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Effect of Operational Speed on Incorporation and Chopping Efficiency of Rotary Tiller for *In-situ* Incorporation of Green Manural Crops

R. V. Adake[1], V. M. Mayande[2], A. C. S. Kumar[3], I. Srinivas[4] and B. S. Reddy[5]

ABSTRACT

Critical components of rotary tiller have been modified for *in-situ* incorporation of green manural crops and its performance was studied at various operational speeds in comparison with existing rotary tiller. The results revealed that operational speeds had significant effect on incorporation and chopping efficiency of both the models ($P \geq 0.001$). Moreover, the performance of modified rotary tiller was superior to existing model at all the speeds and type of crop incorporated. Peripheral speed of 3.6 m/s and forward speed of 0.7 m/s were found to be optimum for *in-situ* incