalin

recorded the highest grain yield (2763 Kg ha^{-1}) followeded by *R. japonicum* + Fluchloralin (2700 Kg ha^{-1}). All these treatments were at par with *Rhizobium japonicum* treatment alone. Praharaj and Dhingra (1995) who reported increase in yield due to herbicidal application with *Rhizobium* on soybean. The increased yield with application of pendamethalin and fluchloralin can be ascribed to their weed control. This study implies that *Rhizobium* inoculation proved potentially helpful in significantly increasing the biological nitrogen fixation in combination with chemical weed control practice.

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Effect of Chemicals and Botanicals on Powdery Mildew of Mustard (*Brassica juncea* L.)

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ABSTRACT

Application of Wettable sulphur (0.25%) at initiation of disease was found to be effective in controlling powdery mildew of mustard caused by *Erysiphe cichoracearum* and thereby increased seed yield, additional income and economic returns

Mustard (*Brassica juncea* L.) is an important oilseed crop grown under a wide range of climatic conditions. The crop suffers from many diseases but the important among them is powdery mildew incited by Erysiphe cichoracearum cause considerable yield losses. Dange *et al.*, (2002) reported 16.97 per cent reduction in grain yield of Mustard due to Powdery mildew disease with per cent disease intensity of 50.75. The present study was, therefore, undertaken to find out effective control measures.

MATERIAL AND METHODS

A field trial was conducted for four years during 1999-2000 to 2002-2003 in *Rabi* season at Zonal Agricultural Research Station, Yavatmal, Maharashtra. Test variety Pusa bold was sown with a row to row and plant to plant spacing of 45 x 10 cm in a plot of 3.6 x 4.5 m size. Recommended doses of fertilizer and insect control measures were followed. The fungicides tested were, Wettable sulphur (0.25%), Tridemorph (0.07%), Dinocap (0.1%), Ridomil MZ (0.2%), Carbendezim (0.01%), Copper oxychloride (0.25%), fosetyl Al (0.2%), Neem seed kernal extract (5%), Neem leaf extract (5%), Eucalyptus leaf extract (5%) and Ipomoea leaf extract (5%). Four sprays of fungicides and plant extracts were given at 30, 40, 60 and 75 DAS. For recording disease observations, ten plants were selected randomly from each treatment and five leaves from each selected plant were observed 4 days after last spray. Disease intensity was recorded as per the scale 0-9 given by Mayee and Datar, 1986 and PDI was calculated.

RESULTS AND DISCUSSION

The data of fungicidal effect on Powdery mildew disease, yield and incremental cost benifit ratio (ICBR) is presented in Table 1. Dinocap 0.1 per cent was found very effective and significantly superior in reducing powdery mildew (33.9 %), followed by Tridemorph (35.5 %), Carbendazim (36.8%) and Wettable sulphur (37.6%) over control (55.5%). However, they were at par with each other. Tridemorph recorded significantly higher seed yield (7.7 q ha^{-1}), followed by Dinocap (7.6 q ha^{-1}), Wettable sulphur (7.5 q ha^{-1}) and Carbendazim (7.4 q ha^{-1}) and were at par wtih each other. Among plant extracts Neem seed kernal extract 5 per cent found effective and significantly superior in minimising powdery mildew infection (44.5%) and increasing seed yield (6.2 q ha^{-1}) over control (5.0 q ha^{-1}). Efficacy of above fungicides in controlling powdery mildew of Mustard was also reported earlier by Jani *et al.*, (1991) and Patel *et. al.* (1992). The incremental cost benefit ratio (ICBR) was highest (1:2.75) in Wettable sulphur, followed by Carbendazim (1:2.24) and Tridemorph (1:2.12). Rest of the fungicides and plant extracts recorded minimum C:B ratio.

Based on four years results, Wettable sulphur 0.25 per cent proved effective in reducing powdery mildew incidence by 32.3 per cent (PDI 37.6%) and increasing seed yield (7.5 q ha^{-1}) with highest C:B ratio (1:2.75), followed by Carbendazim (1:2.24) and Tridemorph (1.2.12).

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Table 1. Efficacy and economics of fungicides and plant extracts on powdery mildew severity and yield of Mustard

	PDI				Pooled	Seed yield (q ha^{-1})				Pooled	% reduction	ICBR
	1999-2000	2000-2001	2001-2002	2002-2003	mean	1999-2000	2000-2001	2001-2002	2002-2003	mean	in disease	
Wett. sulphur	20.0 (26.5)	69.5 (56.6)	22.0 (27.8)	38.7 (38.4)	37.6 (37.3)	6.7	8.0	7.6	7.3	7.5	32.3	1:2.75
Tridemorph	20.1 (26.6)	65.4 (54.0)	22.1 (27.2)	34.2 (35.5)	35.5 (35.8)	6.6	8.5	8.1	7.7	7.7	36.1	1:2.12
Dinocap	16.9 (24.2)	64.1 (53.30)	19.7 (26.2)	36.0 (36.3)	33.9 (35.0)	6.1	8.8	8.0	7.5	7.6	38.9	1:1.44
Ridomil MZ	23.4 (28.9)	78.5 (62.5)	31.2 (33.9)	41.0 (39.8)	43.5 (41.3)	5.6	7.3	7.4	5.4	6.4	21.6	1:0.46
Carbendazim	18.9 (25.6)	68.2 (55.7)	21.9 (27.8)	38.2 (38.2)	36.8 (36.9)	6.4	8.4	7.9	6.9	7.4	33.2	1:2.24
Copper oxychloride	24.8 (29.8)	78.3 (62.4)	29.9 (33.1)	42.6 (40.7)	43.9 (41.5)	5.8	7.6	7.2	4.9	6.4	20.9	1:1.15
Fostyl-AL	21.2 (27.4)	73.2 (58.9)	31.8 (34.3)	43.2 (41.0)	42.4 (40.4)	5.7	7.0	7.3	5.7	6.5	23.7	1:0.52
Neem seed Kernal Extract	24.5 (31.2)	81.1 (62.3)	31.5 (34.1)	41.1 (39.7)	44.5 (42.4)	5.5	6.7	7.3	5.4	6.2	19.8	1:1.48
Neem leaf extract	28.5 (32.3)	84.3 (66.7)	32.2 (34.5)	45.2 (42.2)	47.6 (43.9)	5.2	6.5	7.0	4.8	5.9	14.4	1:1.06
Eucalyptus leaf	28.6 (32.2)	82.8 (65.6)	34.1 (35.7)	45.2 (42.2)	47.7 (43.9)	5.3	6.5	7.0	4.7	5.9	14.2	1:1.08
Ipomoea leaf extract	30.5 (35.3)	83.4 (66.1)	30.4 (33.3)	42.7 (40.8)	46.8 (43.4)	5.2	6.3	6.8	4.8	5.7	15.8	1:0.89
Control	33.5 (35.3)	90.9 (72.8)	45.4 (42.3)	52.3 (46.3)	55.5 (49.1)	4.1	5.6	6.6	3.9	5.0	-	-
SE (m) ±	0.56	0.98	1.4	0.79	1.7	0.34	0.47	0.46	0.20	0.39	-	-
CD at 5%	1.7	2.9	4.2	2.3	4.9	0.99	1.4	1.3	0.57	1.1	-	-

Figures in parentheses are arcsine values

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Green House Evaluation of *Rhizobium* Strains For Increasing Early Growth of *Acacia catechu* Wild

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ABSTRACT

A total of 42 *Rhizobium* strains isolated from *Acacia catechu* seedlings grown in five climatically diverse and geographically widely separated localities were tested for their ability to nodulate and fix atmospheric nitrogen with *Acacia catechu* Wild in green house. Significant differences in number of nodules, shoot and root dry weight and affectivity was found. Five isolates Sln-20, Nhn-63, Uhf-76, Dhm-121 and Nrl-94 were found highly effective in increasing the early growth of host seedlings. It is concluded from this study that five isolates can fulfilled the nitrogen requirement of seedlings as effectively as chemical nitrogen.

Woodland legumes such as Acacia species are becoming important in afforestation of degraded lands on account of their nitrogen fixing ability (Oldeman, 1983). Enhancing early growth of nitrogen fixing trees in the nurseries is important in seedling production as early growth of many such trees is slow. Inoculating seedlings with the effective strain of *Rhizobium* isolates may increase the growth rate. Therefore, it becomes necessary to isolate and screen efficient strains of *Rhizobium* from native population which can compete and establish well, when inoculated. Similar studies were carried out by many workers earlier. (Wynne *et al.*, 1980; Matos and Schroder, 1989; Dreyfus and Dommergues, 1981).

The present investigation deals with the evaluation of the characterized strains for their effectiveness in increasing the early growth of seedlings under green house conditions.

MATERIAL AND METHODS

The present study was carried out in the Green house of Dr.Y.S.Parmar University of Horticulture and Forestry, Nauni, Solan, during 1997-2000. The Seedlings of *Acacia catechu* were collected from the Forest Department Nurseries from different agroclimatically diverse zones of Himachal Pradesh.

a) Selection and isolation of *Rhizobium* strains

Root nodule bacteria capable of nodulating *Acacia catechu* were isolated from seedlings grown in five agroclimatically diverse and geographically widely separated locations in Himachal Pradesh, India. The method for selection of *Acacia catechu* isolates was followed as given by Vincent, 1970. Single colony isolates were maintained on Yeast Extract Mannitol Agar (YEMA) slopes.

b) Soil preparation

Soil was obtained from the depth of 0 to 22.5 cm from fallow area, air dried and sieved through 2mm sieve. Soil was mixed with sand in the ratio of 2:1 and 0.5 per cent $CaCO_3$, 0.05 per cent K_2HPO_4 and 20g FYM Kg^{-1} of soil. The soil was sterilized thrice an alternate day at 121°C for 3 hours.

c) Inoculum preparation

All the 42 *Rhizobium* isolates were grown on YEMA slopes for 3 days. This growth was harvested in sterilized water and one milliliter of suspension containing 108 cells ml^{-1} were used for each seed inoculation.

d) Seed germination

Seeds of *Acacia catechu* were surface sterilized and scarified with concentrated H_2SO_4. washed with sterilized distilled water and were transferred aseptically to water agar plates (0.75% w/v). These plates were incubated at 25 – 30°C.

e) Sowing of seeds, thinning, watering and harvesting

Five germinated seeds were sown at equidistance in 5 holes and one ml of inoculum was applied over each seed. Nitrogen control pot was supplied with 88 ppm of NO_3 nitrogen pot^{-1} as dilute KNO_3. The plants were randomized in green house. After 4 –6 days, thinning was done and three plants pot^{-1} were maintained. Seedlings were harvested 60 days after emergence. Root and shoot were dried to constant weight at 50°C.

RESULTS AND DISCUSSION

All the 42 isolates modulated *Acacia catechu* in the green house. The data on the variation in the nodule number, root and shoot dry weight per cent shoot and root dry weight increases over

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Table 1. Effect of Rhizobium inoculants on symbiotic parameters of *Acacia catechu*

Rhizobium Isolates	Nodule number	Dry Weight (mg plant^{-1})				Plant biomass (mg)
		Root		Shoot		
Sln-2	4.88	80.00	(60.00)*	196.25	(23.82)**	276.25
Sln-3	4.33	60.00	(20.00)	125.00	(-21.14)	185.00
Sln-4	4.00	70.00	(40.00)	120.00	(-24.29)	190.00
Sln-8	4.55	80.00	(60.00)	165.00	(4.21)	245.00
Sln-10	4.55	73.34	(46.68)	173.33	(29.66)	246.67
Sln-12	4.88	80.00	(60.00)	147.50	(-6.64)	227.50
Sln-14	5.22	40.00	(-20.00)	125.00	(-21.14)	165.00
Sln-17	5.22	66.67	(33.34)	206.66	(30.38)	273.33
Sln-19	5.22	55.00	(10.00)	80.00	(-49.53)	135.00
Sln-20	4.88	410.00	(720.00)	720.00	(354.25)	1130.00
Sln-23	4.55	75.00	(50.00)	223.75	(41.17)	298.75
Sln-24	6.55	73.33	(46.67)	173.33	(9.36)	246.67
Sln-26	5.00	28.75	(-42.50)	125.00	(-21.14)	153.75
Sln-29	5.77	35.00	(-30.00)	87.50	(-44.79)	122.50
Sln-32	4.55	40.00	(-20.00)	100.00	(-36.90)	140.00
Sln-34	9.00	122.50	(145.00)	255.00	(60.88)	377.50
Sln-39	4.55	94.25	(88.50)	125.00	(-21.14)	219.35
Nhn-42	5.55	50.00	(0.00)	81.67	(-48.47)	131.67
Nhn-45	4.88	40.00	(-20.00)	137.00	(-13.56)	177.00
Nhn-48	4.88	70.00	(40.00)	133.34	(-15.87)	203.34
Nhn-50	4.55	83.33	(66.66)	168.35	(6.20)	251.66
Nhn-54	5.00	76.25	(52.50)	143.75	(-9.31)	220.00
Nhn-60	4.55	40.00	(-20.00)	168.33	(6.21)	208.33
Nhn-62	6.77	86.75	(73.50)	175.00	(10.41)	261.75
Nhn-63	4.00	70.00	(40.00)	545.00	(243.85)	615.00
Nhn-64	4.33	115.00	(130.00)	60.00	(-62.14)	175.00
Nhn-66	4.55	48.33	(-3.34)	228.33	(44.06)	276.66
Uhf-68	11.11	86.67	(73.34)	170.00	(7.26)	256.67
Uhf-69	4.66	60.00	(20.00)	113.80	(-28.21)	173.80
Uhf-71	4.45	51.25	(2.50)	132.50	(-16.40)	183.75
Uhf-72	4.00	95.00	(90.00)	100.00	(-36.90)	191.00
Uhf-73	4.66	54.17	(8.34)	204.16	(28.81)	258.33
Uhf-76	7.78	51.25	(2.50)	295.00	(86.12)	346.25
Nrl-91	4.33	60.00	(20.00)	177.50	(11.99)	237.50
Nrl-94	5.00	106.00	(112.00)	316.67	(99.79)	423.33
Nrl-95	4.55	103.33	(106.00)	181.67	(14.62)	285.00
Dhm-100	4.00	45.00	(-10.00)	205.00	(29.34)	250.00
Dhm-106	4.45	47.50	(-5.00)	141.25	(--10.88)	188.75
Dhm-111	4.45	45.00	(-10.00)	105.00	(-33.75)	150.00
Dhm-114	5.25	75.00	(50.00)	181.67	(14.62)	256.67
Dhm-117	7.00	62.50	(25.00)	187.50	(18.30)	250.00
Dhm-121	11.00	105.00	(110.00)	260.00	(64.04)	410.00
AC-4	9.56	77.50	(55.00)	126.25	(-20.35)	203.75
UIC	0.00	50.00		158.50		208.50
UIC+N	0.00	59.75		264.75		324.13
SE of mean	0.307	15.790		27.529		
CD at 0.05%	0.850	88.87		184.664		

* - The values are per cent increase in root dry weight over control

** - The values are per cent increase in shoot dry weight over control.

UIC – Uninoculated control UIC+N - inoculated nitrogen control (88 ppm KNO_3)

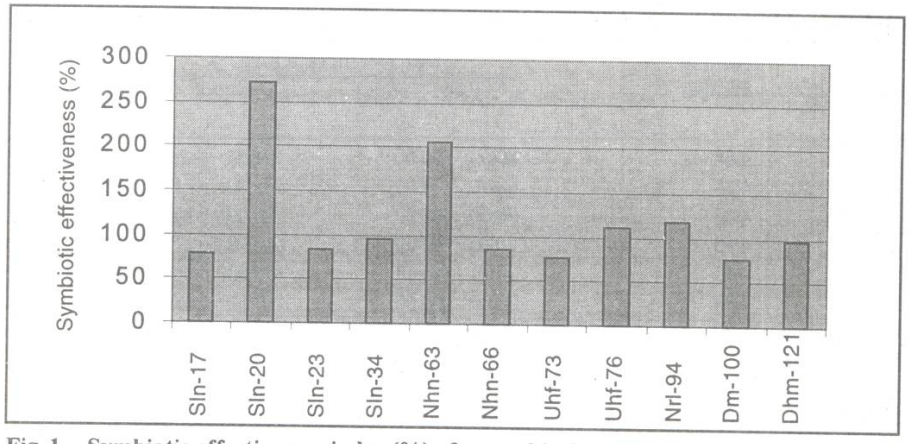

Fig. 1. Symbiotic effectiveness index (%) of some rhizobial isolates inoculated on *Acacia catechu* grown in pots

uninoculated control and plant biomass due to *Rhizobium* inoculation are given in Table 1. The large amount of variation was in the average nodule number was noted, having the range between 4.00 to 11.11. The highest numbers of nodules were found in Uhf-68. Highest per cent increase over uninoculated root and shoot dry weight was found in Sln-20. Highest plant biomass was found in Sln-20 followed by Nhn-63.

Comparing the per cent symbiotic effectiveness (dry weight of shoot inoculated plant^{-1} dry weight of shoot N control plant x 100) of the isolates with uninoculated nitrogen control five isolates, Sln-20, Nhn-63, Uhf-76, Dhm-121 and Nrl-94 showed more than hundred per cent symbiotic effectiveness. Only the isolates having more than 75 per cent of symbiotic effectiveness are shown in Fig. 1.

Most of the isolates tested showed increase in plant growth parameters, which indicates their beneficial association with the host plant. The result clearly shows that the growth and nodulation of *Acacia catechu* were very much influenced by different *Rhizobium* isolates. However, variation in their performance may be attributed to their virulence and inherent variation in the symbiotic effectiveness. Similar variation has been reported in many groups of rhizobia (Wynne et al., 1980; Matos and Schroder, 1989; Dreyfus and Dommergues, 1981).

The first requirement in the bacterial strain selection for the use as inoculant is that it should promptly form a fully effective nitrogen fixing association with the host legume (Vincent, 1968). Among the 42 isolates of *Rhizobium*, five isolates Sln-20, Nhn-63, Uhf-76, Nrl-94 and Dhm-121 showed more than 100 per cent symbiotic effectiveness. This indicate the importance of *Rhizobium* inoculation in the establishment of seedlings in the early stage of growth and these four isolates can fulfill the nitrogen requirement of the seedlings as effectively as chemical nitrogen. The strain Nrl-94 may be considered to be most suitable strain of *Rhizobium* for field utilization against *Acacia catechu*.

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Genetic Divergence in Aromatic Traditional Rice Accessions From Chhattisgarh and Madhya Pradesh (*Oryza Sativa* L.)

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ABSTRACT

Genetic divergence as measured by D^2 technique was studied for different morphological and quality traits in 135 rice genotypes. The analysis of variance revealed significant differences among the genotypes for each character studied. Based on genetic distance 135 genotypes were grouped into 10 different clusters. The maximum intra cluster distance was observed in cluster I comprising 5 popular improved genotypes Viz., Madhuri-11, Pusa Basmati-1, PR-111, Toroari Basmati and IR-64. The genotypes Viz., Rajabhog, Jandhri Nadgi and Samundar fer are grouped in cluster X, Toroari Basmati, Pusa Basmati-1 and IR-64 in cluster I, Bedro and Ghoda Punchhi in cluster III, Chinnor, Rajim-12 and Rajabhog incluster IV, Rukhmanibhog and Jaigundhi in cluster VI, Rukhmanibhog and Jaigundhi in cluster VI, Vishnubhog and Gangabarud in cluster VIII and Bhanta phool and Durar phool in cluster VIII.These genotypes have difference for morphological and quality characters may be utilized in future breeding programme to obtain high heterotic effects or to evolve desirable recombinants. Cluster I and IV were identified as genetically divergent on the basis of cluster mean and distance. Out of 135 genotypes studied 67 genotypes are scented, 46 mild scented and 22 non-scented.

Genetic improvement mainly depends on the amount of genetic variability present in the population. In any crop germplasm serve as a valuable source of base population and provide scope for wide variability. Information on the nature and degree of genetic divergence would help the plant breeder in choosing the right type of parents for breeding programme (Vivekanandan and Subramanian, 1993).

The spectrum of variability in segregating generation for grain yield and quality parameter depends on the genetic diversity of the combining parents. Hence, estimation of genetic diversity for grain yield and quality parameters among genotypes is important for planning the future crossing program. Mahalanobis D^2 statistic is potential tool for estimating it, as has been emphasized by (Rahman *et al.,* 1997). In the present study an attempt was made to classify and understand the nature and magnitude of genetic diversity present in available rice germplasm for grain yield and quality traits.

MATERIAL AND METHODS

The material for this study consisted of 128 aromatic rice germplasm from Chhattisgarh and Madhya Pradesh states in India along with seven cultivars. The material was grown in a randomised block design with two replications. Each line was grown in 4.2 m long rows at spacing of 20 cm between rows and 20 cm between plants in rows. The experiment was conducted during the wet season 2000. The recommended dose of NPK was applied at the rate of 60, 40 and 20 kg ha^{-1}, respectively. Observations were recorded on twenty traits including biometrical and quality characters viz. days to 50 per cent flowering, plant height, ear bearing tillers $plant^{-1}$, panicle length, filled and unfilled grains per panicle, 1000 grain weight, paddy length, paddy length: breadth ratio, brown rice length, brown rice length: breadth ratio, kernel length, kernel length: breadth ratio, kernel length of cooked rice, kernel length: breadth ratio of cooked rice, elongation ratio, alkali spreading value, amylose content, head rice recovery and grain yield $plant^{-1}$. Hundred gram paddy of each genotype was taken in duplicate and shelled in a Satake laboratory dehusker and milled in sample McGill Miller No. 1 under standard condition to about 8 per cent degree of milling recovery was determined after separating broken ($3/4^{th}$ grain or less) from the milled rice in duplicate (Indudhra Swamy and Bhattacharya, 1984). Alkali spreading value was measured in terms of alkali disintegration using a '7' point numerical scale (Little *et al.*, 1958). The amylose content was determined as per the procedure suggested by Juliano (1971). Kernel length

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after cooking (KLAC) and kernel breadth after cooking were measured with graduated cardboard (Pillaiyar and Mohandoss, 1981). Elongation ratio was derived by dividing the mean L/B ratio of cooked rice to the mean L/B of milled rice (Juliano and Perez, 1984). The aroma was determined by following the method of 0.5 per cent KOH (Tomar and Prasad, 1997). The analysis of genetic divergence carried out by using Mahalanobis D^2 statistic (Rao, 1952). Grouping of varieties was done as per the procedure by Spark (1973).

RESULTS AND DISCUSSION

The analysis of variance revealed significant differences among the genotypes for all characters except panicle length indicating existence of variability among the genotypes for the characters studied. Based on the relative magnitude of D^2 values 135 genotypes were grouped into ten clusters (Table 1).

The cluster VI was the biggest cluster consisting of 30 genotypes followed by 24 in cluster IX, 21 in cluster V, 16 in cluster VII, 14 in cluster X and 13 in cluster II, 7 genotypes in cluster III, 5 genotype in cluster I, 3 genotypes in cluster IV and a minimum number of 2 genotypes in cluster VIII. The cluster I consisted of 5 popular improved varieties viz., Madhuri-11, Pusa Basmati-1, PR-111, Taroari Basmati and IR-64. The cluster VIII comprised of 2 accessions Bhantaphool and Duarar phool and cluster III of seven accessions Lallo-14, Angar moti, Anterved, Chhote dubraj, Kadam phool, Lallu-14, and Anterved. The above grouping indicates existence of wide genetic divergence among constituent genotypes. Such high degree of divergence was found in local collections (Sardana *et al.*, 1997; Sarawgi *et al.*, 1998 and Usha Kumari and Rangaswamy 1997) as well as in international collections (Roy and Panwar 1993).

The maximum intra cluster distance was observed in cluster I (4.821) followed by VIII (3.503) and III (3.106) and the minimum intra cluster distance exhibited by cluster IV (1.828) indicating limited genetic diversity among these genotypes. The unidirectional selection practiced in the past might have resulted in less divergence between these genotypes (Usha Kumari and Rangaswamy 1997) (Table 2).

The relative divergence of each cluster from other cluster (inter cluster distance) indicated greater divergence between cluster I and IV (11.384) followed by cluster I and X (9.982), cluster I and VI (9.963) and cluster I and VIII (8.970). The selection of divergent genotypes from above cluster would produce a broad spectrum of variability for morphological and quality traits, which may enable further selection and genetic improvement. The hybrids developed from the selected genotypes within the limits of compatibility of these clusters may produce high magnitude of heterosis or desirable transgressive segregants that would be rewarding in a rice breeding programme. The present study revealed that due emphasis in breeding programme should be given to IR-64, Taroari Basmati and Pusa Basmati -1 of cluster I, Bedro and Ghoda Punchhi of cluster IV, Sansari and Tulsi mala of cluster X and Aatma shital and Vishnubhog of cluster VI.

The average cluster wise mean values for different characters presented in Table 3 showed that the genotypes included in cluster X viz., Rajabhog, Jandhri Nadgi and Samundar fer recorded high yield per plant and filled grains per panicle. The genotypes Taroari Basmati, Pusa Basmati -1 and IR-64 in cluster I had maximum values for ear bearing tiller, 1000 grain weight, length of paddy, brown rice and milled rice, kernel length of cooked rice and their ratio and alkali spreading value. The genotypes Bedro and Ghoda Punchhi in cluster IV had minimum days to 50 per cent flowering intermediate value of amylose content and alkali spreading value. The genotype Chinnor, Rajim-12 and Rajabhog of cluster V had maximum head rice recovery percentage and elongation ratio and minimum unfilled grain. Genotypes Rukhmanibhog and Jaigundi in cluster VI had maximum panicle length and filled grains panicle^{-1}. The genotypes Bishnmbhog and Gangabarud included in cluster VII showed better mean value than other clusters for panicle length, length of paddy, brown rice, milled rice and cooked rice and their ratios. The genotypes Bhanta phool and Durar phool forming a separate cluster VIII and showed maximum value for plant height and unfilled grain, 1000 grain weight, kernel length of cooked rice, elongation ratio, head rice recovery and grain yield plant^{-1}. Thus, these genotypes hold great promise as parents to obtain promising elite lines

Table 1. Genotypes included in different clusters

Cluster number	No. of genotype included in each cluster	Name of genotype
I	5	Madhuri-11, Pusa Basmati-1, PR-111, Taroari Basmati, IR-64
II	13	Badshahbhog(B:42I), Badshahbhog (B:528), Bashabhog (B:1717), Jai Gundi (J:248), Sarso phool (S:1715), Sarsariya (S:428), Jira shankar (J:304), Tulsi amrit (T:174), Tulsi manjari (T:247), Laxmi bhog (L:834), Lokti masi (L:88), Ramjira (R:397), Shrikamal (S:665)
III	7	Lalloo-14 (L:90), Angar moti (A:451), Anterved (A:219), Chhote dubraj (C:796), Kadam phool (K:1978), Lallu-14 (L:2021), Anterved (A:215)
IV	3	Bhantha dubraj (B:2021), Ghoda punchhi (G:821), Elaychi (E:15), Bedro
V	21	Bagmuchh (B:1689), Wasmati (W:48), Pans patri (B:1589), Baysabhog (B:30), Laxmi bhog (L:1238S), Chinnor (C:3341), Duban mua (D:625), Haruna dubraj (H:41 I), Mai dubraj (M:836), Jam dhan (J:215 II), Rajim - 7 (R:167), Rajim -12 (R:169 II), Ramkali (R:273 III), Sapri II (S:342 II), Sarsariya (S:269), Thakur prasad (T:180), Raja bhog (R:399), Bans patri (B:728 I), Kali muchh (K:1056), Bag muchh (B:1689), Dubrej
VI	30	Aama Gohi (A:349), Aatma Shital (A:3287), Atma Shital (A:543), Aziya Sal (A:367 II), Akbar Badshah (A:593), Bajraj (B:1358), Barang (B:1166), Badshahbhog (B:1389), Badshahbhog (B:2094), Badshahbhog (B:2461), Badshahbhog (B:2495), Badshahbhog (B:2504), Badshahbhog (B:2812), Badshahbhog (B:2814), Bisnu bhog (B:1094), Vishnoo bhog (V:9), Bikoni (B:525 II), Chini Kapoor (C:30 II), Chirai nakhi (C:751), Chitar sing (C:705), Ganga balu (G:467), Ganga baru (G:39), Jai woga (J:112), Bhanta phool (B:1087), Krisna bhog (K:1019), Rukhmani bhog (R:4950), Samund chini (S:980 I), Lokti muchni (L:748), Dhawara sawa (D:716), Jai gundi (J:248)
VII	16	Majhali dubraj (M:915), Sukla phool (S:227), Wans phool (W:91), Tulsi prasad, Chhatri bhog (C:539), Gopal bhog (G:583), Mohan bhog (M:873), Bishum bhog (B:678), Chhatri (C:43), Elaychi (E:15), Ganga barud (G:3), Kali muchh (K:2533), Kubri Mohar (K:1292 I), Chhatri (C:808), Chinikapoor (C:459), Indira A-9
VIII	2	Bhanta phool (B:1971), Durar phool (J:1004)
IX	24	Muni bhog (M:1A II), Chinnor (C:606), Dubraj (D:19 I), Dubraj (D:202), Dubraj (wild scented) (D:202), Dubraj (D:743), Dubraj (wide scented) (D:808), Dubraj Dhan (Deshi) (D:961), Dubraj scented (D:324), Bandi dubraj (B:2875), Bandwa dubraj (B:2258), Bhainsa dubraj (B:2268), Deshi dubraj (D:1366), Moti dubraj (M:576 II), Dudaga (D:116 II), Duah nag (D:668 I), Ganga prasad (G:230), Ganjo (G:1035), Garra kat (G:113 III), Jhilli safri (J:109 IV), Jhulari (J:28), Jira (J:293 II), Jira dhan (J:50), Sonth (S:715)
X	14	Badsabhog (B:1209), Badshahbhog (B:1029), Badshahbhog (B:1340), Badshahbhog (B:1727), Raja bhog (R:509), Urai Butta (U:78 II), Dudgi (D:1205), Ganga barud (G:397), Jaw phool (J:378), Jandhri nadgi (J:403), Samundar fer (S:672 I), Sansari (S:1049), Tulsi mala (T:237), Turiya poto (T:143)

Note : Figure in parentheses indicate accession number

Table 2 : Mean intra-cluster (diagonal and bold) and inter cluster divergence among the clusters

Cluster Number	I	II	III	IV	V	VI	VII	VIII	IX	X
I	**4.821**	8.946	6.291	11.384	5.945	9.963	5.275	8.97	5.824	9.982
II		**2.801**	5.755	4.978	4.339	2.726	5.016	5.992	5.225	2.912
III			**3.106**	6.879	4.498	6.171	4.221	8.136	4.618	6.767
IV				**1.828**	7.671	4.796	7.524	7.155	7.665	4.509
V					**2.608**	4.852	2.831	6.77	2.238	5.354
VI						**2.749**	5.522	6.784	5.398	2.384
VII							**2.952**	5.887	3.076	5.858
VIII								**3.503**	7.267	6.315
IX									**2.311**	5.425
X										**2.654**

Note: Intra -diagonal, inter of the diagonal

Table 3 : Cluster mean for morphological and quality traits

Cluster Number	No of geno. in each cluster	Characters																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
I	5	94.80	111.03	6.84	24.84	105.32	29.58	18.86	9.58	4.50	7.52	3.59	6.48	3.46	8.84	3.52	1.38	19.21	4.13	58.81	9.23
II	13	105.04	145.44	6.77	27.58	136.15	29.77	13.35	6.35	2.73	4.62	2.18	4.08	2.13	6.15	2.25	1.51	15.98	4.00	66.69	7.06
III	7	82.93	122.43	5.99	23.80	117.45	16.24	17.34	8.20	3.39	5.84	2.71	5.06	2.66	6.97	2.21	1.38	23.21	5.37	61.14	7.27
IV	3	92.33	156.73	5.13	27.77	143.22	11.88	18.15	6.03	2.16	4.30	1.53	3.67	1.43	6.50	1.83	1.78	16.31	3.08	72.49	9.37
V	21	108.43	131.86	5.49	23.90	139.02	28.25	14.86	7.67	3.66	5.92	2.95	5.07	2.81	6.79	2.45	1.34	19.03	6.17	60.41	8.98
VI	30	106.17	145.42	6.43	27.99	170.94	18.75	11.32	5.85	2.67	4.51	2.08	3.93	2.09	5.84	2.09	1.49	17.14	6.27	64.90	9.47
VII	16	100.75	153.37	6.33	27.78	135.62	20.52	15.86	7.85	3.71	6.18	3.03	5.44	2.98	7.33	2.67	1.35	17.99	4.19	55.92	9.54
VIII	2	106.50	163.05	5.05	46.15	160.95	31.24	18.67	7.20	3.10	5.78	2.42	4.85	2.50	7.85	2.51	1.62	14.39	2.00	67.98	9.82
IX	24	108.98	121.77	5.06	22.01	153.23	20.09	15.56	7.78	3.63	6.00	3.03	4.99	2.75	7.23	2.64	1.45	19.21	4.62	51.81	9.47
X	14	107.39	141.23	5.81	26.85	188.91	21.37	11.73	5.92	2.68	4.41	2.15	3.80	2.03	6.05	2.26	1.59	15.90	2.43	67.34	10.14

1 - Days to 50 per cent flowering 2 - Plant height (cm) 3 - Ear bearing tillers per plant 4 - Panicle length (cm) 5 - Filled grain per panicle 6 - Unfilled grain percentage 7 - Thousand grain weight (gm) 8 - Paddy length (mm) 9 - Paddy length :breadth ratio 10 - Brown rice length (mm) 11 - Brown rice length :breadth ratio 12 - Kernel length (mm) 13 - Kernel length : breadth ratio 14 - Kernel length of cooked rice (mm) 15 - Kernel length : breadth ratio of cooked rice 16 - Elongation ratio 17 - Amylose content (%) 18 - Alkali spreading value 19 - Head rice recovery percentage 20 - Grain yield per plant (gm)

through hybridization and to create further variability for these characters.

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Heterotic Studies in Single and Three Way Cross Hybrid in Sunflower (*Helianthus annuus* L.)

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ABSTRACT

The present investigation was undertaken with a view to produce and compare three-way hybrid with corresponding single cross hybrids. Three cytoplasmic male sterile lines, three non-corresponding maintainer lines and five restorer lines were used to synthesize 45 three way cross hybrids (TWC) and 15 single cross (SC) hybrids. The comparative study of single and three-way cross hybrids indicated that, large number of three-way cross hybrids have manifested significant positive heterosis over their related single crosses for most of the characters studied except days to 50 per cent flowering, head diameter, percentage of filled seeds head^{-1} and oil content, respectively. For seed yield plant^{-1}, the TWC hybrid [(234A x IB 240 B) 271 R] recorded the highest heterosis of 68.30 per cent over the corresponding single cross.

The cross [(21A x IB 103/1-1-1B) 278 R) with 8.10 per cent heterosis showed maximum heterosis for oil content over the corresponding single cross hybrid. These promising TWC hybrids need to be tested in multilocation trials in order to assess the adaptability, stability and uniformity in appearance.

The main advantage of single cross hybrid is their uniformity, increased hybrid seeds, hence low cost of seed production. The public hybrids released presently in the country for commercial cultivation are single cross hybrids and the yields of single cross are fairly stagnant over the years. To break this yield plateau, some new methods are to be investigated. One such appraoch is production of three-way cross hybrids. Three way cross hybrids have proved useful in sorghum (Walsh and Atklus, 1973). However, in sunflower they are of recent origin (Bochkowi and Sharygina, 1988). Therefore the study was undertaken to know the comparative performance of three way cross hybrids over related single cross hybrids for yield and yield contributing characters through heterosis.

MATERIAL AND METHODS

The study comprised of production of two way cross hybrids (TWC), by crossing three cytoplasmic sterile lines (21 A, 23 A, 302 A) with three unrelated maintainer lines (IB103/1-1-1B, IB 148/2-1-1B -1B, IB 240B) in all possible combinations and further restoring fertility by crossing with five fertility restorer lines (270 R, 271 R, 272R, 273R, 278 R). By using the same cytoplasmic male sterile lines and fertility restorer lines resultant 15 single cross (SC) hybrids were produced. Thus 72 entries consisting of the TWC hybrids, SC hybrids and parents were evaluated in randomized complete block design with three replications during summer 1999 at Oil Seeds Research Unit, Dr. PDKV, Akola. Recommended packages of practices were followed to raise the disease free and healthy crop.

The evalaution of heterosis in single way and three way crosses in sunflower were carried out for nine characters viz, days to 50 per cent flowering, days to maturity, plant height, leaf area index, head diameter, percentage filled seeds head^{-1}, 100 seed weight, oil content, seed yield plant^{-1}. The heterosis in three - way crosses [(A x B) R] over the corresponding single cross (A x R) was calculated by formula.

$$\frac{[(A \times B)\,R] - (A \times R)}{(A \times R)} \times 100$$

Where, [(A x B) R] is the mean performance of three - way cross hybrid and (A x R) of single cross hybrid (Naresh, 1993).

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Table 1 : Heterosis in three way crosses over corresponding single crosses.

Characters	Number of significantly heterotic TWC crosses		Range of heterosis	Best heterotic cross
	+ve	-ve		
Days to 50 % flowring	2	3	-10.48 to 14.94	[(302A x IB 240 B) 272 R]
Days to maturity	14	10	-8.60 to 11.54	[(302 A x IB 240 B) 272 R]
Plant height	25	17	-24.19 to 3854	[21 A x IB 240 B) 270 R]
Leaf area Index	20	11	-18.54 to 8.64	[302 A x IB 103/1-1-1B)] 278] & [(302A x IB 103/1-2-1B)]278R]
Head diameter	4	33	-37.24 to 10.31	[(302 A x IB 240 B)271 R]
Percentage of filled seeds head^{-1}	10	12	-5.27 to 6.43	[(334A x IB 240 B) 271 R]
100 Seeds weight	21	15	-20.00 to 27.05	[(320A x IB 148/2-1-IB)273 R]
Oil content	14	19	-8.90 to 8.10	[(21A x IB 103/1-1-I B) 278R]
Seed yield plant^{-1}	38	2	-10.79 to 68.30	[(234A x IB 240 B) 271 R]

RESULTS AND DISCUSSION

From Table 1 it is revealed that the heterosis was found to be significantly superior in most of the characters in some of the TWCs over their corresponding SC hybrids. The extent of heterosis was highest for seed yield plant^{-1} (68.30 %) in TWC [(234 A x IB 240 B) 271 R], over its corresponding SC hybrids (274A x 271 R) and 38 TWC hybrid were found tobe superior over SC hybrids. As per the oil content character is concerned the extent of heterosis was only 8.10 per cent exhibited by TWC [(21A x IB 103/1-1-1B) 278 R]. The high extent of heterois exhibited by other TWCs over their corresponding SC hybrids in other characters were 38.54 per cent [(234A x IB 240 B) 271 R] for plant height, 27.05 per cent [(302 A x IB 148/2-1-IB) 273 R] for seed weight, 14.94 per cent and 11.54 per cent [302 A x IB 240 B) 272 R], respectively for early flowering and early maturity, respectively. For other characters like leaf area index, head diameter and percentage of filled seeds, the extent of heterosis was 8.64 per cent, 10.31 per cent, 6.43 per cent in the TWCs.

During the present investigation most of the TWC hybrids excelled their corresponding single crosses in seed yield. (38 out of 45 TWC). The probable cause may be the buffering action against unfavourble climatic condition and heterotic effect in female of three way cross hybrids due to incorporation of additional line incorporated in these hybrids. These promising TWC hybrids need to be tested in multilocation trials in order to assess the adaptability, stability and uniformity in appearance. The increased yield of TWC hybrids over single cross hybrids have been reported in sunflower by Naresh *et. al.* (1996) and Makane *et. al.* (1998)

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Development and Evaluation of IPM Module For Effective and Economical Management of Major Pests of Rainfed Cotton

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ABSTRACT

An IPM module was developed and recommended by Dr.PDKV, Akola for the management of major pests of cotton during 1998-99. In the present studies some refinements in the components of this recommended IPM module were made for more effective and economical management of major pests of rainfed cotton, This refined IPM module so developed was evaluated in comparison with the recommended existing IPM module and recommended chemical control measures module, for three years (2001-02 to 2003-04) at Cotton Research Unit, Dr. PDKV, Akola, Maharashtra. From the present studies it was concluded that the refined IPM module consisting of thiomethoxam 70 WS seed treatment @ 4.28 gm kg^{-1} seed, one spray of acetamiprid 20 SP @ 15 g.a.i. ha^{-1} for sucking pests based on ETL, two releases of *Trichogramma chilonis* egg parasitoid @ 1.5 lakh ha^{-1} at 45-50 and 55-60 days after germination of crop and for bollworms ETL based one spray of neemark 300 ppm @ 5 ml L^{-1} followed by one spray of spinosad 45 SC @ 50 g.a.i ha^{-1} and one spray of beta-cyfluthrin 2.5 EC @ 0.0025 per cent should be adopted for effective and economical integrated management of major pests of rainfed cotton.

Cotton is an important cash crop and plays a key role in economy of the nation. India ranks first in the world as regards the acreage under cotton crop. However, in India cotton crop ranks first on which insecticide use is maximum i.e. 44.5 per cent out of total pesticide consumption in the country, whereas in world cotton crop occupies third position with respect to pesticidal use which is only 10.2 per cent (Pawar *et. al.*, 2003). This indiscriminate and excessive use of pesticides on cotton crop in the country leads to the harmful residues, resurgence of secondary and minor pests, development of resistance in insect pests to pesticides, adverse effects on natural enemies of cotton pests, environmental pollutions etc. This prompted a neccessity of rational use of insecticides for the management of cotton pests in a manner that can be effective while also being compatible with the environment. The most logical appraoch towards achieving this is to adopt integrated pest management approach for the management of major pests of cotton.

Taking into consideration the importance and present need of integrated pest management an IPM module was developed and recommended by Dr. PDKV, Akola during 1998-99 for the management of major pest of cotton on the basis of three years study. However, present studies were undertaken to develop IPM module which will be more effective and economical as compared to already recommended IPM moudle. For this some refinements were made in the components of already recommended IPM module by replacing with some of the new and effective components. This refined IPM module so developed in this way was evaluated for its effectiveness and economical viability in comparison with the existing IPM module and recommended chemical control measures module. For this a field experiment was conducted for three years (2001-02 to 2003-04) at Cotton Research Unit, Dr. PDKV, Akola, Maharashtra.

MATERIAL AND METHODS

A field experiment was conducted at Cotton Research Unit, Dr. PDKV, Akola during *Kharif* season of 2001-02, 2002-03 and 2003-04 under rainfed conditions. The design of experiment was RBD with seven replications. The plot size was 12.6 x 11.4 m and cotton variety PKV Hy-2 was grown at 90 x 60 cm spacing for this studies. Recommended agronomic practices were followed to raised the crop under rainfed condition. The treatments included in this experiments were -

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1) Module - 1 Existing IPM module
2) Module - 2 Refined IPM module
3) Module - 3 Recommended chemical control measures

Plant protection measures were undertaken as and when the population or infestation of a particular pest was reached to ETL in a particular module. However, parasitoid releases were undertaken at a specific time and interval. Details of treatments undertaken in various modules during 2001-02, 2002-03, 2003-04 is given in Table 1.

Weekly observations were recorded on the population of sucking pests and bollworm incidence to ascertain the pest load for imposition of ETL based treatments in various modules.

The ETL'S considered for major pests of cotton for these studies were as given below

1) Aphids	- 10 aphid nymphs leaf^{-1}
2) Jassids	- 2 Jassid mymphs leaf^{-1}
3) Thrips	- 10 thrips leaf^{-1}
4) Aphids, Jassids, Thrips together	- 10 insects leaf^{-1}
5) White Flies	- 10 adults or 20 nymphs leaf^{-1}
6) Bollworm complex	- 5 per cent damage in green fruiting bodies (squares, flowers and green bolls) on plant

Following observations were recorded fortnightly on randomly selected five plants from each net plot to ascertain the effectiveness of the various modules.

1) Population of sucking pests (aphids, jassids, thrips and white flies) on 3 leaves (top, middle and bottom) plant^{-1}
2) Population of predators on whole plant
3) Population of *H. armigrea* eggs and bollworm larvae on whole plant.
4) Bollworm complex damage in green fruiting bodies (squares, flowers and green bolls) on plant

In addition to this post harvest observations on open bolls damage, loculi damage due to bollworms complex and yield of seed cotton were recorded at each picking. The three years data were subjected to statistical analysis and the pooled results obtained are presented and discussed below.

RESULTS AND DISCUSSION

a) Population of sucking pests and predators in various modules (Table 2) :

Population of aphids, thrips and white flies recorded in various modules were non significant. However, there were significant differences as regards the population of Jassids. Module-1 and module-2 were found at par with each other and recorded minimum population of jassids (1.12 leaf^{-1}) and both these modules were found significantly superior over module-3 (4.30 leaf^{-1}).

The population of chrysopa eggs were significant. Maximum population (1.93 plant^{-1}) was observed in module-1 and this module was found at par with module-2 (1.74 plant^{-1}) and significantly superior over module-3 (1.16 plant^{-1}).

Lady bird beetle population were found non significant in various modules. However, maximum population was found in module-2 (0.26 plant^{-1}) followed by module-1 (0.24 plant^{-1} and module-3 (0.17 plant^{-1}).

b) Bollworm incidence and damage in various modules :

i) Population of *H. armigera* eggs, *H. armigera* larvae and *E. vitella* larvae (Table 3):

The data obtained were non significant regarding population of *H. armigera* eggs in various modules.

There were no significant differences in various modules as regards the pooled average population of *H. armegera* and *E. vitella* larvae.

ii) Infestation of bollworm complex in green fruiting bodies and in opened bolls at harvest (Table 3) :

Minimum infestation of bollworm complex in green fruiting bodies (4.58%) and also in opened bolls at harvest (34.31%) was found in module-2. And this module was found significantly superior over module-1 and module-3.

c) Loculi damage due to bollworm complex, pink bollworm and yield of seed cotton at harvest in various modules (Table 4) :

Lowest loculi damage due to bollworm complex was found in module-2 (13.69%) and this module was significantly superior over module-1

Table 1. Details of treatments undertaken in various modules during 2001-02, 2002-03 & 2003-04

S.N.	Details of treatments undertaken	Dates of application of treatments		
		2001-2002	2002-03	2003-04
A)	**Module I : Existing IPM module**			
1.	Imidacloprid (Gaucho) 70 WS seed treatment @ 10 g kg^{-1}	25.06.2001	05.07.2002	04.072003
2.	Spraying of Methyl demeton 25 EC (0.03%)	31.07.2001	14.08.2002	05.08.2003 & 20.08.2003
3.	*Trichogramma chilonis* releases (two) @ 1.25 lakha ha^{-1}	31.08.2001 & 14.09.2001	07.09.2002 & 18.09.2002	03.09.2003 13.09.2003
4.	Srpaying of Neemark 300 ppm (5 ml L^{-1})	18.10.2001	30.09.2002	16.09.2003
5.	Spraying of Endosulfan 35 EC 0.06%	12.11.2001	29.10.2002	01.10.2003
6.	Spraying of Fenvalerate 20 EC @ 0.0125%	22.11.2001	-	-
7.	Srpaying of HaNPV@ 500 LE ha^{-1}	-	10.10.2002	18.09.2003
8.	Spraying of Bt @ 1000 gm ha^{-1}	-	-	16.10.2003
B)	**Module - 2 : Refined IPM module**			
1.	Thiomethoxam (Cruiser) 70 WS seed treatment @ 4.28 g kg^{-1}	25.06.2001	05.07.2002	04.07.2003
2.	Spraying of acetamipride 20 SP (150 g.a.i. ha^{-1})	28.08.2001	14.08.2002	26.08.2003
3.	*Trichogramma chilonis* releases (Two) @ 1.5 lakh ha^{-1}	31.08.2001	07.09.2002 & 18.09.2002	03.09.2003 & 13.09.2003
4.	Spraying of Neemark 300 ppm (5ml L^{-1})	03.09.2001	30.09.2002	16.09.2003
5.	Spraying of spinosad (Tracer) 45 SC (50 g.a.i. ha^{-1})	18.10.2001	09.10.2002	18.09.2003
6.	Spraying of Beta-cyfluthrin (Bulldock) 2.5 EC @ 0.0025%	12.11.2001	-	1.11.2003
C)	**Module -3 : Recommended chemical control measures**			
1.	Soil application of Phorate 10 G @ 10 kg ha^{-1}	26.06.2001	06.07.2002	05.07.2003
2.	Spraying of Dimethoate 30 EC spray @ 0.03%	-	-	05.08.2003
3.	Spraying of Methyl demeton 25 EC @ 0.02%	31.07.2001 & 28.08.2001	14.08.2002 & 13.09.2002	20.08.2003
4.	Spraying of Endosulfan 35 EC @ 0.06%	03.09.2001	31.10.2002	-
5.	Spraying of Quinalfos 25 EC @ 0.05%	19.10.2001	10.10.2002	01.10.2003
6.	Spraying of Carbaryl 50 WP spray @ 0.2%	13.11.2001	-	16.10.2003
7.	Spraying of Dimethoate 30 EC @ 0.03% + endosulfan 35 EC @ 0.06%	-	30.09.2002 & 01.10.2002	19.09.2003
8.	Spraying of Monocrotophos 36 EC spray @ 0.06%	-	27.08.2002	-
9.	Spraying of Fenvalerate 20 EC @ 0.0125 %	23.11.2001	-	-

(18.76%) and module-3 (21.42%) and the later two were at par with each other.

Regarding loculi damage due to pink bollworm minimum loculi damage was observed in module-2 (7.02%) and this module was found at par with module-1 (9.64%) and superior over Module-3 (10.70 %) module-1 and module-3 were found at par with each other.

Highest yield of seed cotton (1242.68 kg ha^{-1}) was obtained from module-2. This module was found significantly superior over module-1 and module-3 which were at par with each other and yield obtained from these modules were 919.35 kg ha^{-1} and 820.79 kg ha^{-1}, respectively.

d) Cost effectiveness in various modules (Table 6) : Gross income, Net income and Cost Benefit Ratio :

Maximum gross income (Rs. 28580.95 ha^{-1}), Net income (Rs. 24475.61 ha^{-1}) and cost benefit ratio (1:5.96) was obtained from module-2 followed by module-1 and module-3.

From module-1 Rs. 21144.59 gross income, Rs. 17520.93 net income and 1:4.83 cost benefit ratio

Table 2. Pooled average population of sucking pests and predators in various modules on cotton variety PKV Hy-2

S.N.	Module	Pooled average population of sucking pests plant^{-1} on 3 leaves				Pooled average population of predators plant^{-1}	
		Aphids	Jassids	Thrips	White flies	Chrysopa eggs	Lady bird beetle
1.	Module-1 (Existing IPM module)	8.87 (0.53)*	1.12 (0.30)*	34.54 (1.04)	3.21 (0.56)*	1.93 (0.45)*	0.24 (0.09)*
2.	Module-2 (Refined IPM module)	8.83 (0.52)	1.12 (0.30)	29.12 (1.11)	3.13 (0.58)	1.74 (0.42)*	0.26 (0.09)*
3.	Module-3 (Recommended chemical control module)	18.21 (0.67)	4.30 (0.68)	37.39 (1.11)	2.95 (0.58)	1.57 (0.39)*	0.17 (0.06)*
	SE (m)±	0.07	0.10	0.07	0.03	0.01	0.02
	CD at 5%	-	0.30	-	-	0.04	-
	CV%	18.48	36.77	9.72	10.51	5.01	36.18

( ) log values, ( )* x + 1 log values

Table 3. Pooled average bollworm incidence and damage in various modules on cotton variety PKV Hy-2

S.N.	Module	Pooled av. population of *H. armigera* eggs plant^{-1}	Pooled av. population of *H. armigera* & *E. vitella* larvae plant^{-1}	Pooled av. % infestation of bollworm complex in GFB	Pooled av. % damage due to bollworm complex in opened bolls at harvest
1.	Module-1 (Existing IPM module)	1.30 (0.31)*	0.37 (0.12)*	5.99 (2.38)**	49.34 (44.62)
2.	Module-2 (Refined IPM module)	1.33 (0.32)	0.31 (0.28)	4.58 (2.08)	34.31 (35.49)
3.	Module-3 (Recommended chemical control module)	1.18 (0.30)	0.31 (0.11)	6.55 (2.45)	52.60 (46.50)
	SE (m)±	0.02	0.01	0.09	1.80
	CD at 5%	-	-	0.26	5.15
	CV%	10.61	16.19	5.91	6.50

( ) Arc sine values, ( )* X +1 log values, ( )** Sq. root values

Table 4.Pooled loculi damage at harvest and yield of seed cotton variety PKV Hy-2

S.N.	Module	Pooled av. % loculi damage due to bollworm complex at harvest	Pooled av. % loculi damage due to pink bollworm at harvest	Pooled yield of seed cotton kg ha^{-1}
1.	Module-1 (Existing IPM module)	18.76 (4.25)	9.64 (2.94)	919.35
2.	Module-2 (Refined IPM module)	13.69 (3.59)	7.02 (2.46)	1242.68
3.	Module-3 (Recommended chemical control module)	21.42 (4.54)	10.70 (3.09)	820.79
	SE (m)±	0.19	0.18	77.97
	CD at 5%	0.54	0.53	224.16
	CV%	7.00	9.87	11.98

( ) Sq. root values

Table 5. Pooled cost of inputs and its application cost in various modules

S.N.	Inputs	Quantity applied ha^{-1}	Rate, Rs.	Cost of inputs and its application cost (Rs.)		
				Module-1	Module-2	Module-3
1.	Imidacloprid (Gaucho) 70 WS seed treatment @ 10gm kg^{-1}	40 gm	Rs. 75 5 g^{-1}	600	-	-
2.	Methyl demeton 25 EC spray (0.03%) & (0.02%)	240 160ml^{-1}	Rs. 280 l^{-1}	89.33	-	141.67
3.	*Trichogramma chilonis* releases (Two) @ 1.5 lakh ha^{-1}	3 lakh	Rs. 200 lakh^{-1}	600	600	-
4.	Neemark 300 ppm spray (5 ml L^{-1})	2.5 l	Rs. 130 l^{-1}	325	325	-
5.	Endosulfan 35 EC spray 0.06%	850 ml	Rs. 220 l^{-1}	178	-	249.33
6.	Fenvalerate 20 EC spray @ 0.0125%	325 ml	Rs. 240 l^{-1}	26.00	-	26.00
7.	Thiomethoxam (Cruiser) 70 WS seed treatment @ 4.28 g kg^{-1}	17.12 g	Rs. 180 5 g^{-1}	-	616	-
8.	Acetamipride 20 SP spray (150 g.a.i. ha^{-1})	75 g	Rs. 260 50 g^{-1}	-	390	-
9.	Spinosad (Tracer) 45 SC spray (50 g.a.i. ha^{-1})	111 ml	Rs. 1100 100 ml^{-1}	-	1221	-
10.	Beta-cyfluthrin (Bulldock) 2.5 EC spray (18 g.a.i. ha^{-1})	720 ml	Rs. 485 l^{-1}	-	232.67	-
11.	Soil application of Phorate 10 G @ 10 kg ha^{-1}	10 kg	Rs. 60 kg^{-1}	-	-	600
12.	Quinalfos 25 EC spray @ 0.05%	1 lit	Rs. 260 l^{-1}	-	-	260
13.	Carbaryl 50 WP spray @ 0.2%	2 kg	Rs. 320 kg^{-1}	-	-	426.67
14.	HaNPV spray @ 500 LE ha^{-1}	500 LE	Rs. 1800 l^{-1}	600	-	-
15.	Monocrotophos 36 EC spray @ 0.06%	825 ml	Rs. 280 l^{-1}	-	-	77.00
16.	Dimethoate 30 EC spray @ 0.03%	500 ml	Ra. 200 l^{-1}	-	-	100
17.	Spraying of Bt. @ 1 kg ha^{-1}	1 kg	Rs. 910 kg^{-1}	303.33	-	-
18.	Labour	5 labour spray^{-1}	Rs. 47	19 lab	15.33	-
19.	Labour charges @ Rs. 47		Rs. 47	893	720.67	1582.33
	Total			3623.66	4105.34	3463.00
20.	No. of chemical insecticidal spray undertaken			2.66	2.66	5.66

Table 6. Pooled cost effectiveness in various modules

S.N.	Particulars	Module-1	Module-2	Module-3
1.	Seed cotton yield (q ha^{-1})	919.33	1242.65	820.79
2.	Cost of seed cotton (Rs. ha^{-1})	21144.59	28580.95	18878.17
3.	Cost of inputs and its application (Rs. ha^{-1})	3623.66	4105.34	3463
4.	Net income (Rs ha^{-1})	17520.93	24475.61	15415.17
5.	Cost benefit ratio (C:B ratio)	1:4.83	1:5.96	1:4.45

Rate of seed cotton @ Rs. 2300 q^{-1}

was obtained, where as from module-3 Rs. 18,878.17 gross income Rs. 15415.17 net income and 1:4.5 cost benefit ratio was obtained.

From the present studies undertaken for three years (2001-02 to 2003-04) it can be concluded that module-2 (Refined IPM module) was found most

effective in the management of aphids, jassids, thrips and bollworms and recording highest yield of seed cotton as compared to module-1 (Existing IPM module) and module-3 (Recommended chemical control measures). This was due to the refinements of components of existing IPM module (module-1) which were, one spray of acetamiprid 20SP @ 15 a.i. ha^{-1} instead of methyl demeton 25 EC @ 0.03%, one spray of spinosad 45SC @ 50 a.i. ha^{-1} instead of endosulfan 35 EC @ 0.06% and Ha NPV @ 500 LE ha^{-1} and one spray of beta.cyfluthrin 2.5 EC @ 0.0025 per cent instead of fenvalerate 20 EC @ 0.0125 per cent.

As regards the efficacy of acetamiprid against sucking pests obtained in present study, similar type of results were also reported by Dandale *et. al.*, (2000, 2001 and 2001[a]) as regards the efficacy of spinosad and beta-cyfluthrin against cotton bollworm, recording highest yield of seed cotton.

In the present studies in module-2 i.e. rainfed IPM module there was reduction in three chemical insecticidal sprays as compared to module-3 i.e. recommended chemcial control measures with maximum cost benefit ratio and net monetory return. Lavekar *et. al.*, (2001) also reported the use of two releases of *T. chilonis* eggs parasitoid and NSE 5 per cent with need based use of chemical insecticides for reduction in insecticide usage and economically integrated pest management in dry land cotton.

From the findings of the present studies undertaken for three years it could be recommended that the following plant protection package included in refined IPM module should be adopted for the effective and economical management of pests of rainfed cotton and for reduction in chemical insecticidal usage.

1) Thiomethoxam 70 WS seed treatment @ 4.28 g kg^{-1} seed
2) One spray of acetamiprid 20 SP @ 15 g a.i. ha^{-1} for sucking pests based on ETL.
3) Two releases of T. chilonis egg parasitoied @ 1.5 lakhs ha^{-1} at 45-50 and 55-60 days after germination of crop
4) One spray of neemark 300 ppm at 5 ml l^{-1} for bollworm based on ETL
5) One spray of spinosad 45 SC @ 50 g.a.i. ha^{-1} for bollworm based on ETL
6) One spray of beta-cyfluthrin 2.5 EC @ 0.0025 per cent for bollworm based on ETL

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Incidence of Aphids, *Aphis gossypii* Glover in Tomato Genotypes with Regards to Bio-physical Parameters

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ABSTRACT

The incidence of aphid in upper leaves was observed least in Sun 5715, followed by Manimaker, Ganpati and NS 101 genotypes. Manimaker, Sun 5715 and NS 101 received least population of aphid in middle leaves, whereas, genotyes Ganpati had minimum population of aphid in lower leaves. The length-width ratio of upper leves was positively correlated with population of aphid on upper leaves, the correlation coefficient being 0.666, this clearly showed that with the increase in broadness of leaf, there was an increase in population of aphid, which was responsible for the susceptibility of different tomato genotypes. The number of trichomes of all three leaves i.e. upper, middle and lower leaves had negatively correlated with the aphid population, the correlation coefficient being -0.754, -0.821 and -0.619, respectively. This indicated that presence of trichomes of leaf surface of genotypes sun 5715, Manimaker, Ganpati and NS 101 had adverse affect on the population of aphid and responsible for the resistance of different tomato genotypes.

Tomato, *Lycopersicon esculantum* (Mill) is an important vegetable crop grown all over the world. It is rich source of several vitamins and minerals. India is the second largest vegetable producer of the world. In India, the total vegetable production was 96.54 million tonnes in an average area of 6.89 million hectare, out of it, tomato production was 7.42 million tonnes from an area of 0.52 million hectare during 2002 (Anonymous, 2004). In Chhattisgarh state, the tomato production was 5.11 lakh tonnes from an area of 15,488 hectare during 2003-2004 (Anonymous, 2004). Tomato crop is attacked by varius polyphagous aphids, *Myzus persicae*, *Aphis gossypii, Macrosiphum euphorbiae* etc. whereas no aphids are host specific for tomato. Consequently, wherever tomato is cultivated then there is chance of attack of local aphids. Aphids feed by piercing and sucking from the plant usually on the underside of the leaves and on the young shoots. The most severe damage however is caused by transmitting virus diseases (Zimmerman *et al.*, 1976). There was great variation in the population of aphids in defferent tomato genotypes which leads to under take the study on the effect of bio-physical parameters on aphids population.

MATERIAL AND METHODS

The experimental trial was conducted with eight open pollinated (Pusa Ruby, S-22, Punjab Keshri, Sanjeewani BWT 101, Sun 5715, Navodaya, Manimaker and NS 101) and five hybrids (Kubergeeta, Ganpati, Sadabahar, Paras Dadi and Akash) genotypes in randomized block design with three replications at Horticultural Research Farm (IGKV), Raipur, Chhattisgarh against aphid, *Aphis gossypii*, during spring summer season of 2001-2002. Aphid infestation was observed at ten days intervals on upper, middle and lower leaves, from randomly selected ten plants. The leaf area was calculated with the help of measuring scale by spreading on whole length and width of leaves from starting to end point and thereafter these were multiplied with constant factor i.e. 0.9 as per the method described by Achnlither (1978). The bio-physical parameter like leaf area, length width ratio and presence of trichomes were recorded from ramdomly selected five plants consisting of upper, middle and lower leaves and as such ten leaves of each portion were observed. The length width ratio of leaf was calculated with the help of mathematical calculation. The length of each genotpe leaves was divided to width of each genotype leaves. The number of trichomes was recorded with the help of binocular microscope by taking one sq.cm. leaf cut from leaf surface randomly, thereafter it was placed under binocular miroscope, followed by counting of number of trichomes. The number of trichomes was recorded from ramdomly selected ten leaves on upper, middle and lower leaves on both surface of

1, 2, and 3 Department of Entomology, IGKV, Raipur (CG)

the leaves. The data on mean population of aphid was transformed into $\sqrt{n + 0.5}$ by using square root transformation. The mean population of aphid was correlated with leaf area, length width ratio of leaf and number of trichomes on upper, middle and lower leves of different genotypes. However, the regression equation was worked out on significantly correlated values. The different between open pollinated and hybrid genotypes were also worked out applying 't' test of significance.

RESULTS AND DISCUSSION

The mean population of aphid on different genotypes in reltion to various bio-physical parameters of upper, middle and lower leaves are presented in Table 1. In upper leaves the mean population of aphid per leaf varied from 1.77 to 6.22. The minimum population was recorded in genotypes like Sun 5715 (1.77), Manimaker (2.16), Ganpati (2.16) and NS 101 (2.55) with no significant differences among them. Significantly maximum population of aphid was recorded in Sadabahar (6.22), followed by Pusa Ruby (5.05) and S-22 (5.00) with no significant differences among them. In middle leaves minimum population of aphid was recorded in Manimaker (2.44), followed by Sun 5715 (2.55) and NS 101 (2.77) with no significant difference among them, whereas maximum population of aphid was recorded in S-22 (5.11), Sadabahar (5.11) and Akash (4.99) without significant difference among them. In case of lower leaves the population of aphid varied from 1.08 in Ganpati to 2.50 in Kubergeeta.

The differences in aphid population in all the open pollinated and hybrid genotypes were found to be non significant.

There was variation in the leaf area of different genotypes and it ranged from 2.54 sq. cm. in Sanjeewani BWT 101 to 8.75 sq. cm. in Pusa Ruby in upper leaves, whereas, in middle and lower leaves it varied respectively from 6.33 sq. cm. in NS 101 to 13.68 sq.cm. in pusa ruby and 5.24 sq.cm. in S-22 to 11.94 sq. cm. in Navodaya. The leaf area had no correlation with aphid population on upper. middle and lower leaves. This indicated that crop canopy as well as some other factors might be responsible for the variation in population of aphid found on different leaves. Hiderbrand *et. al.*, (1993) reported that tomato leaves having some volatile compounds like 6 carbon aldehyde and alcohols which influeced the population of aphid. Liu and Young (1993) observed that the population of *Aphis gossypii* decreased with the increasing concentration of tanin, proline and soluble sugar.

The length width ratio of middle and lwoer leaves of different genotypes had a positive and linear relationship with the mean population of aphid but non significant. However, the length width ratio of upper leaves was significantly positive and linear relationship with the mean population of aphid, the correlation coefficient being 0.666 (Fig. 1). The regression equation being $Y = 14.868 + 9.058 X$, where X is the length width ratio of leaves and Y is the mean population of aphid per leaf. This indicated that every one unit increse in the length width ratio, there will be increase in aphid population by 9.058 leaf^{-1}, which showed population of aphid increased with increase in length with ratio or broadness of leaves which was responsible for the susceptibility of different tomato genotypes, whereas such correlation was not observed in middle and lower leaves.

The number of trichomes in upper leaves was negatively correlated with the mean population of aphid in upper leaves, the correlation coefficient being -0.754, the regression equation (Fig. 2) being $Y = 7.0438 - 0.0024 X$, where X is the number of trichomes on leaves and Y is the mean population of aphid leaf^{-1}. This indicates that every one increase in number of trichomes of upper leaves, there will be decrease in 0.0024 aphid leaf^{-1}. The number of trichomes on middle leaves was also negatively correlated with the mean population of aphid in middle leaves, the correlation coefficients being -0.8216, the regression equation (Fig. 3) being $Y=6.652-0.0022 X$, where Y is the mean population of aphid and X is the number of trichomes on leaves. This indicates that everyone increase in number of trichomes on leaves here will be decrease in 0.0022 aphid leaf^{-1}. Similarly, the number of trichomes on lower leaves was also negatively correlated with the mean population of aphid in lower leaves, the correlation coefficient being -0.619, the regression equation (Fig 4) being $Y = 2.459-0.007 X$ where Y is the mean population of aphid and X is the number of trichomes on leaves. This indicates that with every one increase in number of trichome of leaves, there will be decrease in 0.0007 aphid leaf^{-1}. These relationships showed that presence of trichome on leaf surface had adverse effect on the population of aphid. Naveed *et al.*,

Table 1. Incidence of aphids, *Aphis gossypii* in tomato genotypes in relation to biophysical parameters

Genotypes	Mean population of aphid			Leaf area (sq.cm.)			Length width ratio			No. of trichmes (sq.cm.)$^{-1}$		
	U	M	L	U	M	L	U	M	L	U	M	L
Pusa ruby	5.05 (2.34)	4.71 (2.27)	1.75 (1.42)	8.75	13.68	9.68	2.08:1	2.01:1	1.92:1	785.36	762.64	745.40
S-22	5.00 (2.34)	5.11 (2.36)	1.70 (1.28)	3.71	7.06	5.24	2.04:1	1.85:1	1.84:1	1100.00	859.16	974.68
Punjab Keshri	4.16 (2.15)	3.89 (2.09)	1.67 (1.46)	5.16	10.73	10.05	2.16:1	1.79:1	1.86:1	852.00	1041.32	784.00
Sanjeewani BWT 101	4.94 (2.33)	4.22 (2.17)	1.58 (1.36)	2.54	7.84	9.04	2.21:1	2.05:1	1.77:1	917.32	1149.32	1056.68
Sun 5715	1.77 (1.51)	2.55 (1.73)	1.17 (1.27)	4.65	7.26	6.30	1.92:1	1.83:1	1.77:1	1368.00	1600.00	1578.68
Navodaya	4.11 (2.14)	4.27 (2.18)	2.00 (1.58)	5.46	11.80	11.94	2.24:1	1.84:1	1.78:1	1072.00	1020.00	1101.32
Manimaker	2.16 (1.63)	2.44 (1.70)	1.33 (1.35)	5.28	9.07	7.46	1.98:1	1.92:1	1.71:1	1573.32	1621.32	1832.00
NS 101	2.55 (1.73)	2.77 (1.81)	1.17 (1.27)	3.53	6.33	7.40	2.06:1	1.87:1	1.70:1	2032.00	1989.32	1880.00
Kubergeeta	5.27 (2.39)	2.83 (2.08)	2.50 (1.67)	6.75	9.25	6.85	2.06:1	1.97:1	1.85:1	1040.00	1061.36	993.32
Ganpti	2.16 (1.62)	2.88 (1.83)	1.08 (1.25)	8.35	10.77	11.63	1.92:1	1.87:1	1.95:1	2018.68	1742.64	1780.00
Sadabahar	6.22 (2.58)	5.11 (2.35)	2.33 (1.67)	4.71	8.90	7.30	2.23:1	1.85:1	1.71:1	1110.68	1156.00	1174.64
Paras dadi	2.94 (1.85)	3.22 (1.92)	1.33 (1.32)	5.83	9.46	9.00	2.07:1	1.76:1	1.87:1	1980.00	1338.64	1576.00
Akash	4.95 (2.30)	4.99 (2.34)	1.42 (1.32)	6.11	10.08	10.56	2.03:1	1.89:1	1.82:1	956.00	1169.00	909.00
SE (m) ±	0.12	0.10	0.19									
CD at 5 %	0.35	0.30	NS									

Note : The figures are transformed in $\sqrt{n + 0.5}$ are given in parentheses, NS = Non Significant, U = upper leaves, M= middle leaves and L = lower leaves

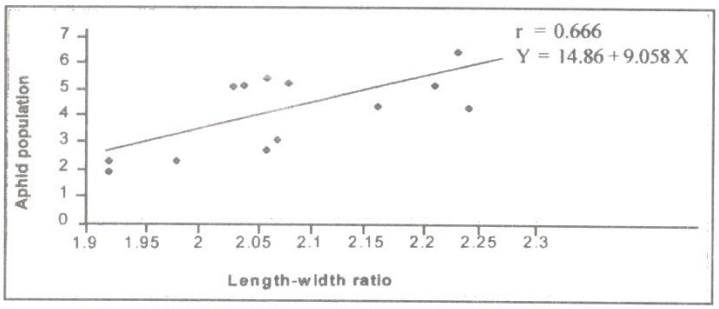

Fig.1 : Regression of aphid population on length-width ratio of upper leaf.

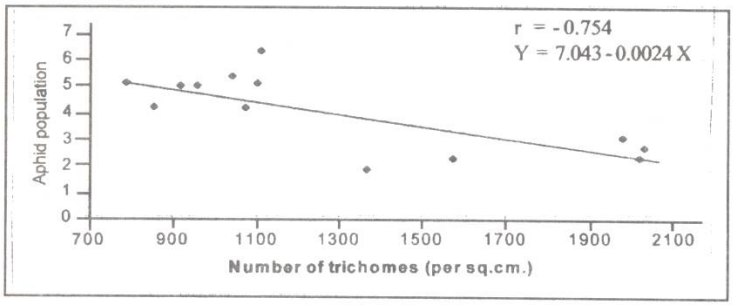

Fig.2 : Regression of aphid population on number of trichomes on upper leaf.

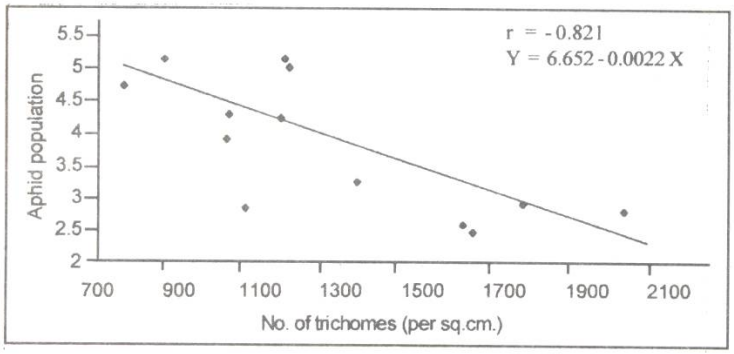

Fig. 3 : Regression of aphid population on number of trichomes on middle leaf

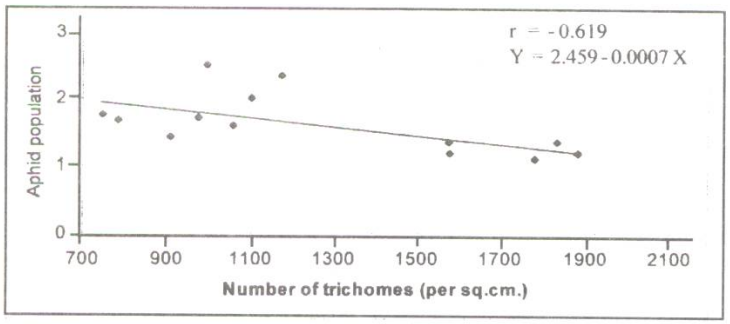

Fig. 4 : Regression of aphid population on number of trichomes on lower leaf.

(1995) also observed the importance of hairs on population density of aphid. They reported that low hair density and a shorter hair length had a larger population of aphid indicating the importance of trichomes in imparting resistance against aphid.

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Studies on Integrated Pest Management in Rainfed Cotton

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ABSTRACT

Three modules were formulated and evaluated for effective and economical integrated management of major pests of rainfed cotton for three years (1996-97 to 1998-99) at Cotton Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra and it was concluded that for economical and effective integrated management of major pests of hybrid cotton under rainfed condition, the module consisting of seed treatment with Imidacloprid 70 WS @ 10 g kg^{-1} before sowing, one spray of recommended systemic insecticide for sucking pests based on E.T. level, if required, two releases of *Trichogramma chilonis* egg parasitoid @ 1.5 lakh ha^{-1} at 45-50 and 55-60 days after sowing, one spray of HaNPV @ 500 LE ha^{-1}, one spray of 5 per cent neem seed extract and need based one or two sprays of recommended insecticides for bollworms based on E.T. level, should be used.

Cotton is an important cash crop of Maharashtra State occupying an area of about 31 lakh ha, of which 60 per cent area is in Vidarbha region. However the yield ha^{-1} of Maharashtra is low as compared to National average. Amongst the various reasons for low yields, the losses due to insect pests is one of them.

Area under cotton crop in country is only 5 per cent of the total cropped area, but 54 per cent of chemical pesticides are being used for the control of pests of cotton crop. (Kapadia and Mohla, 1980). This excessive and the indiscriminate use of pesticides resulted in development of resistance of pesticides in pests, adverse effects on beneficial insects, residue problems, resurgence of secondary and minor pests and environmental pollution etc. so it is now high time that every one must think of the alternative methods for cotton pests management like cultural, mechanical, physical, legal and biological in an integrated manner and only when the pest population reaches to economic threshold level, pesticides should be used to bring it down. This can be achieved only through integrated management approach. Taking into consideration the importance and need of integrated pest management, present studies on integrated pest management in rainfed cotton were undertaken at Cotton Research Unit, Dr. PDKV, Akola Maharashtra during *Kharif* season of 1996-97 to 1998-99.

MATERIAL AND METHODS

A field experiment was conducted during *Kharif* season of 1996-97, 1997-98 and 1998-99 at Cotton Research Unit, Dr.PDKV, Akola. The cotton Hybrid PKV Hy-4 was raised on 0.3 ha at 60 cm x 60 cm spacing every year. The block 0.1 ha each was used for Module-1 (Bio-intensive), Module -2 (Adaptable module) and Module - 3 (Recommended package of practices module). The cotton crop was raised following recommended package of practices except for the plant protection measures. The design of the experiment was randomized block design with seven replications.

The observations on population of major sucking pests i.e aphids, jassids, thrips, mites and white flies, predators (*Chrysoperla* eggs and lady bird beetle adults) were recorded on 3 leaves $plant^{-1}$ by randomly selecting 5 plants from each replication in all the three modules at 15 days interval.

The observations on bollworm complex damage in green fruiting bodies (squares, flowers and green bolls) were recorded by randomly selecting 5 plants from each replication at 15 days interval.

The observations on loculi damage due to bollworm complex and pink bollworm at harvest were recorded on 5 plants $replication^{-1}$ and yield of seed cotton from randomly selected 5 plants from each

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Details of treatments undertaken in various modules

1) Module -1 (Bio-intensive module)

S.N.	Treatments undertaken	Dates of application		
		1996-97	1997-98	1998-99
i	Imidacloprid 70 WC (Gaucho) seed treatment @ 10 gm kg^{-1}seed	-	8-7-97	3-7-98
ii	Release of Chrysoperla eggs @ 50,000 ha^{-1} (1996-97) and @ 10,00 ha^{-1} (1997-98, 1998-99)	7-9-96	25-8-97 & 26-9-97	6-8-98
iii	Release of *T. chilonis* egg parasitoid @ 1.5 lakh ha^{-1}	18-9-96 30-9-96	5-9-97 & 16-9-97	27-8-98 & 8-9-98
iv	Spray of HaNPV@ 500 LE ha^{-1}	15-10-96 & 16-11-96	3-10-97	12-9-98
v	Spray of NSE 5%	31-10-96	16-10-97	24-9-98
vi	Spray of B.t.	8-11-96	–	27-10-98

2) Module - 2 (Adaptable module)

S.N.	Treatments undertaken	Dates of application		
		1996-97	1997-98	1998-99
i	Imidacloprid 70 WS (Gaucho) seed treatment @ 10 gm kg^{-1} seed	–	8-7-97	3-7-97
ii	Spray of Methyl demeton 25 EC @ 0.03%7-9-96	3-9-97	5-8-98	
iii	Releases of *T. chilonis* egg parasitoid @ 1.5 lakh ha^{-1}	18-9-96 &	5-9-97 & 39-9-96	27-8-98 30-9-97
iv	Spray of NSE 5 %	15-10-96	30-9-97	24-9-98
v	Spray of HaNPV @ 500 LE ha^{-1}	30-10-96	10-10-97	11-9-98
vi	Spray of Endosulfan 35 EC @ 0.06%	-	4-11-97	27-10-98
vii	Spray of Fenvalerate 20 E @ 0.0125%	8-11-96	–	21-11-98
viii	Spray of Monocrotophos 36 WSC @ 0.1% for white flies	16-11-96	–	–

3) Module - 3 (Recommended package of practices Module)

S.N.	Treatments undertaken	Dates of application		
		1996-97	1997-98	1998-99
i	Soil application of Phorate 10 G @ 10 kg ha^{-1} at sowing	-	9-7-97	3-7-98
ii	Spray of Phosphamidon 85 WSC @ 0.02%	17-8-96	–	–
iii	Spray of Methyl demeton 25 EC @ 0.02% (1996-97) and 0.03% (1997-98 & 1998-99)	7-9-96	18-8-97 & 3-10-97	5-8-98
iv	Spray of Endosulfan 35 EC @ 0.06%	15-10-96	19-9-97 & 4-11-97	26-10-98
v	Spray of endosulfan 35 EC @ 0.06% (1996-97) + copper oxychloride 91997-98)	30-10-96	4-9-97	-
vi	Spray of carbaryol 50 WP @ 0.2% (1996-97) + copper oxychloride (1997-98)	16-11-96	15-10-97	-
vii	Spray of Monocrotophos 36 WSC @ 0.1% for white flies	-	22-10-97	-
viii	Spray of Dimethoate 30 EC @ 0.03% + carbaryl 50 WP @ 0.2%	–	–	22-9-98
ix	Spray of Endosulfan 35 EC @ 0.06 % + Methyl demeton 25 EC @ 0.03%	–	–	10-9-98
x	Spray of Fenvalerate 20 EC @ 0.0125 % + Monocrotophos 36 WSC @ 0.07%	-	-	21-11-98

replication was recorded. Seed cotton yield (q ha^{-1}) replication^{-1} was calculated on the basis of yield obtained from 5 plants replication^{-1}.

In all the above modules imposition of treatments were based on ET. level except for parasitoid release, where in it was undertaken at specific interval. Observations were recorded once in a week to ascertain the pest load.

RESULTS AND DISCUSSION

A) Sucking pests (Table 1)

The pooled data regarding the population of aphids, jassids, mites and white flies were non-significant. However lowest population of aphids, jassids and white flies (13.29, 4.80 and 3.61 plant^{-1} on 3 leaves) was observed in module -1 (Bio-intensive module) followed by module - 2 (Adaptable module) whereas lowest population of mites was noticed in module-3 (Recommended package of practices module), followed by module -2.

The pooled date regarding population of thrips plant^{-1} on leaves were significant. Lowest population of thrips (14.92 plant^{-1} on 3 leaves) were recorded in module - 3 and was significantly superior over module-1 and 2. However the pooled average population of sucking pests i.e. aphids, jassids, thrips, mites and white flies was below ETL in module-1 and module-2.

B) Population of predators (Table 2)

The pooled data on the population of chrysopa eggs and lady bird beetle adults were non-significant, but maximum population of chrysopa eggs (1.25 plant^{-1} on 3 leaves) was recorded in module-2 (Adaptable module) and lady bird beetle adults in module-3, followed by module -2.

C) Bollworm damage (Table 3)

The pooled data regarding infestation of bollworm complex in green fruiting bodies (squares, flowers and green bolls), loculi damage due to bollworm complex and pink bollworm at harvest were non-significant. However minimum infestation of bollworm complex in green fruiting bodies (5.93%), minimum loculi damage due to bollworm complex (35.57%) and pink bollworm (15.19%) was recorded in module-2 (Adaptable module), followed by module-1 (Bio-intensive module).

D) Yield of seed cotton (Table 3)

The pooled data on yield of seed cotton were non-significant. However highest yield of seed cotton (9.72 q ha^{-1}) was recorded in module-2 (Adaptable module), followed by module -1 (Bio-intensive module) (9.44 q ha^{-1}) and module-3 (Recommended package of practices module) (7.99 q ha^{-1}).

E) Cost effectiveness (Table 4)

Highest pooled cost benefit ratio (1:6.79) was obtained from module-2 (Adaptable module),

Table 1. Pooled average population of sucking pests in various modules in rainfed cotton (PKV Hy-4) (1996-97 to 1998-99)

S.N.	Modules	Pooled average population of sucking pests plant^{-1} on 3 leaves				
		Aphids	Jassids	Thrips	Mites	White flies
1.	Module 1 (Bio-intensive module)	13.29	4.80	24.26	7.11	3.61
		(1.83)	(1.46)	(2.67)	(1.71)	(1.15)
2.	Module 2 (Adaptable module)	14.32	5.24	29.39	5.93	4.56
		(1.97)	(1.54)	(2.63)	(1.38)	(1.37)
3.	Module 3 (Recommended package	14.51	8.85	14.92	5.90	5.76
	of practices module)	(1.93)	(1.96)	(2.15)	(1.56)	(1.43)
	'F' test	N.S.	N.S.	Sig.	N.S.	N.S.
	SE (m)±	0.03	0.23	0.086	0.18	0.11
	CD at 5 %	-	-	0.34	-	-
	CV%	3.28	24.13	6.03	19.92	14.26

Figures in parentheses are log transformed values

Table 2. Pooled average population of predator in various modules in rainfed cotton (Var. PKV Hy.-4) (1996-97 to 1998-99)

S.N.	Modules	Pooled average population of predators pests plant^{-1} on 3 leaves	
		Chrysopa eggs	Lady bird beetle adults
1.	Module 1 (Bio-intensive module)	1.11	0.62
		(0.71)	(0.45)
2.	Module 2 (Adaptable module)	1.25	0.86
		(0.78)	(0.48)
3.	Module 3 (Recommended package of	0.85	1.15
	practices module)	(0.59)	(0.32)
	'F' test	N.S.	N.S.
	SE (m) ±	0.06	0.11
	CD at 5 %	-	-
	CV %	14.85	-

Figures in parentheses are log transformed values

Table 3. Pooled average bollworm damage and yield of seed cotton in various modules in rainfed cotton (Var. PKV Hy.-4) (1996-97 to 1998-99)

S.N.	Modules	Pooled Av. % infestation of bollworm complex in green fruiting bodies	Pooled AV. % loculi damage at harvest due to bollworm complex	Pooled Av. % loculi damage at harvest due to pink bollworm	Yield of seed cotton q ha^{-1} based on the yield of 5 plants replication^{-1}
1.	Module 1 (Bio-intensive module)	6.37	36.58	15.39	9.44
		(2.57)*	(37.17)**	(3.89)*	
2.	Module 2 (Adaptable module)	5.93	35.57	15.19	9.72
		(2.48)*	(36.86)**	(3.87)*	
3.	Module 3 (Recommended package	6.47	41.73	17.06	7.99
	of practices module)	(2.50)*	(40.20)**	(4.09)*	
	'F' test	N.S.	N.S.	N.S.	N.S.
	SE (m) ±	0.15	1.18	0.11	0.46
	CD at 5 %	-	-	-	-
	CV %	10.14	5.39	4.73	8.72

( )* Square root values, ( )** Arc sin values

followed by module-3 (1:5.20) and module-1 (1:1.17). Lowest pooled cost benefit ratio was obtained in module-1 (Bio-intensive module) as compared to other two modules due to high inputs involved in this module. In module-2 (Adaptable module) average 2.67 chemical insecticidal sprays were required with high cost benefit ratio, but in module-3 (Recommended package of practices module) 5.67 chemical insecticidal sprays were required with less cost benefit ratio than module-2. That means due to adoption of plant protection packages included in module-2, three insecticidal sprays, could be curtailed with highest cost benefit ratio.

Taking into consideration highest cost benefit ratio (1:6.79) obtained in module-2 and curtailment in 3 insecticidal sprays over module-3, it could be concluded from the present studies that the following plant protection packages included in module-2 should be adopted for reduction in insecticide usage and for economical and effective integrated management of pests of hybrid cotton under rainfed condition.

Table 4. Cost effectiveness in various modules (Pooled) (1996-97 to 1998-99)

S.N.	Modules	Seed cotton yield q ha^{-1}	Total cost of seed cotton Rs. ha^{-1}	Cost of inputs & its application Rs. ha^{-1}	Net income Rs. ha^{-1}	Cost benefit ratio (CB ratio)	Pooled No. chemical insecticidal sprays undertaken
1.	Module 1 (Bio-intensive module)	9.44	19838	9158.33	10679.67	1:1.17	Nil
2.	Module 2 (Adaptable module)	9.72	20419	2619.47	17799.53	1:6.97	2.67
3.	Module 3 (Recommended package of practices module)	7.99	16786	2706.17	14079.83	1:5.20	5.67

Rate of seed cotton Rs. 2100/- q^{-1}

i) Imidacloprid 70 WS seed treatment @ 10 g kg^{-1} seed before sowing
ii) One spray of recommended systemic insecticide based on E.T. level if required
iii) Two releases of *Trichogramma chilonis* @ 1.5 lakh ha^{-1} at 45-50 and 55-60 days after sowing.
iv) One spray of HaNPV @ 500 LE ha^{-1}
v) One spray of 5 per cent neem seed extract
vi) Need based one or two sprays of recommended insecticides for bollworms based on E.T. level.

The above findings regarding the adoption of plant protection package i.e. imidacloprid seed treatments, two releases of *T. chilonis*, sprays of HaNPV and NSE 5 per cent and need based use of chemical insecticides for reduction in insecticide usage and for economical and effective integrated pest management of pests of hybrid cotton under rainfed condition are in conformation with the findings of Lavehar *et. al.*, (2001) who also reported the use of imidacloprid seed treatment, two releases of *T. chilonis*, spray of HaNPV and NSE 5 per cent etc. for reduction in insecticide usage and for economical integrated pest management in dry land cotton. Rao and Reddy (1999) also observed that bioagents and botanicals were the important components of IPM in cotton, whereas Vaissaryre *et. al.*, (1997) reported the use of predatory and parasitoid insects, insect pathogens under integrated pest management.

Zhang *et. al.* (1996) reported the effectiveness of HaNPV against *H. armigera* on cotton equivalent to that of recommended chemical insecticides. Gupta and Sharma (1996) obtained satisfactory control of the bollworm complex and also an increase in cotton yield with the combined application of neem, Bt. and 84 per cent reduced rate of synthetic pyrethroids.

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Adoption of University Recommended Cotton Technologies and the Constraints Faced by the Farmers

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ABSTRACT

The study was conducted in Buldana tahsil of Buldana district. The data were collected from 150 cotton growers. The practicewise adoption of university recommended cotton technologies was studied and the results revealed that only 54.67 per cent of the respondents had complete adoption of dry sowing, followed by weeding under cultural operation (42.66 %). More than 40 per cent of the respondents had partial adoption of *deshi* varieties (45.33%), monsoon sowing of cotton (41.33%), use of pesticides (56.00%) and fungicide (48.00%) for plant protection. Education, land holding, area under cotton crop, social participation, socio-economic status, extension contact and scientific orientation was found to be positively and significantly related with adoption of the cotton growers.

Cotton (*Gossypium* spp.) is most important commercial crop of the world. It is called as white gold. India ranks third in cotton production in the world next to China and U.S.A.. Maharashtra ranks first in India for the cotton production (Anonymous, 2001). In case of Vidarbha region of Maharashtra state, area under cotton cultivation was 15.17 lakh ha and production was 16.27 lakh bales. The area under cotton cultivation in Buldhana district was 2.16 ha and the production was 2.12 lakh bales in 1998. The area under cotton cultivation in Buldhana tahsil was 25,203 ha in 1998 and production was 130 kg ha^{-1} (Anonymous, 2000).

Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola has developed and recommended cotton technologies for farmers. Efforts are being made for transfer of these technologies. But the farmers are not using these university recommended technologies to the fullest extent. Hence, the present study is undertaken to assess the extent of adoption of these technologies as well as to identify the constraints faced by the farmers in adoption of technologies recommended for cotton by Dr. PDKV, Akola. The study was conducted in Buldana district during the year 2002-2003 with the following

OBJECTIVES

1. To study the adoption level of the cotton growers about university recommended cotton technologies.
2. To study the relationship between, socio-economic, communication, psychological characteristics of the cotton growers with adoption of the farmers about university recommended technologies.
3. To study the constraints faced by the farmers in adoption of university recommended technologies.

MATERIAL AND METHODS

The study was undertaken in purposively selected Buldhana tahsil of Buldhana district. Buldhana tahsil is comprised of 97 villages, out of which 15 villages were randomly selected having cotton area. From these villages, 150 cotton growers were selected randomly by proportionate sampling method. Selection of university recommended technologies was done in consultation with specialist of Cotton Research Unit, Dr. PDKV, Akola. The data were collected from the respondents through the pretested interview schedule. The independent variables viz., education, land holding, area under cotton crop, social participation, socio-economic status, extension contact and scientific orientation were studied, while adoption was the dependent variable. The constraints encountered in adoption of university recommended cotton technologies by respondents were also studied.

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Table 1. Distribution of respondents according to their practicewise adoption of university recommended cotton techologies

S.N.	Cotton technologies	Extent of adoption (n=150)		
		Complete	Partial	Non-adoption
I	**Varieties**			
1.	Deshi variety - AKA-5, AKA-7	34 (22.67)	68 (45.33)	48 (32.00)
2.	American variety - AKA-081, PKV Rajat	29 (19.33)	55 (36.67)	66 (44.00)
3.	Hybrid-PKV Hy. 2 and 4	42 (28.00)	60 (40.00)	48 (32.00)
II	**Sowing time**			
1.	Dry sowing - 1st or 2nd week of June	82 (54.67)	19 (12.67)	49 (32.67)
2.	Monsoon sowing - 15th to 30th June	35 (23.33)	62 (41.33)	53 (35.34)
III	**Spacing**			
1.	Deshi variety - 60 x 15 cm	32 (21.33)	60 (40.00)	58 (38.67)
2.	American variety - 60 x 30 cm	24 (16.00)	55 (36.67)	71 (47.33)
3.	Hybrid - 60 x 60 cm	37 (24.67)	52 (34.67)	61 (40.67)
IV	**Intercropping**			
1.	Cotton + Greengram - 1:1	23 (15.33)	35 (23.33)	92 (61.34)
2.	Cotton + Black gram - 1:1	15 (10.00)	28 (18.66)	107 (71.33)
3.	Cotton + sorghum + pigeonpea + sorghum- 6:1:2:1	0 (0.00)	32 (21.33)	118 (78.66)
V	**Intercultural operations**			
1.	Hoeing (3 to 4)	44 (29.33)	89 (59.33)	17 (11.83)
2.	Weeding (2-3)	64 (42.66)	72 (48.00)	14 (9.33)
VI	**Plant protection**			
1.	Spraying of Endosulfan 35% EC and Dimethoate 30% EC for control of bollworm and sucking pests	34 (22.66)	84 (56.00)	32 (21.34)
2.	Spraying of Moncozeb and Copper for control of leaf spot and dahiya disease of cotton	28 (18.66)	72 (48.00)	50 (33.34)

Figures in parentheses indicate percentage

RESULTS AND DISCUSSION

1. Adoption of University recommended cotton technologies

The practicewise adoption of cotton technologies by the cotton growers is given in Table 1.

The practicewise adoption of university recommended cotton technologies in Table 1 revealed that the majority of the respondents had complete adoption with regards to dry sowing of cotton (54.67%), followed by weeding for cotton (42.66%). The respondents had complete adoption with regards to hybrids (28.00%), deshi varieties

(22.67%) and American varieties (19.33%). Complete adoption of monsoon sowing of cotton as recommended by the university was 23.33 per cent of the respondents.

Regarding adoption of spacing it is seen that 24.67 per cent of the respondents had complete adoption of hybrids, followed by 21.33 per cent adoption of deshi varieties and 16.00 per cent adoption of American varieties.

Intercropping was rarely adopted by the respondents. Only 15.33 per cent of the respondents had complete adoption of cotton + greengram (1:1), followed by cotton + blackgram (1:1) 10.00 per cent of the respondents. Cotton + sorghum + pigeonpea + sorghum (6:1:2:1) intercropping recommendation was adopted completely by none of the respondents under study.

Hoeing as intercultural operation was found to be adopted completely by 29.33 per cent of the respondents. As regards plant protection, it is seen that only 22.66 per cent of the respondents adopted plant protection measure completely for control of bollworm and sucking pest, while 18.66 per cent of the respondents undertaken spraying completely for control of leaf spot and dahiya disease of cotton.

Further, it is seen that majority of the respondents had partial adoption in respect of university recommended cotton technologies. As regards partial adoption of varieties, it is observed that the adoption of deshi varieties was found to be more (45.33%) than that of hybrids (40.00%). The adoption of American varieties was found to be 36.67 per cent.

Monsoon sowing was adopted partially by 41.33 per cent of the respondents, followed by only 12.67 per cent adoption of dry sowing. The recommended spacing of deshi variety was partially adopted by 40.00 per cent of the respondents, followed by spacing of American varieties 36.67 per cent and hybrids (34.67%).

As regards intercropping it is revealed that 23.33 per cent of the respondents were found to be partially adopting cotton + green gram intercropping, followed by 21.33 per cent cotton + sorghum + pigeonpea + sorghum and 18.66 per cent cotton + black gram.

Hoeing as intercultural operation was found to have partially adopted by 59.33 per cent of the respondents followed by weeding 48.00 per cent.

Spraying of insecticide for control of bollworm and sucking pests was found to have adopted partially by 58.00 per cent respondents, followed by 48.00 per cent respondents controlling of leaf spot and dahiya disease by spraying fungicide.

2. Relationship of selected independent variables with adoption

The correlation coefficient of personal, socio-economic, communication and psychological characteristics of the respondents with adoption were worked out and presented in Table 2.

The results in Table 2 indicated that the independent variable namely education, social participation, socio-economic status and scientific orientation were found to be positively and significantly related at 0.01 level of probability, whereas land holding, area under cotton crop and extension contact were found to be positively and significantly related at 0.05 level of probability with adoption of university recommended cotton technologies by the respondents. It could be inferred that with the increase in education, land holding,

Table 2. Correlation coefficient of independent variable with adoption

S.N.	Characteristics	Coefficient of correlation (r)
1.	Education	0.243**
2.	Land holding	0.201*
3.	Area under cotton crop	0.200*
4.	Social participation	0.209**
5.	Socio-economic status	0.267**
6.	Extension contact	0.205*
7.	Scientific orientation	0.377**

** Significant at 0.01 level of probability * Significant at 0.05 level of probability

area under cotton crop, social participation, socio-economic status, extension contact and scientific orientation of an individual, the adoption level about university recommended cotton technologies also increased. These findings were supported by Garje (1992) and Jagdale and Nimbalkar (1993).

3. Constraints faced by the farmers in adoption of University recommended technologies

The constraints encountered by the respondents in adoption of university recommended cotton technologies are presented in Table 3, which are self explanatory. However, from the table, the major findings revealed that, more than fifty per cent of the respondents (58.66%) reported "requires high wages of labour" for intercropping and for weeding operation, followed by lack of knowledge about the intercropping practice cotton + sorghum + pigeonpea + sorghum (54.66%).

The lack of knowledge about spacing for American varieties was also reported by 38.00 per cent of the respondents. High cost of pesticides and fungicides was found to be one of the constraints reported by 35.33 per cent respondents. Delayed monsoon for sowing was obstacle for 32.66 per cent respondents. High cost of seeds and non availability of labour for weeding at proper time was found as constraint in case of 32.00 per cent each.

Table 3. Distribution of respondents according to constraints faced by them

S.N.	Constraints	Frequency (n =- 150)	Percentage
I.	**Varieties**		
1.	Lack of knowledge about university recommended cotton varieties	43	28.66
2.	Non-availability of university recommended variety seeds at proper time	16	10.66
3.	High cost of seeds	48	32.00
II.	**Sowing time**		
1.	Lack of knowledge about dry sowing time	22	14.66
2.	Delayed monsoon for sowing	49	32.66
III.	**Spacing**		
1.	Lack of knowledge about spacing for American varieties	57	38.00
2.	Recommended spacing did not suit to soil type	18	12.00
IV.	**Intercropping**		
1.	Lack of knowledge about cotton + sorghum + pigeonpea + sorghum	82	54.66
2.	Require more labour at the time of sowing for cotton + sorghum + pigeonpea + sorghum	32	21.33
3.	High wages of labour	88	58.66
V.	**Intercultural operations**		
1.	Non-availablility of labour for weeding at proper time their control measires	48	32.00
2.	High wages of labour for weeding	88	58.66
VI.	**Plant protection measure**		
1.	Lack of knowledge about important cotton pests and their control measures	16	10.66
2.	Lack of knowledge about important cotton disease and their control measures	24	16.00
3.	High cost of pesticides and fungicides	53	35.33
4.	Non availability of plant portection appliances in time	22	14.66

Lack of knowledge about university recommended cotton varieties was also the constraint for more than one-fourth of the respondents (28.66%). Requirement of labour at the time of sowing for cotton + sorghum + pigeonpea and sorghum intercropping was the constraint for about more than one-fifth of the respondents (21.33%) as reported by them.

Apart from this, others are the constraints but not of serious nature and not of majority of the respondents.

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Export Performance of Indian Rice in the World Market

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ABSTRACT

India has become self sufficient as regards food grains and exporting rice for quite some time in spite of our burgeoning population. In world rice scenario, India contributed 21.57 per cent rice production during the period of 2000-2001. India's share in world rice export was only 12.33 per cent during 1996-1997 and 9.89 per cent 2000-2001. While world is moving steadily towards free trade with quotas almost gone and tariffs and subsidies reduced, we have an opportunity to earn foreign exchange by exporting products in which we have a comparative advantage. Rice is one of such commodities, which we can use as a more effective dollar earner.

Rice is a primary staple food in many developing and least developed countries. Such countries can ill afford to depend on global market for meeting their food security needs. Indian agriculturists have been growing rice, the most important cereal in the country, since the dim dawn of history. The vast alluvial plains of major rivers like the Ganges, the Brahmaputra, the Godavari, the Krishna and the Cauveri are conductive to rice cultivation and our farmers through centuries of experience, have mastered the traditional art of growing the rice crop. India, undoubtedly, enjoys a clean comparative advantage in rice production. No wonder, India contributes major share in world rice production and export. The efforts have been made in this paper to competitiveness of India's rice in global market.

MATERIAL AND METHODS

The secondary data collected from various sources have been used for the study. A simple tabular analysis was done in the present study to draw the meaningful conclusion.

RESULTS AND DISCUSSION

India has become self sufficient as regards foodgrains and is exporting rice for quite some time, inspite of our burgeoning population. However, it becomes evident that there is little room for complacency when we look at the export of rice and compare it with other countries. Before proceeding, we may have a look at the production and export of rice in Table 1.

Production and export of rice :

From the Table 1, it is evident that, the production of rice in India has increased from 122.50 MMT in 1996-97 to 128.20 MMT in 2000-2001. The percentage change over the base year was recorded to 4.65 per cent. Thus India has made significant progress in rice production during the period of time. In world rice scenario, India contributed 21.57 per cent rice production during the period of 2000-2001. India ranks second in rice production (next to China 31.95 %) in the world. This share is stable during past 10 years.

Total export of rice in world has been estimated as 20.35 MMT in 1996-97 and 25.99 MMT in 2000-2001. Thus during this period, the percentage change has been estimated to 27.71 per cent. Further it is also observed that, the export of rice is neither stable nor growing at a steady rate. India's share in world rice exports was only 12.33 per cent during 1996 and 9.89 per cent in 2000-2001. World is moving steadily towards free trade, with quotas, almost gone and tariffs and subsidies reduced, we have an opportunity to earn foreign exchange by exporting products in which we have a comparative advantage. Rice is one such commodity and we have to examine whether we can use it as a more effective dollar earner. To increase rice exports, India has to produce more. Domestic availability should not be reduced, as quarter of our population is still living below the poverty level. But will a rise in production increase

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exports of rice. However we will be able to at least maintain our share in world rice exports, if production grows.

Major importers of Indian rice :

From the Table 2 it is observed that, India's total exports of rice was Rs. 3172.36 crores, in which contribution of Basmati rice was 39.33 per cent and that of Non-basmati rice 60.67 per cent in 1996-97. In the year 2000-2001, the total rice exports from India was Rs. 3125.92 crores. Contribution of Basmati rice was 56.95 per cent and that of Non-basmati 43.05 per cent.

The year 2000-2001 has seen a quantum jump in global rice trade. The rice consuming population is substantial and increasing. Bangladesh with a high population growth rate, is a major importer of non-basmati rice from India with 26.86 per cent of rice being imported from India in value terms in 2000-2001. India does not export cereal in a large way to any other South or South-East Asian country at present, but there is a significant demand for Indian rice among burgeoning rice eating ingredient population in Saudi Arabia, Kuwait, United Arab Emirates, Kenya, United Kingdom, South Africa, Nigeria, etc. hence, there is no reason for us to fear that Indian rice will fail to find buyers in the international market, if its supply increases. While a decline in price will make Indian rice more competitive in the global market.

Prospects of rice export

In China, the largest producer of rice in the world, the crop has suffered this year, owing to lack of adequate rainfall in Sichuan, Jiangsu, Anhui and some northeastern provinces. Similarly, rice production has suffered badly in recent year in Cambodia, too, in the wake of dry spells. In the Philippines, torrential rains caused by the typhoon 'Feria' has hit the rice crop though the damage has been limited. Droughts and insecurity for the last three years continue to plague agricultural production in the Near East. This season's paddy output suffered in Iran owing to dry weather during planting time. The scenario is Egypt too, where rice production is due to decline this year. Insufficient

Table 1. Major country-wise production and exports

(Production and export in million metric tonnes)

S.N.	Major countries	1996-97		2000-2001		Percentage changes over the base period	
		Production	Export	Production	Export	Production	Export
1.	India	122.50 (21.55)	2.51 (12.33)	128.20 (21.57)	2.57 (9.89)	4.65	2.39
2.	China	197.03 (34.66)	0.36 (1.76)	189.92 (31.95)	2.82 (10.85)	-3.60	683.33
3.	Vietnam	26.40 (4.64)	3.50 (17.20)	32.55 (5.48)	4.60 (17.70)	23.29	31.42
4.	Thailand	22.33 (3.93)	5.45 (26.78)	24.00 (4.03)	6.84 (26.32)	7.47	25.50
5.	USA	7.77 (1.37)	2.64 (12.98)	8.66 (1.46)	2.67 (10.27)	11.45	1.13
6.	Pakistan	6.46 (1.14)	1.60 (7.86)	7.20 (1.21)	1.79 (6.89)	11.46	11.87
7.	Others*	185.94 (32.71)	4.29 (21.09)	203.85 (34.20)	4.70 (18.08)	9.63	9.55
8.	World	568.43 (100.00)	20.35 (100.00)	594.38 (100.00)	25.99 (100.00)	4.56	27.71

(Figures in parentheses indicate the percentage of total)

* Others included Indonesia, Bangladesh, Myanmar, Philippines, Japan, Brazil, Republic of Kenya, Uruguay, Australia, Italy, Argentina

Source : FAO

Table 2. Major importers of Indian rice

S.N.	Countries	1996-97			2000-2001		
		Basmati	Non-basmati	Total	Basmati	Non-basmati	Total
1.	Saudi Arabia	642.07	253.80	895.87	1058.51	211.13	1269.64
		(51.46)	(13.18)	(28.24)	(59.45)	(15.69)	(40.61)
2.	United Kingdom	95.76	81.80	177.56	173.05	46.89	219.94
		(7.67)	(4.25)	(5.60)	(9.72)	(3.48)	(7.03)
3.	Kuwait	98.23	-	98.23	125.92	-	125.92
		(7.87)		(3.09)	(7.07)		(4.03)
4.	United Arab Emirates	69.91	-	69.91	102.45	-	102.45
		(5.60)		(2.20)	(5.75)		(3.28)
5.	United States	230.95	-	230.95	70.51	-	70.51
		(18.51)		(7.28)	(3.96)		(2.25)
6.	France	9.06	-	9.06	33.68	-	33.68
		(0.73)		(0.28)	(1.89)		(1.07)
7.	Belgium	2.93	-	2.93	24.09	-	24.09
		(0.23)		(0.09)	(1.35)		(0.77)
8.	Yemen	0.06	20.25	20.85	19.22	37.64	56.86
		(0.05)	(1.05)	(0.66)	(1.08)	(2.79)	(1.82)
9.	Nepal	-	9.33	9.33	16.45	29.79	46.24
			(0.48)	(0.29)	(0.92)	(2.21)	(1.48)
10.	Oman	9.97	-	9.97	16.21	-	16.21
		(0.8)		(0.31)	(0.91)		(0.52)
11.	Bangladesh	-	145.29	145.29	-	361.51	361.51
			(7.55)	(4.58)		(26.86)	(101.56)
12.	South Africa	-	189.31	189.31	-	158.17	158.17
			(9.83)	(5.96)		(11.75)	(5.06)
13.	Russia	-	317.50	317.50	-	156.20	156.20
			(16.49)	(10.00)		(11.61)	(4.99)
14.	Nigeria	-	10.13	10.13	-	109.08	109.08
			(0.53)	(0.32)		(8.10)	(3.49)
15.	Shrilanka	-	192.20	192.20	-	51.15	51.15
			(9.98)	(6.06)		(3.80)	(1.64)
16.	Singapore	-	7.86	7.86	-	26.40	26.40
			(0.41)	(0.25)		(1.96)	(0.84)
17.	Others	88.16	697.25	785.41	140.25	157.62	297.87
		(7.06)	(36.22)	(24.75)	(7.88)	(11.71)	(9.53)
	Total	1247.64	1924.72	3172.36	1780.34	1345.58	1325.92
		(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)
	Percentage of total export	1247.64	1924.72	3172.36	1780.34	1345.58	3125.92
		(39.33)	(60.67)	(100.00)	(56.95)	(43.05)	(100.00)

Figures in parentheses indicate the percentage of total
Source : FAO/DGCI & S

rainfall has also affected production of the crop in EI Salvador, Cuba, Honduras, Mexico, Nicaragua and Panama. Fortunately for India, thanks to abundant rainfall, rice production is expected to go up by some 2 per cent according to forecasts made by Food and Agricultural Organization. Hence India will most likely enjoy better export prospects regarding rice.

India's export-import policy for rice

Import of rice was not freely allowed in India. Imports of rice was made through Food Corporation of India (FCI) as per domestic requirements. On the other hand, export of rice was allowed subject to registration of contracts with APEDA. Rice has now been shifted to State Trading. On the face of it, import is freely allowed on commercial consideration by FCI. There is no official directive to the agency on how much to import under what circumstances.

The government has also put in place non-tariff barriers to check import. No consignment can be important even for consumption unless an import permit and an official phytosanitary certificate issued by the authorizer officer accompany it. This has made applicable from 1st June, 2001. In India, the actual import duty is now 70 per cent for milled rice and 80 per cent for other varieties. Imports at these levels of protection are not viable.

Summary

1. The production of rice in India has increased from 122.50 MMT in 1996-97 to 128.20 MMT in 2000-2001.
2. In world rice scenario India contributed 21.57 per cent rice production during the period 2000-2001. India ranks second in rice production in the world.
3. India's share in world rice export was only about 12.33 per cent during 1996-97 and 9.89 per cent in 2000-2001.
4. India's total exports of rice was Rs. 3172.36 crores, the contribution to Basmati rice being 39.33 per cent and non-basmati rice having 60.67 per cent in 1996-97. While in the year 2000-2001, the total rice exports from India was Rs. 3125.92 crores with Basmati contributing 56.95 per cent and non-basmati rice was 43.05 per cent of the total export.
5. Saudi Arabia, Bangladesh, United Kingdom, Kuwait, United Arab Emirates, United States, Russia, Nigeria etc. are major rice importing countries of Indian rice.

Suggestions

1. In a world moving steadily towards free trade, with quotas almost gone and tariffs and subsidies reduced, we have an opportunity to earn foreign exchange by exporting products in which we have a comparative advantage. Rice is one such commodity.
2. To increase rice exports India has to produce more, however it will not be a wise policy to starve our countrymen in order to get dollars. Domestic availability should not be reduced.
3. There is a significant demand for Indian rice among burgeoning rice eating immigrant population in Saudi Arabia, Kuwait, United Arab Emirates, Kenya, United Kingdom, South Africa, Nigeria and a host of other countries. Hence, there is little reason for us the fear that Indian rice will fail to find buyer in the international market, its supply increases.

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Investigation of Serum Inorganic Phosphorus Levels in Cows After Administration of Organic and Inorganic Phosphorus Preparations

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ABSTRACT

Total 18 crossbred cows having a suboptimal serum inorganic phosphorus levels (Below 4 mg dl^{-1}) were divided into three equal groups. First group (T_1) was kept untreated control, second group (T_2) and third group (T_3) were treated with organic (@ 10 ml IM) and inorganic phosphorus preparation (5 ml IM), 3 doses on alternate days, respectively. The serum calcium and inorganic phosphorus was estimated on '0' day and at 24, 48, 72, 96 and 120 hr after administration of drug. The serum inorganic phosphorus and calcium level in group T_2 and T_3 was significantly increased over the T_1 group and produced 5-8 per cent increase in the milk yield. The results indicated that the organic and inorganic phosphorus containing drugs are equally effective to treat subclinical hypophosphataemia in cattle. However, the rise in serum inorganic phosphorus level was earlier in group treated with inorganic phosphorus than organic phosphorus group.

Diets low in phosphorus or unsupplemented with phosphorus resulted into development of hypophosphataemia in dairy cattle (Shukla *et. al.*, 2001). The incidences are more common in growing and milking animals as the demand for phosphorus are more during those stages. The mild to moderate progressive phosphorus deficiency is usually determined by low serum inorganic phosphorus levels which is clinically indicated by pica, reduction in feed intake, stunted growth, reduced milk yield, reduced fertility and in the later stages osteodestrophy.

The progressive or acute hypophosphataemia condition is usually treated with parenteral administration of organic or inorganic phosphorus containing preparations. The present investigation has been undertaken to study the relative merits and demerits of administration of inorganic and organic phosphorus preparations in terms of inorganic phosphorus and calcium levels in the serum in hypophosphataemic dairy cows.

MATERIAL AND METHODS

Total 18 crossbred lactating cows (5-10 years) between 2nd to 6th lactation and at mid lactation from livestock instructional farm, Dr. Panjabrao Deshmukh Krishi Vidyapeeth and Gorakshan dairy farm, Akola were selected on the basis of low serum inorganic phosphorus (below 4 mg dl^{-1}) level. The cows were equally divided into three equal groups. First group (T_1) was kept untreated control. Second group (T_2) was treated with organic phosphorus preparation (20% solution containing 0.2 g of Sodium salt of 4 - dimenthylamino-2 - Methyl - Phenyl-phospinic acid) @ 10 ml per cow IM, total three doses on alternate days. Third group (T_3) was treated with inorganic phosphorus preparation (40% solution of sodium acid phosphate) @ 5 ml per cow IM, total three doses on alternate days.

The serum calcium and inorganic phosphorus were determined prior to drug administration (0 days) and then at 24, 48, 72, 96 and 120 hr, after administration of drug by (Autochem 2011) semi autoanalyzer using Span Diagnostic kits.

Milk yield was recorded prior to treatment and subsequently after end of treatment. The data were analyzed statistically as per the methods of Snedecor and Cochran (1967).

RESULTS AND DISCUSSION

Average changes in serum inorganic phosphorus and calcium levels at different intervals in different groups of cows are shown in Table 1.

The serum inorganic phosphorus level before treatment in all groups under experiment were ranging between 3.41 $\pm$ 0.14 to 3.78 $\pm$ 0.53 mg dl^{-1}.

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Table 1. Average changes in serum inorganic phosphorus and calcium level at different intervals in different groups of cows.

S.N.	Paramerters	Group	Before treatment 0 hr	After administrating 24 hr	48 hr	72 hr	96 hr	120 hr
1.	Serum inorganic phosphorus ($mg\ dl^{-1}$)	T_1	3.41 ± 0.14	3.36 ± 0.12	3.55 ± 0.18	3.46 ± 0.11	3.63 ± 0.29	345 ± 0.13
		T_2	3.45 ± 0.26	3.00 ± 0.55	3.36 ± 0.09	3.91 ± 0.30	5.03 *a ±0.57	5.61*a 0.91
		T_3	3.78 ± 0.53	3.48 ± 0.24	4.43*a ±0.80	4.80 *a ±0.40	5.05 *a ±0.25	5.65 *a+ ±0.28
2.	Serum calcium ($mg\ dl^{-1}$)	T_1	10.55 ± 0.40	10.6 ± 0.79	10.21 ± 0.26	10.20 ± 0.17	10.20 ± 0.32	10.30 ± 0.28
		T_2	10.91 ± 1.26	9.38 ± 1.44	12.38 a ±0.58	10.45 ± 1.07	10.48a ±0.58	11.56 a ±0.47
		T_3	10.55 ± 0.76	9.01 ± 1.15	11.53a ±1.25	11.13a ±0.67	11.36a ±0.55	11.68a ±0.59

* Significant difference ($p<0.05$) within the group compared to pretreatment value

a Significant difference ($p<0.05$) between untreated control group to treated groups during corresponding period

Subsequently to the administration of phosphorus containing preparations the level was significantly raised in both the treatment groups. In untreated control (T_1), it remained significantly lower than in treated groups, indicating that both the drugs (organic/inorganic) could rise the serum inorganic phosphorus to the desired level after respective treatment regimen. However, inorganic phosphorus containing drug initiated rise in serum phosphorus level earlier than (24 to 48 hr) organic phosphorus preparation group (Table 1). Jagadeeswaran and Jagdishkumar (1998) also report similar trend in acute hypophosphataemic condition in dairy heifers. Cheng *et al.*, (1998) also observed the significantly increase in plasma inorganic phosphorus concentration after six hours in cows treated with IV inorganic phosphorus than cows treated with organic phosphorus solution.

Sonawane, *et. al.*, (2000) noticed significant rise in plasma inorganic phosphorus level on 5th day after administration of single dose of organic phosphorus preparation (Tonophosphon, 20 % solution) IM in subclinical hypophosphataemic cows. Whereas, Haque and Verma (1992) observed significantly increase in serum inorganic phosphorus level in crossbred cows after multiple intramuscular administration of organic phosphorus preparation (Tonophosphon, 1 g daily for 15 days). Delay rise in serum inorganic phosphorus level after administration of organic phosphorus preparation may be attributed to the release of inorganic phosphorus from the organic complex may be a slow process in the body which may be one of the important reasons for not initiating rise in serum phosphorus level quickly (Jagadeeswaran and Jagdishkumar, 1998) and it may be exerting its effect by way of either mobilizing the phosphorus from reserve or by stimulating the general metabolic process (Sonawane, *et. al.*, 2000).

The serum calcium level in both the treated groups was significantly increased over the untreated control group. These observations indicated that administration of phosphorus containing preparation (inorganic/organic) also raised serum calcium level to the significant extent over untreated group.

Administration of phosphorus containing drugs produced 5-8 per cent increased in the milk yield. This finding is in agreement with the result obtained by Sonawane *et al.*, (2000). It may be probably because of formation of phospholipids (the components of milk formation) after administration of phosphorus containing drugs in hypophosphataemic cows (Prakash and Naik, 2000).

From the above investigation it is concluded that the organic and inorganic

phosphorus containing drugs are equally effective to treat subclinical hypophosphataemic condition. Inorganic phosphorus containing drugs would be more useful in treating acute hypophosphataemic condition due to their quick effect.

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RESEARCH NOTE

Status of Greenhouse Technology in Akola and Washim District (A case study)

Greenhouse technology is one of the promising technologies to improve the quality and productivity of the crop. But due to high investment, it is not gaining popularity. A few enthusiastic persons are using this technology. Considering the present status of greenhouse technology in India, early adopter should be motivated and action should be taken to increase area under greenhouse at faster rate. The greenhouse technology has potential to meet the growing demand of crops.

A survey was conducted in Akola and Washim district (M.S.) in the year 2000-2001 to know the awareness and status of greenhouse technology and to estimate the existing material and suggest modification in design of poly-net house.

Only eleven greenhouses were observed in these regions in which seven were located in Akola district and four were in Washim district. In Akola district, out of seven greenhouses, four were polyhouse while three were net house. In Washim district, two greenhouses were polyhouses while two were net houses. The greenhouses were low to medium cost type. The existing poly/net houses were mostly used for nursery bed preparation and raising of seedlings (papaya). The main purpose of Taluka Seed Farm (T.S.F.) and District Fruit Nursery (D.F.N.) is to promote the farmers of that vicinity for adoption and transfer of technology at user's end for value addition and to increase the village economy.

The existing poly/net houses erected in this region are not matching with the appropriate design, which can create the favourable microclimate in Vidarbha region. It is also observed that these structures have no definite shape, proper orientation, lack of cooling system and proper natural ventilation. The steel components are used more than required

Table 1. Details of Poly/Net houses surveyed

S.N.	Location (District)	Dimension(m) L x W x H	Cost (Rs sq.m.$^{-1}$)	Type
1.	T.S.F., Alanda (Akola)	18.7 x 6.3 x 3.20 (117.87)	549	Modified quonset type polyhouse
2.	T.S.F., Gadegaon (Akola)	20.8 x 4.76 x 2.56 (99.21)	652	Modified quonset type polyhouse
3.	Mr. H.N. Patil, Kanheri (Akola)	19.2 x 4.26 x 3 (79.87)	509	Modified quonset type polyhouse
4.	D.F.N., Shirso (Akola)	25 x 4 x 2 (100)	328	Ground to ground type polyhouse
5.	D.F.N., Malegaon (Washim)	25 x 5 x 4.5 (108)	547	Modified quonset type polyhouse
6.	D.F.N., Malegaon (Washim)	25 x 4 x 2 (100)	328	Ground to ground type polyhouse
7.	T.S.F., Alanda (Akola)	20 x 4 x 2.25 (80)	447	Even gable type net house
8.	Mr. Suresh Sedhani, Akot (Akola)	25.6 x 11.52 x 3.5 (294.91)	395	Even gable type net house
9.	D.F.N., Wadha (Washim)	15.5 x 6.25 x 2.46 (96.87)	406	Even gable type net house
10.	D.F.N., Shirla	15.5 x 6.25 x 2.46 (96.87)	406	Even gable type net house
11.	D.F.N., Malegaon (Washim)	15.5 x 6.25 x 2.46 (96.87)	406	Even gable type net house

that in turn added to the construction cost. Most of the structures are not properly maintained. In some structures, the tearing of the U.V. stabilized sheet was major problem, which was noted due to welding spots and some projections on the steel structure during the fabrication. Also while fixing the film over the skeleton, the frame was not painted by white paint and wrapping of the plastic film with frame which was in contact with the film.

Majority of the polyhouses were quoneset type with no roof ventilation and/or fan and pad system. Such polyhouses can not maintain a proper microclimate during summer. However, they can be used effectively in rainy and winter season for raising of high value seedlings and propagation of grafts and cutting in rainy and winter season.

As there is vast scope for floriculture industries in this region and availability of the natural resources may be helpful to propagate the greenhouse technology in this region by erecting semi-controlled type polyhouses or even net houses.

The survey reveled that the farmers are having awareness of greenhouses. The interrupted power supply is the major problem in this area. The farmers have not followed design consideration for erecting the greenhouse. Farmers need guidance for proper management of greenhouse for its maximum output. More area can be brought under greenhouse cultivation if the advantages of technology are explained to farmers. The modification in existing structure should be made to have better results in future.

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Effect of FYM and Nitrogen on Yield, Quality and Uptake of Nutrients by Safed Musli (*Chlorophytum borivilianum*)

Safed musli (*Chlorophytum borivilianum*) is an important perennial herb, belongs to family Lilliaceae, widely distributed in India. Sheriff and Chennaveeraiah (1972) reported 13 species, out of which 8 are endemic to the sub continent in India. *Chlorophytum borivilianum* is considered as most important species of Safed musli. The fasciculated roots of this herb of great medicinal values mainly due to the presence of saponin having aphrodisiac property. Due to its increasing demand and attractive market price as well as medicinal value, area under Safed musli is increasing day by day, however the information on manures and fertilizer management was lacking and therefore the present investigation was carried out.

A field experiment was conducted at Nagarjun Medicinal Plants Garden, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *kharif* 2001-2002. The experimental soil was slightly calcareous, alkaline, clayey, rich in available K (286 kg ha^{-1}), low in organic carbon (0.38 %), available N (152 Kg ha^{-1}) and Olsen's P (15.2 Kg ha^{-1}). The treatments comprised of three levels of FYM (0, 10,20 t ha^{-1}) and four levels of nitrogen (0, 25,50 and 75 Kg N ha^{-1}) with three replications tried in FRBD. A basal dose of P_2O_5 @ 50 Kg ha^{-1} and K_2O @ 25 Kg ha^{-1} was applied to all the treatments. At maturity (240 days after planting), the roots were dug out and after washing with water; the post harvest observations were recorded. The saponin content of roots was estimated by procedure as described by Birk *et al.* (1963) and the protein content was estimated by multiplying the N content (Kjeldahl's method) by the factor 6.25. Nutrient content was estimated by adopting standard analytical procedures (Piper, 1966) and the uptake of nutrients on the average dry matter basis at various growth stages was computed by multiplying the respective nutrient content with the dry matter yield.

Application of various levels of FYM and nitrogen recorded a significant increase in fresh and dry root yield of Safed musli. (Table 1). Application of 20 t FYM/ ha significantly increased the fresh and dry root yield over all the treatments and FYM 10t ha^{-1} over control. Non-significant effect of FYM application on the content of saponin was noticed, however the total yield of saponin and content and yield of protein were significantly improved with the FYM application and highest values were noticed with 20 t FYM ha^{-1}.

Application of 75 kg N ha^{-1} increased the fresh and dry root yield over all the nitrogen levels, except 50 kg N ha^{-1}. Similarly 50 kg N ha^{-1} was at par with 25 kg N ha^{-1} however it was superior over control (0 kg N ha^{-1}). No significant effect of nitrogen application was observed on the content and total yield of saponin. The content and yield of protein was significantly influenced by nitrogen applications.

The uptake of nutrients was increased with increasing rate of FYM and nitrogen applications and the highest uptake of nitrogen was noticed with the application of 20 t FYM and 75 kg N ha^{-1} alone or in combination. The phosphorus uptake was also increased with FYM and nitrogen applications. On the contrary, the application of nitrogen at various levels had non-significant effect on the uptake of potassium. Application of FYM and nitrogen resulted in higher uptake of nutrients might be due to balanced nutrition resulted into better accumulation of nutrients by the crop. These results are in agreement with the findings of Sharma (1996).

Table 1: Fresh and dry root yield, uptake of nutrients and total yield of saponin of Safed musli

Treatments	Fresh root yield q ha^{-1}	Dry root yield q ha^{-1}	Uptake of nutrient (Kg ha^{-1})			Total yield of saponin (Kg ha^{-1})	Total yield of protein (Kg ha^{-1})
			N	P	K		
FYM level (t ha^{-1})							
M0 (0)	23.25	3.92	8.15	0.84	9.10	20.27 (5.25)	31.37 (7.99)
M1 (10)	29.69	5.20	10.15	1.10	11.35	28.79 (5.64)	45.04 (8.57)
M2 (20)	37.98	6.64	11.41	1.31	12.92	37.92 (5.67)	58.67 (8.84)
SE (m)±	1.377	0.246	0.345	0.057	0.509	1.749 (0.136)	2.211 (0.062)
CD at 5%	4.040	0.720	1.012	0.268	1.493	5.043 (NS)	6.487 (0.187)
Nitrogen levels (Kg ha^{-1})							
No (0)	26.47	4.58	7.26	0.80	10.40	25.21 (5.48)	38.00 (8.28)
N1 (25)	28.94	5.02	9.48	1.00	10.32	27.62 (5.47)	43.62 (8.56)
N2 (50)	31.91	5.57	10.22	1.13	11.35	31.22 (5.63)	47.79 (8.44)
N3 (75)	33.90	5.86	12.69	1.40	12.50	31.95 (5.48)	50.69 (8.60)
SE (m)±	1.590	0.284	0.040	0.066	0.588	1.985 (0.158)	2.5540 (0.071)
CD at 5%	4.660	0.830	1.170	0.194	NS	NS (NS)	7.491 (0.209)
Interaction Effect							
SE (m)±	2.735	0.493	0.690	0.114	1.018	3.438 (0.273)	4.423 (0.123)
CD at 5%	NS	NS	2.020	NS	NS	NS (NS)	NS (NS)

Figures in the parentheses refer to the content (%)

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Efficacy of Fe Sources to Control the Chlorosis in Safed Musli *(Chlorophytum borivilianum)*

Chlorosis is frequently appeared on Safed musli at early stages of growth, particularly in Safed musli grown on calcareous soils. Chlorosis is primarily associated with iron deficiency and it affects the growth and photosynthesis in the plants (Zakerzheviskli, *et. al.* 1987). Among the factors, the presence of $CaCO_3$ in soils is considered to be the most important factor responsible for Fe deficiency. Safed musli (*Chlorophytum borivilianum*) has assumed great importance now a days, as it has good market value and potential. The white product fetches more price than the pale yellow or brownish material. It has also a large and consistent market demand in the country and the current projection of the annual demand is estimated between 500 to 800 tones (Bordia, 1992).

The research work carried out so far on the nutritional management to control the chlorosis in Safed musli is very meager. Due to its good market price and medicinal value, area under Safed musli is increasing day by day. The local farmers have queries about its package of practices particularly of agronomic practices to control the chlorosis and therefore, the present investigation was carried out.

A field trial was conducted during *Kharif* 2000-01, to study the efficacy of Fe sources to control the Chlorosis in Safed musli *(Chlorophytum borivilianum)* at Nagarjun Medicinal Plants Garden, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola(Maharashtra). The treatments comprised of Fe sources viz, FeSO4, FeCl3 and Fe(NH4) SO4 applied through soil and foliar, and soil application of Iron pyrite(FeS_2).The foliar applications were done @ 0.5 per cent concentration, sprayed twice at an interval of 15 days after 15 and 30 days after planting. The soil applications were made @ of 25 kg ha^{-1}, applied at the time of raised bed preparation except that of Iron pyrite. It was applied @ 100 kg ha^{-1} before 15 days of planting. The experimental soil was calcareous ($CaCO_3$ 6.68%), alkaline in soil reaction (pH 8.2), low in organic carbon, available nitrogen, phosphorus and rich in potassium. The contents of available sulphur and DTPA Zn, Fe, Mn were 9.28, 0.80,5.20 and 2.00, respectively. The chlorotic plant count was recorded after 60 days of planting and plant samples collected at this stage was analysed for chlorophyll content .The yield of fasciculated roots was recorded as per the treatments. The chemical analysis of soil and plants was performed by standard procedures (Arnon, 1949, Jackson, 1967, Piper, 1966, Tabatabai and Bremner, 1970 , Lindsay and Norvell, 1978).

The data presented in Table 1 indicated that the basal application of iron through various sources was found to have beneficial effects on the chlorophyll content and yield of fresh roots.

Table 1: Effect of Fe sources on the root yield of Safed musli

Treatments	Chlorotic plant count (lakh ha^{-1})	Chlorophyll content (mg g^{-1} tissue)	Yield of fresh roots (q ha^{-1})
T_1- $FeSO_4$ (Foliar)	0.496 (22.32)	0.48	14.16
T_2 -$FeSO_4$ (Soil)	0.383 (17.23)	0.45	14.80
T_3 -$FeCl_3$ (Foliar)	0.526 (23.67)	0.46	14.06
T_4 -$FeCl_3$ (Soil)	0.363 (16.33)	0.43	15.00
T_5 -Fe (NH_4) SO_4 (Foliar)	0.486 (21.88)	0.46	15.40
T_6 -Fe (NH_4) SO_4 (Soil)	0.273 (12.28)	0.52	16.00
T_7 -Pyrite (FeS_2)	0.250 (11.25)	0.56	17.56
T_8 –Control	0.520 (23.40)	0.27	12.76
SE (m) $\pm$	0.024	0.021	0.50
CD at 5 %	0.075	0.064	1.51
C. V. %	10.38	8.10	8.79

Figures in parentheses refer to the per cent chlorotic plants.

Table-2 Nutrient status of Safed musli plant and soil after harvest as influenced by Fe sources

Treatments	Nutrient Status (ppm)							
	Plant				Soil			
	S*	Fe	Mn	Zn	S	Fe	Mn	Zn
$FeSO_4$ (Foliar)	0.320	160	64.0	28.0	9.47	5.30	1.93	0.81
$FeSO_4$ (Soil)	0.300	150	59.3	36.0	10.2	5.60	2.06	0.85
$FeCl_3$ (Foliar)	0.329	160	65.3	30.0	8.69	5.30	1.96	0.78
$FeCl_3$ (Soil)	0286	143	50.0	28.0	9.65	5.30	2.20	0.81
$Fe(NH_4)SO_4$ (Foliar)	0.333	157	70.0	32.0	9.35	5.30	1.93	0.76
$Fe(NH_4)SO_4$ (Soil)	0.330	160	80.0	32.0	9.70	5.60	2.20	0.68
Pyrite (FeS_2)	0.370	180	85.0	32.0	10.4	6.00	2.33	0.70
Control	0.276	110	52.0	30.0	9.34	5.26	2.00	0.81
SE(m)±	0.013	6.10	3.60	1.60	0.42	0.23	0.10	0.037
CD at 5%	NS	18.0	10.90	NS	NS	NS	NS	NS
C.V.%	7.450	6.90	9.50	9.08	7.64	7.36	8.87	8.40

* Expressed in percentage basis

Significantly lowest count of chlorotic plants was recorded with the basal application of pyrite @ 100 kg ha^{-1}. However, it was at par with the basal application of ferrous ammonium sulphate. Similar results were also observed in respect of chlorophyll content. The highest chlorophyll content was found with basal application of pyrite, followed by soil application of ferrous ammonium sulphate. However, the values were statistically at par. The yield of fresh roots was significantly more with the basal application of pyrite. No significant differences were found in the root yield due to application of other iron sources through soil or foliage. These results are supported by the findings of the field experiment conducted at Udaipur (Anonymous, 2002-03).Soil application of elemental sulphur or two sprays of $FeSO_4$ significantly increased the chlorophyll content of the leaves and recorded highest fleshy root yield.

The content of Fe and Mn in Safed musli plant was significantly highest with the application of pyrite but it was at par with the soil application of ferrous ammonium sulphate (Table 2). The content of Fe, Mn, and S was lowest in the control. No significant increase in the content of S and Zn in plant and S, Fe, Mn and Zn in soil were found due to application of various sources of iron through soil or foliage. Kaul, *et. al.* (1978) and Tiwari, *et. al.* (1984) also reported increased contents of Fe, Mn, and Zn due to application of pyrite. Iron pyrite contains 22-24 per cent S and 20-22 per cent Fe. The role of sulphur is multidimensional and therefore the role of pyrite is of special significance in calcareous soils.

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Effect of Organic Manure and Fertilizer on the Yield and Quality of Safed Musli

Safed musli (*Chlorophytum borivilianum*) is an important medicinal perennial herb, which belongs to family Lilliaceae. It is widely distributed in India, particularly in the valley of Himalaya, Satpuda, Vindhya, Aravalli and in hilly areas of Bihar and Assam, and also found in the parts of Rajasthan, Gujarat and Maharashtra.

The fasciculated roots of Safed musli are of economic importance having aphrodisiac properties and form an important ingredient of herbal tonics (Kirtikar and Basu, 1975).The roots of this herb have great medicinal value mainly due to the presence of saponin content (2-17%). In structure the saponins consist of a sugar with sapogenine, the latter being the physiologically active portion of the molecule. The roots of Safed musli were found to contain sodium (0.04 mg g^{-1}), potassium (0.80 mg g^{-1}), calcium (6.6 mg g^{-1}), magnesium (1.9 mg g^{-1}), phosphorus (3.2 mg g^{-1}), copper (0.048 mg g^{-1}) and zinc in traces (Bordia, *et. al*, 1995).

Safed musli traditionally grows in forest and is collected as one of the forest products by the tribals. They sold it to private contractors/ businessman on throw away price. Recent research advances in commercialization of certain forest products have generated a great awareness and interest amongst tribals. Safed musli is one of such products that has potentiality due to its immense medicinal value. Because of good market price and medicinal value, area under Safed musli is increasing day by day. The local farmers have queries about its package of practices, particularly the manure and fertilizer management and therefore, the present investigation was carried out to study the effect of FYM and fertilizer levels on growth, root yield and quality of Safed musli.

A field experiment to study 'Effect of organic manure and fertiliser on the yield and quality of Safed musli *(Chlorophytum borivilianum)*' was conducted at Nagarjun Medicinal Plants Garden, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (Maharashtra) during *Kharif* 2000-01. The treatments (12) comprised of application of FYM @ 0, 10 and 20t and NPK fertilizer @ 0:0:0, 15:30:15, 30:60:30 and 45:90:45 kg per hectare applied alone or in combination and replicated thrice in factorial randomized block design.

The soil of the experimental site was slightly calcareous ($CaCO_3$ 5.2%), alkaline (pH 7.8) and clayey in texture, sufficient in available K (287 Kg/ha), however low in organic carbon (0.42%), available N (188.0 Kg ha^{-1}) and Olsen's P (15.6 Kg ha^{-1}). Post harvest observations were recorded treatment wise. The sapogenine content in root was estimated by the procedure as described by Mishra, (1998) using L.B.reagent and cholesterol as standard. Total nitrogen in root was estimated by Kjeldahl's method (Piper, 1966) and the nitrogen percent was multiplied with the factor of 6.25 to obtain protein per cent.

Amongst FYM levels application of 20 t FYM produced highest number of roots, fresh and dry roots yield of Safed musli. The length and diameter of roots, and the content of sapogenine and protein were also maximum with the application of 20t FYM per hectare; however, it was at par with the 10 t FYM ha^{-1}. Application of NPK fertilizers significantly increased the yield contributing characters and yield of fasciculated roots and protein content as compared to control. However, no significant difference was noticed among various NPK levels. The NPK level of 15:30:15 Kg ha^{-1} appeared to be optimum for Safed musli. Non-significant of NPK fertilizer was noticed on sapogenine content.

These results are in agreement with the findings of Mandsaur Center of AICRP on Medicinal and Aromatic Plants (Anonymous, 2000-01), who reported that the fresh root yield was significantly influenced due to FYM application however, different NPK graded levels did not influence the fresh root yield of Safed musli.

Table 1 Effect of organic manure and fertilizer on the yield and sapogenine content of Safed musli

Treatments	No. of roots	Length of roots (cm)	Girth (cm)	Yield of fresh roots (g plant^{-1})	Yield of fresh roots (q ha^{-1})	Yield of dry roots (%)	Total sapogenine (%)	Protein (%)
Organic manure (FYM t ha^{-1})								
0	8.88	6.16	0.727	11.78	23.00	3.90	1.016	9.552
10	12.49	8.27	0.811	17.19	33.90	5.78	1.114	9.938
20	13.50	8.45	0.820	19.70	38.00	6.48	1.135	10.003
SE (m)±	0.221	0.064	0.007	0.258	0.363	0.064	0.031	0.114
CD (5%)	0.649	0.189	0.021	0.759	1.066	0.188	0.092	0.334
Chemical Fertilizer (NPK Kg ha^{-1})								
00:00:00	10.81	7.47	0.785	15.17	29.72	5.07	1.032	9.323
15:30:15	12.16	7.79	0.786	17.05	32.34	5.50	1.117	9.960
30:60:30	12.02	7.72	0.786	16.68	32.65	5.57	1.103	10.121
45:90:45	11.50	7.52	0.793	16.01	31.84	5.41	1.102	9.920
SE (m)±	0.255	0.074	0.08	0.298	0.419	0.074	0.036	0.131
CD (5%)	0.749	0.218	NS	0.876	1.231	0.217	NS	0.386
Interaction (FYM x NPK)								
SE (m)±	0.442	0.129	0.014	0.517	0.727	0.128	0.063	0.228
CD (5%)	NS	NS	NS	NS	NS	NS	NS	NS
CV %	6.59	2.93	3.18	5.52	3.98	4.12	10.06	4.01

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Studies on Anthracnose of Mango (*Mangifera indica* L.) Fruit Caused by *Colletotrichum gloeosporioides* Penz.

Mango is a liked fruit by many of us and belongs to family Anacardiaceae. It is the national fruit of India and rightly known as 'King of fruits' owing to its high palatability, excellent colour, flavour and good nutritive value. It is a major fruit crop among all the important fruit growing states of India, wherein it occupies about 10.40 million ha area with annual production of more than 10.5 million tonnes. The area under mango in Maharashtra was 2,50,000 ha. Konkan is the major region of mango production in Maharashtra wherein it occupies an area of 1.47 lakh ha with 3.67 lakh tonnes production (Anonymous, 2001). In developing countries including India, Post harvest losses of fruits have been estimated to be in the range of 5 to 50 per cent or more of the harvest. Even in the countries with most advanced technologies available, the post harvest losses are substantial (Pathak *et. al.*, 1996). Alphonso is one of the leading commercial cultivars of mango. It thrives and yields best under hot and humid agro-climatic conditions of the Konkan region. Sohi *et. al.*, (1973) reported 29 per cent losses in mango fruits of 'Alphonso' cultivar from Bangalore market from it's harvest to consumption. Fruit rot of mango caused by *C. gloeosporioides* was responsible for severe damage and was of common occurrence.

In the present investigation, ecological association of *C. gloeosporioides* was studied with a view to determine effect of infection on mango fruits. Fresh healthy 'Alphonso' fruits of mango were selected. After surface sterilization, fruits were slightly injured by moving sterilized cotton on fruits surface and bit of mycelium alongwith spores was placed on fruits and the whole fruits were kept in sterilized blotting paper under moisture chamber. Temperature of 28 $\pm$ 1°C and relative humidity above 80 per cent was maintained throughout the experiment. The uninoculated fruit served as a control. Symptoms expressed were recorded after every 24 hours for disease development.

Reisolation was carried out from artificially inoculated fruits. The culture obtained on PDA by reisolation was compared with the original culture obtained from naturally infected mango fruits. The fungus was tentatively identified on the basis of colony and morphological characters and later was conformed to species level by Dr. V.G. Rao, Sr. Mycologist, NIKU, Bioresearch Lab., Pune.

Fungus was reisolated from the infected fruits on PDA. The pure culture was established by single hyphal tip method and finally identified as *C. gloeosporioides*. In case of anthracnose, on mature mango fruits, symptoms like round to irregular spots were produced. These spots became black and sunken at the centre and with raised pale grayish margins. At the initial stages of infection, small pinheads were produced on fruits epicarp which increased in size. In the present investigations. *C. gloeosporioides* during early stages i.e. on third day produced small ground spots and typically sunken spots appeared on fifth day from the date of inoculation. This spots on the surface of fruit enlarged with age and coalesced to cover maximum area of fruit in vitro. Later on these spots coalesced and produced necrotic patches. Such fruits further exhibited rotting symptoms. These results are similar to those of Daquioag and Quimio (1973) who reported that woundered mature green fruits developed typical lesions of anthracnose within 48 hours after inoculation while on wounded ripe fruits in 24 hours. Hasabnis (1984) also proved pathogenicity on Alphonso, Kesar, Dudhpedha and Fernandin cultivars and reported that typical black sunken spots were developed within 48 hours in wounded green mature mangoes. Rathod (1994) reported that on the fruit, anthracnose symptoms initiated as typical black sunken spots within 72 hours in case of unwounded and within 48 hours in wounded fruits of Alphonso mango. Also Gupta and Sharma (2000) reported that C. *gloeosporioides* produce slightly sunken spots on half mature and mature mango fruits.

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Stem End Rot (*Botryodiplodia theobromae* Pat.) : A Serious Post Harvest Disease of Mango (*Mangifera indica* L.) Fruits

Since ancient times, the mango has a place of pride among the fruits in India and it occupies about 10.40 million ha area with annual production of more than 10.50 million tonnes. In Maharashtra, Konkan, is the major region of mango production wherein it occupies an area of 1.47 lakh ha with 3.67 lakh tonnes production (Anonymous, 2001). Eventhough, India is the largest mango producing country in the world, it exports are of a negligible proportion i.e. less than 1 per cent of total production of fruits. Various factors are responsible for the short fall in export. Among these most important being spoilage of fruits during storage and transit. Alphonso is one of the most leading commercial cultivars of mango. It thrives and yields best under hot and humid agroclimatic conditions of the Konkan region. Therefore, the Alphonso cultivar is called as "Pride of the Konkan region" (Cheema and Dani, 1934). Under natural conditions, it was usually observed that rotting initiative from stem end point. Rotting symptoms develop during ripening of fruits (Pathak and Srivastava, 1969). Mango fruits in Udaipur market were reported to have 2.22 to 4.2 per cent infection by *B. theobromae* during April-August. Wounding with a cork borer before inoculation of ripe fruits resulted in 36.24 per cent disease severity (Jagdish Chandra and Pathak, 1989). It was reported that *Botryodiplodia rot* spoiled 4-6 per cent fruits every year in Indian markets (Pathak *et al.*, 1996).

In the present investigation, ecological association of *B. theobromae* was studied with a view to determine effect of infection on mango fruits. For this, fresh healthy Alphonso fruits of mango were selected. After surface sterilization, fruits were slightly injured by moving sterilized cotton on fruit's surface and bit of mycelium alongwith spores was placed on fruit and whole fruit was kept in sterilized blotting paper under moisture chamber. Temperature of 28 $\pm$ 1°C and relative humidity of above 80 per cent was maintained throughout the experiment. The uninoculated fruits served as control. Symptoms expressed were recorded after every 24 hours for disease development.

Reisolation was carried out from artificially inoculated fruits. The culture obtained on PDA by reisolation was compared with the original culture obtained from naturally infected mango fruits. The fungus was tentatively identified on the basis of colony and morphological characters and later was conformed to species level by Dr. V.G. Rao, Sr. Mycologist, NIKU, Biorsearch Lab., Pune.

Stem end rot of mango fruits was observed only in ripened fruits. Typical symptoms of this were observed at petiole region of fruit within 2-3 days from initiation of symptoms and the entire fruit completely rotted. The pulp of affected fruit became soft, discoloured, accompanied with fermentative odour and released black fruit out of the rotten fruit. Fungal infection started at inoculated portion i.e. around petiole. On third day, a small portion around the petiole turned black which enlarged with age, covering half portion on the sixth day and the entire fruit got rotted on eighth day. Wheres uninoculated fruits remained free from infection throughout the experiment. These results are in conformity with those of Hasabnis (1984) who reported that pale yellow to dark brown stem end rot symptoms which appeared within 48 hours on artificially wounded as well as unwounded inoculated fruits. Such fruits rot completely within 2-3 days. Gupta and Sharma (2000) reported that during initial stage the epicarp darkened around the base of the pedicel, latter enlarged to form a circular black patches and rapidly turned to black within 2-3 days. Also, Jadeja (2000) proved pathogenicity of *B. theobromae* on mango fruits on variety Kesar and found that 30°C temperature was optimum for fruit rot development. During present investigation in laboratory, temperature 28 + 1°C and relative humidity above 80 per cent was maintained.

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Impact of Watershed Development Programme on Cropping Pattern and Crop Production

Integrated watershed management is considered as an appropriate approach to develop both arable and non-arable lands in such rainfed areas for increasing and stabilising productivity by adopting improved soil and water conservation measures. Taking into consideration the significance and relevance of the facts, an attempt has been made to evaluate the impact of watershed development programme with the following objectives

1) To estimate the impact of watershed development project on productivity and cost of production of different crops.
2) To assess the changes in the land use pattern and cropping pattern in the project area.

The integrated watershed project in Bhandaraj of Patur tahasil of Akola district was purposively selected for the study. In all, 100 farmers were randomly selected, out of which 50 farmers were beneficiaries and 50 farmers were non-beneficiaries. The primary data were collected through survey technique and by adopting personal interview method using specially structured and pretested questionaires. The data pertained to year 2001-2002.

The watershed management activities are presented in Table 1. The table provides the information about the activities carried out under watershed development programme by the selected farmers. It was revealed from Table 1 that, the total area of 158.83 ha. was benefited by different watershed activities. The highest area (25.65 %) was benefited with the Nala bunding, followed by 20.84 per cent with loose boulder structure activities. Nala cement and Nala training are important activities carried out in the project to give a proper direction to the water stream flowing through the field so as to check the soil erosion and naturally helps to conserve soil moisture in the farmers' field.

The information regarding land holding and cropping intensity is presented in Table 2. It is observed from table that, average size of total holding for the sample as a whole of beneficiary and non-beneficiary farmers were 2.95 ha. and 3.07 ha., respectively. Similarly cropping intensity of beneficiary and non-beneficiary farmers was worked out to 156.61 per cent and 106.27 per cent, respectively.

It is revealed from Table 3 that, the cotton + tur (mix cropping) was the main cash crop beneficiary and non-beneficiary farmers which account to 66.07 and 77.11 per cent, respectively. Similarly wheat and gram crops were also important crops grown by the beneficiary farmers as well as by non-beneficiary in the *Rabi* season which contributed to 13.63 and 9.74 per cent area of beneficiary farmers whereas, it was only 3.54 and 2.73 per cent area of non-beneficiary farmers, respectively.

It has been observed from Table 4 that, the

Table 1. Activities carried out under watershed development programme on selected farmers

S.N.	Name of the activities	Total No. of farmers	Total area covered	Per farm area covered
1.	Granded Bund	10	31.53 (19.85)	3.15
2.	nala training	10	21.75 (13.69)	2.17
3.	Nala bunding	10	40.75 (25.65)	4.07
4.	Loose bolder structure	10	33.07 (20.84)	3.30
5.	Nala cement plug	10	31.73 (19.97)	3.17
	Total area benefited	15	8.83 (100.00)	15.86

(Figures in parentheses indicate percentage to total benefited)

Table 2. Land use pattern and cropping intensity of beneficiary and non-beneficiary farmers

S.N.	Particulars	Area in hectare	
		Beneficiary	Non-beneficiary
1.	Total land holding	2.95	3.70
2.	Fallow land	-	0.22
3.	Net cultivated land	2.95	3.45
4.	Double cropped area	1.67	0.22
5.	Gross cropped area	4.62	3.67
6.	Cropping intensity	156.61	106.27

Table 3. Cropping pattern for selected holding

S.N.	Particulars	Area in hectare	
		Beneficiary	Non-beneficiary
1.	Cotton + Tur	3.05	2.83
		(66.07)	(77.11)
2.	Jowar (*Kharif*)	0.49	0.61
		(10.61)	(16.62)
3.	Wheat	0.63	0.13
		(13.63)	(3.54)
4.	Gram	0.45	0.10
		(9.74)	(2.73)
	Total	4.62	3.67
		(100.00)	(100.00)

(Figures in parentheses indicate percentage to total)

Table 4. Impact of watershed development project on production and productivity

S.N.	Crops		Beneficiary farmers	Non-beneficiary farmers	Different per cent
1.	**Cotton + tur**				
	a) Yield (Q ha^{-1})	Cotton	7.19	3.96	81.56
		Tur	1.32	0.96	37.50
	b) Cost of cultivartion (Cost -C) Rs ha^{-1}		8944.60	7592.16	17.81
	c) Cost of production (Rs q^{-1})		1051.06	1543.12	-31.89
2	**Hy. Jowar**				
	a) Cost of cultivation (Cost -C) Rs ha^{-1}		29.41	17.85	64.76
	b) Cost of production (Rs. Q^{-1})		7589.50	680.60	11.51
	c) Cost of production (Rs Q^{-1})		258.05	381.25	-32.31
3	**Wheat**				
	a) Yield (q ha^{-1})	Cotton + Tur	30.20	19.30	56.47
	b) Cost of production (Cost-C) Rs. ha^{-1}		8541.40	7379.75	15.74
	c) Cost of production (Rs q^{-1})		282.83	382.37	-26.03
4	**Gram**				
	a) Yield (Q ha^{-1})	Cotton + Tur	14.50	9.55	55.83
	b) Cost of cultivation (Cost-C) Rs ha^{-1}		3767.30	3308.80	13.85
	c) Cost of production (Rs Q^{-1})		800.19	749.90	6.70

Table 5. Economics of crop production

S.N.	Particulars	Beneficiary	Non-beneficiary
1.	**Cotton + Tur**		
	a) Total cost of cultivation (Cost -C)	8944.60	7592.16
	b) Gross return	17099.25	97.09.75
	c) Net return	8154.65	2117.60
	d) Input-output ratio (B-C ratio)	1:1.91	1:1.28
2	**Hy. Jowar**		
	a) Total cost of cultivation (Cost C)	7589.50	6806.00
	b) Gross return	15118.00	8514.00
	c) Net return	7528.50	1708.00
	d) Input-output ratio (B-C ratio)	1:1.99	1:1.25
3	**Wheat**		
	a) Total cost of cultivation (Cost C)	8541.40	7379.75
	b) Gross return	16610.30	10617.20
	c) Net return	8068.90	3237.45
	d) Input-output ratio (B-C ratio)	1:1.95	1:1.44
4	**Gram**		
	a) Total cost of cultivation (Cost C)	3767.30	3308.80
	b) Gross return	11602.70	7579.30
	c) Net return	7835.40	4270.50
	d) Input-output ratio (B-C ratio)	1:3.08	1:2.30

cost production was comparatively low at the farmer of the project area that of non-project farmers for all crops. Regarding the productivity gain by the beneficiary farmers recorded to observe hy. *Jawar* 64.76 per cent, wheat 56.47 per cent and in case of gram it was worked out to 55.83 per cent. The higher crop productivity in the project area was observed due to improvement in the soil quality and conservation works on the field of beneficiary farmers. It was also observed that there was increase in their productivity as well as cost of cultivtion compared to those non-beneficiary farmers which indicated the influence of adoption of both the resource conservation and improve production technologies.

From Table 5, it was revealed that, the input-output ratio of beneficiary farmers in cotton + *Tur*, *Jawar*, wheat and gram, the beneficiary were worked out 1:1.91, 1:1.99, 1:1.95, 1:3.08, respectively. Whereas in case of non-beneficiaries, it was 1:1.28 from cotton + *Tur*, 1:1.25 for hy. *Jawar*, 1:1.44 for wheat and 1:2.30 from gram crop.

The field level results have recorded that the Watershed Development Programmes have not only contributed to soil and moisture conservation and additional irrigation benefits but also reduced the cost of production by increasing the productivity as compared to non-beneficiary farm. The land use pattern revealed that the land can be brought under double crop by proper management practices and due to availability and consigning the soil moisture for the future crop. Therefore, the Watershed Development Programme approaches by replicating in other dryland areas for sustained development of agriculture and conserving the sources of natural resources of the area.

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Farmers' Field Level Adoption of Soil and Rain Water Conservation Technology

Adoption is the implementation and actual use of innovations by an individual. The extent of adoption of soil and rain water conservation technology varies from farmer to farmer depending on their attributes.Adoption of soil and rain water conservation mostly depends on situation, needs the financial requirements and its availability. The study was undertaken to assess the extent of adoption of soil and rain water conservation practices by an individual farmer on his field. The present study was planned and undertaken with the specific objective, To study the adoption of soil and rain water conservation technology by the farmers.

The study was undertaken in 10 randomly selected villages of Akola and Akot Panchayat Samiti in Akola district of Maharashtra state. From these a sample of selected villages, a sample of 150 farmers was drawn by using proportionate random sampling method. By adopting exploratory design of social research the requisite data were collected from the selected farmers with the help of an interview in a face to face situation. In order to ascertain the adoption, the low cost and viable soil and rain water conservation technology identified and recommended by the Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola was considered and their adoption was ascertained in terms of area and categorized as complete adoption, partial adoption and non adoption.

Adoption of soil and rain water conservation practices

The distribution of the farmers according to practicewise adoption in Table 1 points out that majority of them had adopted the soil and rain water

Table 1. Practice-wise adoption of soil and rain water conservation practices by farmers

S.N.	Technology	Adoption (n=150)		
		Complete	Partial	No
1.	Summer ploughing	127 (84.66)	18 (12.00)	05 (3.34)
2.	Cultivation of land across the slope	114 (76.00)	16 (10.66)	20 (13.34)
3	Brushwood dam	00 (0.00)	71 (47.34)	79 (52.66)
4	Contour bunding	00 (0.00)	57 (36.00)	93 (62.00)
5	Gully pluggin	00 (0.00)	54 (36.00)	96 (64.00)
6	Earthen bunds	00 (0.00)	81 (60.66)	59 (39.34)
7	Loose boulder structure	00 (0.00)	49 (32.67)	101 (76.00)
8	Broad bed and furrow	00 (0.00)	36.00 (24.00)	114 (76.00)
9	Farm pond	00 (0.00)	63 (24.00)	87 (58.00)
10	Vegetative barrier	00 (0.00)	87 (58.00)	63 (42.00)
11	Mulching	04 (2.67)	102 (76.00)	44 (24.00)

Figures in parentheses indicate percentage

conservation practices, that is, summer ploughing (84.66%) and sowing of crop across the slope (76.00%) on complete potential area under cultivation.

It is worthwhile to note that majority of the farmers were found to be making actual use of vegetative mulching (68.66%), preparing earthen bunds (60.66%), creating vegetative barriers of vetiver and marvel (47.33%) on some of the total cultivable area of their holding.

The practices like summer ploughing, cultivation across the slope and mulching are traditional practices used by the farmers since long and therefore their adoption was on large scale. Secondly, the practices like vegetative barrier, earthern bunds and brushwood dams are nearer to the traditional practices and hence they are congruent to old practices. The farmers had adoped them partially. The third set of practices namely, contour bunding, gully plugging, loose boulder structures and broad bed and furrow are relatively new to the farmers and hence their adoption was on lower side. These findings conform the observations of Bhople (1997), Farooq *et. al.*, (1997) and Khatik (1999).

On the basis of the above observations, it can be concluded that more attention need to be paid on the introduction of new and non-congruent practices. The farmers need to be conceived about the utility of these practices by showing them these practices in the field. Their mental set up is required to be changed about these practices for increasing adoption.

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Resource Use Efficiency in Wheat Cultivation in Agro-climatic Zone II-A of Rajasthan

Rajasthan is one of the wheat growing state in India and it constitutes 9.75 per cent (6.9 million tonnes) of the total wheat production in the country. The state having diversities in climatic conditions has been divided into ten agro-climatic zones. Agro-climatic zone II-A cover four districts namely Sikar, Nagaur, Jhunjhunu and eastern part of Churu district. Wheat is one of the important *Rabi* cereal crops in this zone. It occupies 79 per cent (2.25 lakh) area and 87 per cent (4.00 lakh tonnes) production of total *Rabi* cereal crops (Statistics, 2001). The purpose of the study was to evaluate the efficiency with which wheat growers in zone II-A of Rajasthan use their resources to maximise their farm earnings. An attempt was also made to study the resource use efficiency in different categories of farms for suggeting shift of resouces from one category to another category sothat resources could be optimally used.

The zone II-A comprises 22 tehsils distributed among the four different districts namely Sikar, Jhunjhunu, Nagaur and Churu district. Six tehsils were selected by simple random sampling in proportion to total number of tehsils in each district. From each selected tehsil, one agriculture supervisor circle and from each circle two villages were randomly selected. According to holding farmers were divided into three different size group namely small (up to 2 hectares), medium (above 2 to 6 hectares) and large (above 6 hectares). The proportionate number of farmers were selected randomly from 12 selected villages, which were 90, 65 and 25 from small, medium and large farms, respectively. Thus in all 180 farmers were included for the purpose of the study.

The primary data were collected through direct personal interview with the respondents. Whole data were collected by the survey method pertaining to the year 2000-2001. The Cobb-Douglas production function was used for analysis of data.

The regression coefficient (Table 1) of land was positive in medium (0.3358) and all farm (0.0944) but negative in small (-0.1839) and large farms (-0.7687). The regression coefficient of human labour and machine labour were found to be highly significant in small (0.8846 and 0.3747), medium (0.6321 and 0.3218) and all farms (0.8535 and 0.2729), respectively. MVP to MFC ratio was greater than one in small, medium and all farms. The regression coefficient of irrigation and manure and fertilizers were the major factors contributing to gross income, whereas in small farms it was negative (-0.1446 and -0.0374). MVP to MFC ratio was greater than one in medium farms.

The results indicated that human labour, machine labour, irrigation and manure and fertilizers were the chief components that significantly contributed in the gross income of medium farms. While human labour and machine labour were under-utilised and land, bullock labour, seed and manure and fertilizers over-utilized in respect of farmers having large holding. Human labour and machine labour contributed significantly in gross income in respect of small and all farms. It is suggested that reallocation of resources like land, irrigation and manure and fertilizers, minimise of other resources such as bullock labour and seed will greatly increase the gross income of farmers in wheat cultivation.

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Table 1. Regression coefficient and MVP to MFC ratio of wheat cultivation in respect of small, medium and large farms.

Size group	Regression coefficient (elasticity of coefficient)									
	Intercept	Land (ha)	Human labour (Rs.)	Bullock labour (Rs.)	Machine labour (Rs.)	Irrigation (Rs.)	Seed	Manure & fertilizer (Rs.)	Sum of elasticity return to scale	R^2
	a	X1	X2	X3	X4	X5	X6	X7		
Small	0.3702	-0.1839	0.8846**	0.0018	0.3747*	-0.1446*	0.0628	-0.0374	0.9580	0.8182
	-	(0.3700)	(0.2604)	(0.0083)	(0.1715)	(0.0717)	)(0.2610)	(0.0365)		
MVP : MFC	-	-4.021.65	3.79	193.99	2.92	-1.64	1.40	-0.48		
Medium	1.9699	0.3358	0.6321**	-0.0106	0.3218**	0.1895*	-0.3417	0.1564*	1.2833	0.9115
		(0.2815)	(0.2277)	(0.0075)	(0.1026)	(0.0806)	(0.2106)	(0.0652)		
MVP : MFC		6609.44	2.88	-1128.17	2.96	2.06	-6.38	1.66		
Large	-4.1253	-0.7687	1.5365	-0.0332	0.3668	0.0266	-0.1801	-0.0392	0.9087	0.4037
		(1.4785)	(1.6304)	(0.0421)	(0.7391)	(0.5476)	(1.1082)	(0.6792)		
MVP : MFC		-	8.80	-	4.40	0.31	-3.42	-0.45		
		16185.57		31939.38						
Overall	0.7887	0.0944	0.8535**	-0.0057	0.2729**	0.0151	-0.0544	0.0258	1.2015	0.8016
		(0.2813)	(0.2325)	(0.0070)	(0.1059)	(0.0731)	(0.2003)	(0.0444)		
MVP : MFC		1957.40	3.98	-951.62	2.49	0.17	-1.09	0.30		

** Significant at one per cent level, * Significant at five pre cent level

R^2 = Coefficient of multiple determination, MVP = Marginal value product, MFC = Marginal factor cost

Note : Figures in parentheses indicate the respective standard error

Post Harvest Life of Nagpur Mandarin Fruit as Influenced by Chemicals

Mandarin is highly perishable at ambient temperature and needs transportation period over 10 days to reach the parts of importing countries. It is necessary to extend its storage life by maintaining its market quality. Saraswathi and Azhakiamanavalan (1996) observed better shelf life of mandarin and sweet orange, respectively using 2, 4-D chemical treatment. Sandhu *et al.*, (1989) reported that the reduction in weight loss by bavistin treatment might be due to inhibition of germination of spores and by delaying the appearance of blue molds. Bhullar *et al.*, (1981) found that the cycocel gave better retention of juice indicating thereby a slower rate of dehydration. Among the alternative means, short period of storage, which are likely to prove more helpful, storage of fruits by the application of growth regulators is the most recent and successful method. A trial was undertaken at Department of Horticulture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.), India, during October 2002.

Freshly harvested, well-matured fruits having uniform size and colour were brought to the laboratory on 26th October, 2002. The trial was laid out in completely randomized design with 11 treatments having 5 replications.

The fruits were washed, air-dried and were dipped for 15 min. separately in each solution meant for each treatment. The chemically treated fruits were dried and kept in single layer in ventilated corrugated fibreboard boxes that were kept in laboratory at room temperature. The room temperature and relative humidity ranged from 15°C to 32.5°C and 38.6 to 70 per cent, respectively.

It was observed that the percentage loss in weight of the whole fruit was considerably lowered when the fruits were treated with NaCl 1% in combination with Cycocel 500 ppm and 2,4-D 500 ppm. treated fruits as compared to all other treatments, followed by treatment T_8 i.e. NaCl 1% + 2,4,D 500 ppm and (10.72%) followed by T_{10} i.e. Bavistin 1000 ppm (12.42%) after 35 days of storage. Whereas weight loss was found to be maximum in control (39.60%). The weight loss in fruits increased with the length of storage period.

The check in physiological weight loss may be due to the retardation of process of transpiration and respiration, which is lower during storage. The cycocel also causes the slower rate of dehydration thereby decreasing the physiological loss in weight of fruits. More the rate of dehydration more will be the physiological loss. The 2, 4-D was also found to be effective to reduce the physiological loss in weight. The weight loss reduction due to bavistin might be the reason that bavistin has its inhibiting

Table 1: Effect of post harvest treatments on the PLW (%) and diameter of Nagpur mandarin fruit (cm) at room temperature

Treat-ments	Particulars	PLW (%) Days after storage			Diameter (cm) Days after storage		
		7	21	35	7	21	35
T_1	NaCl 1%	8.59(2.93)	17.22(4.14)	33.11(5.75)	4.84	4.74	4.56
T_2	GA_3 200 ppm	8.29(2.87)	16.03(4.00)	32.41(5.69)	4.96	4.75	4.67
T_3	Cycocel 500 ppm	7.41(2.72)	7.92(2.80)	14.92(3.86)	5.10	4.99	4.84
T_4	2,4-D 500 ppm	8.74(2.95)	15.75(3.96)	36.24(6.01)	5.10	4.95	4.69
T_5	2,4,5-T 100 ppm	8.39(2.87)	16.22(4.02)	29.40(5.42)	5.00	4.79	4.64
T_6	NaCl 1%+ GA_3 200 ppm	7.43(2.72)	9.32(3.04)	20.24(4.49)	4.96	4.90	4.73
T_7	NaCl 1%+ Cycocel 500 ppm	7.11(2.66)	7.43(2.72)	9.18(3.02)	5.10	5.05	4.90
T_8	NaCl 1%+ 2,4-D 500 ppm	7.39(2.71)	7.56(2.74)	10.72(3.27)	5.07	5.00	4.92
T_9	NaCl 1% + 2, 4, 5-T 100 ppm	7.40(2.72)	8.21(2.86)	18.43(4.29)	5.08	4.94	4.79
T_{10}	Bavistin 1000 ppm	7.40(2.72)	7.62(2.76)	12.42(3.52)	5.02	4.96	4.84
T_{11}	Control (water dip)	8.62(2.92)	17.28(4.15)	39.60(6.29)	4.79	4.72	4.58
	CD at 5%	0.02	0.03	0.02	0.17	0.14	0.2

(Figures in parentheses are square root transformations)

Table 2: Effect of post harvest treatments on the juice content (%)

Treatments	Particulars	Juice content (%)			Shelf life
		7	21	35	(days)
T_1	NaCl 1%	67.60	41.41	32.97	18.82
T_2	GA_3 200 ppm	46.62	40.86	33.60	20.90
T_3	Cycocel 500 ppm	46.81	42.08	35.95	26.70
T_4	2,4-D 500 ppm	46.69	41.02	34.88	20.32
T_5	2,4,5-T 100 ppm	47.38	41.97	33.78	23.80
T_6	NaCl1%+$GA_3$200 ppm	47.65	42.10	34.39	23.99
T_7	NaCl 1%+Cycocel 500 ppm	49.16	45.78	39.41	31.32
T_8	NaCl 1%+ 2,4-D 500 ppm	48.95	43.90	36.26	29.56
T_9	NaCl 1%+ 2,4,5-T 100 ppm	47.60	42.48	35.41	25.76
T_{10}	Bavistin 1000 ppm	47.45	42.49	36.26	29.02
T_{11}	Control (water dip)	45.93	39.96	33.87	17.01
	CD at 5%	0.40	0.91	0.18	0.64

effect on respiration rates of the fruits as a result of which, the treated fruits were firmer as compared to control.

The diameter of fruit decreased with increasing storage period. The least change in diameter of fruit at 35 days was found in treatment T_8 (4.92 cm), T_7 (4.90 cm) and T_{10} (4.84 cm) as compared to control (4.58 cm). Due to loss of weight and juice content of fruit, the diameter of fruit decreases. Juice content was decreased with the increasing storage period and it can be directly correlated with the loss of fruit weight due to evapotranspiration and respiration.

The treatment T_7 was found to be significantly superior over all other treatments in respect of shelf life and recorded the maximum shelf life of 31.32 days, followed by treatments T_8 (29.56 days) and T_{10} (29.02 days), which were found at par with each other. Significantly minimum shelf life of fruit was recorded in treatment T_{11} i.e. control (17.01 days) followed by treatment T_1 (18.82 days).

From these findings, it can be concluded that cycocel, 2,4-D along with NaCl 1 per cent and bavistin was found to be effective in increasing the shelf life of mandarin fruit. Shelf life of fruit was significantly influenced by the chemical treatments.

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Response of Different Levels of Nutrients and PSB on Fruit Yield and Economics of Sapota

Sapota is the important fruit crop of Vidarbha and day by day area under this crop is increasing. But little information is available on the nutrient management of this crop in Vidarbha. By adopting appropriate application of fertilizers to sapota, the efficiency of absorption and utilization of fertilizer nutrients can be enhanced, leading to prevention of loss and economy of their use. Many of the recommendations are based on ad-hoc basis. Unlike in other fruit crops, no schedule of fertilization is practiced by farmers in sapota. Even today fertilization of sapota is unknown practice. The productivity of sapota in the region is very low. This is due to many factors and one of the important factor is nutrition. Therefore, integrated nutrient management assumed to be more important in sapota. In view of this and considering the importance of sapota crop in commercial horticulture, the experiment was undertaken to standardize the nutritional requirement for the region.

A field experiment on nutrient management in sapota cv. Kalipatti was conducted at University Department of Horticulture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.) on 30 years old trees in five consecutive years (1999, 2000, 2001, 2002 and 2003) in randomized block design with four replciations and six treatments comprised 75 kg FYM + 1500 g N + 1000 g P_2O_5 + 500 g K_2O, 75 kg FYM + 1500 g N + 1000 g P_2O_5 + 500 g K_2O + 12.5 g PSB, 112.5 kg FYM + 1000 g N + 600 g P_2O_5 + 300 g K_2O, 150 kg FYM + 500 g N + 300 g P_2O_5 + 150 g K_2O, 187.5 kg FYM and 75 kg FYM tree^{-1}. Recommended cultural practices were adopted for proper upkeep of sapota plantation. FYM, NPK and PSB were applied as per the treatments. Nutrients viz. N, P_2O and K_2O were applied through urea, single super phosphate and muriate of potash, respectively. FYM was applied in the month of May and NPK fertilizers were applied in two split doses i.e. in the month of July and September followed by irrigation.

Furit yield

It is evident from the data given in Table 1 that different fertilizer treatments showed significant influence on number of fruit tree^{-1} and weight of fruit plant^{-1}. Significantly, maximum fruit yield tree^{-1} in terms of number (2230.50) and weight (204.48 kg) were produced by the plant receiving 75 kg FYM + 1500 g N + 1000 g P_2O_5 + 500 g K_2O + 12.5 g PSB tree^{-1} (T_2). This was followed by treatment T_1, T_4 and T_3 and were at par with each other. However, significantly minimum fruit yield in terms of number (1645.20) and weight (113.75 kg) were recorded in treatment T_6 (75 kg FYM), followed by treatment T_5 (187.5 kg FYM). This

Table 1. Number of fruits tree^{-1} under different treatments

Treatments	Average no. of fruits plant^{-1}					Pool
	1999	2000	2001	2002	2003	mean
T_1 - 75 kg FYM + 1500 g N + 1000 g P_2O_5 + 500g K_2O	1833.50	2872.50	3049.00	1092.50	1156.00	2000.70
T_2 - 75 kg FYM + 1500 g N + 1000 g P_2O_5 + 500 g K_2O + 12.5 g PSB	2000.00	3062.75	3040.00	1146.00	1903.75	2230.50
T_3 - 112.5 kg FYM + 1000 gN + 600 g P_2O_5 + 325 g K_2O	1480.00	2805.50	2920.00	892.50	1486.75	1916.95
T_4 - 150 kg FYM + 500 g N + 300 g P_2O_5 + 150 g K_2O	1533.00	2697.50	2976.00	1073.50	1450.50	1946.10
T_5 - 187.5 kg FYM	1410.00	2638.75	2676.00	930.00	1327.00	1796.35
T_6 - 75 kg FYM	1266.00	2412.50	2576.00	820.00	1151.50	1645.20
SE (m) $\pm$	21.76	29.22	52.85	60.40	22.34	38.49
CD at 5%	61.12	82.08	156.86	182.10	66.76	113.74

Table 2. Weight of fruit tree^{-1} under different treatments

Treatments		Average no. of fruits plant^{-1} (kg)					Pooled
		1999	2000	2001	2002	2003	Mean
T_1	75 kg FYM + 1500 g N + 1000 g P_2O_5 + 500g K_2O	129.01	220.99	221.92	83.06	86.18	148.26
T_2	75 kg FYM + 1500 g N + 1000 g P_2O_5 + 500 g K_2O + 12.5 g PSB	175.00	290.70	275.12	107.73	173.85	204.48
T_3	112.5 kg FYM + 1000 gN + 600 g P_2O_5 + 325 g K_2O	120.47	248.64	245.57	73.76	127.63	164.21
T_4	150 kg FYM + 500 g N + 300 g P_2O_5 + 150 g K_2O	131.88	253.39	264.33	99.61	130.89	175.64
T_5	187.5 kg FYM	99.12	202.77	195.17	71.61	98.07	133.10
T_6	75 kg FYM	82.46	175.93	172.19	58.95	79.93	113.75

Table 3.Average fruit weight under different treatments

Treatments		Average no. of fruits plant^{-1} (kg)					Pooled
		1999	2000	2001	2002	2003	Mean
T_1	75 kg FYM + 1500 g N + 1000 g P_2O_5 + 500g K_2O	70.50	77.00	73.00	76.20	74.55	74.25
T_2	75 kg FYM + 1500 g N + 1000 g P_2O_5 + 500 g K_2O + 12.5 g PSB	873.50	95.00	90.50	94.50	91.50	91.80
T_3	112.5 kg FYM + 1000 gN + 600 g P_2O_5 + 325 g K_2O	81.40	88.80	84.10	88.30	85.89	69.42
T_4	150 kg FYM + 500 g N + 300 g P_2O_5 + 150 g K_2O	86.20	94.20	89.00	93.10	90.20	90.54
T_5	187.5 kg FYM	70.30	77.10	73.10	77.00	74.30	74.36
T_6	75 kg FYM	64.45	73.00	67.00	71.90	69.45	69.36
	SE (m) ±	0.783	0.367	0.550	0.580	0.175	1.01
	CD at 5%	2.199	1.033	1.547	1.629	2.133	----

Table 4. Analysis of benefit cost ratio

Treatments		Total expenditure tree^{-1} (Rs.)	Total return tree^{-1} (Rs.)	Net profit tree^{-1} (Rs.)	Added cost over control	Added returns over control	B:C ratio
T_1	75 kg FYM + 1500 g N + 1000 g P_2O_5 + 500g K_2O	74.72	1481.50	1046.78	37.22	344.00	9.24
T_2	75 kg FYM + 1500 g N + 1000 g P_2O_5 + 500 g K_2O + 12.5 g PSB	75.47	2044.80	1969.33	37.97	907.30	23.89
T_3	112.5 kg FYM + 1000 gN + 600 g P_2O_5 + 325 g K_2O	80.86	1642.10	1561.24	43.36	504.6	11.63
T_4	150 kg FYM + 500 g N + 300 g P_2O_5 + 150 g K_2O	87.20	1756.40	1669.20	49.70	618.90	12.45
T_5	187.5 kg FYM	93.75	1331.0	1237.25	56.25	193.50	3.44
T_6	75 kg FYM	37.5	1137.50	1100.00	–	–	–

might be due to more nutrient uptake with increasing level of NPK which in term resulted into more synthesis of nucleic amino acids and amino substances in growing region.And thus, meristematic tissues ultimately enhancing cell division. This may be attributed to the fact that, increasing levels of nutrients in assimilating area of crop due to which the rate of dry matter production was enhanced. Similarly, due to rational partitioning of dry matter to economic sink, the yield attributes were improved. The above results are in conformity with the findings of Batha *et. al.*, (1986), Chang and Kurtz (1983) and Prasad *et. al.*, (1970).

Benefit cost ratio

The data presented in Table 3, also recorded the highest B:C ratio (23.89) in the plants received 75 kg FYM + 1500 g N + 1000 g P_2O_5 + 500 g K_2O + PSB 12.5 g $plant^{-1}$ which was followed by trees received 150 kg FYM + 500 g N + 300 P_2O_5 + 150 g K_2O. The lowest B:C ratio was observed in treatment T_5 (3.44).

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Effect of Chemical on Shelf Life of Orange During Storage

The perishable nature of orange is the main constraint affecting net return from the crop. These fruits cannot be stored conveniently in storage structure. But, however such facilities are limited and beyond the reach of ordinary farmers. Therefore, it is important to suggest convenient and effective method of fruit storage to the farmer, trader and canning industries. Among the alternative means of short period storage, which are likely to prove more helpful, is the storage of fruits by the application of growth regulators that is the most recent and successful method. Hence a study was conducted at Dr Panjabrao Deshmukh Krishi Vidyapeeth, Akola to evaluate the effect of chemical changes and shelf life of orange during storage.

Freshly harvested, well-matured fruits having uniform size and colour were brought to the laboratory on 26th October 2002. The trial was laid out in completely randomized design with 11 treatments having 5 replications. The treatments tried were NaCl (1%), GA_3 (200 ppm), cycocel (500 ppm), 2,4-D (500 ppm), 2,4,5-T (100 ppm), NaCl (1%) + GA_3 (200 ppm), NaCl (1%) + cycocel (500 ppm), NaCl 1% + 2,4-D (500 ppm), NaCl (1%) + 2,4,5-T (100 ppm), Bavistin (1000 ppm) and control.

The fruits were washed in running tap water and then air-dried. Then the fruits were dipped for 15 minutes separately in each solution meant for each treatment. After these treatments, fruits were allowed to dry and kept in single layer in ventilated corrugated fiberboard boxes. Then boxes were kept in laboratory at room temperature. Temperature and relative humidity in the room was recorded. The observations on chemical changes in fruits were recorded at 15 days intervals up to a period of 35 days. The data on initial fruit quality was also recorded at the time of the experiment initiation. For chemical analysis the methods of A.O.A.C. (1985) were followed. The room temperature and relative humidity ranged from 15°C to 32.5°C and 38.6 and 70 per cent, respectively. The other observations are discussed below.

Total soluble solids (TSS) (%) and Titrable acidity (%)

TSS increased during storage, which was probably due to the hydrolysis of polysaccharides and concentration of juice as a result of dehydration. TSS generally increased with the prolongation of the storage period. The cause of high TSS content in control may be due to high rate of dehydration. These results are in general agreed with the results reported by Jawanda *et al.* (1978).

The total titrable acidity in Nagpur mandarin fruits decreased during storage, which might be due to the utilization of the same by the respiratory process. The acidity decreased with the increase of storage period. Treatment T_7 retained maximum acidity probably due to slower rate of respiration Similar results were observed by Siddiqui and Gupta, (1995) in ber. These findings correspond with Kohli and Bhambota (1966) in lime in case of 2,4-D.

Reducing and non-reducing sugars (%)

Reducing and non-reducing sugars in juice of Nagpur mandarin fruit increased during storage which was probably due to the hydrolysis of polysaccharides and concentration of juice as a result of dehydration. The sugars generally increased with the prolongation of storage period. Jawanda *et al.* (1978). From the present findings cycocel, 2,4-D and bavistin result in least change in reducing and non-reducing sugar. Similar results were observed by Bhullar *et al.* (1981) in case of 2,4-D and Sandhu *et al.* (1989) in case of bavistin.

Ascorbic acid (mg 100 g^{-1} juice)

The ascorbic acid content recorded a progressive decline throughout storage period. After 35 days of storage maximum ascorbic acid (21.10 mg 100 g^{-1} juice) was retained by T_7 followed by T_8 (20.80 mg 100 g^{-1} juice).

The cause of retaining minimum ascorbic acid in untreated fruit may be due to rapid loss of ascorbic acid through oxidation. Cycocel and 2,4-D in combination with NaCl 1 per cent might have reduced the rate of oxidation thereby reducing loss of ascorbic acid resulted in retention of ascorbic acid (Bhullar 1981).

The shelf life of the fruits treated with NaCl 1 per cent + cycocel 500 ppm (T_7) was observed to be the highest (31.32 days), followed by T_8 (28.56 days) and minimum in T_{11} (17.01 days).

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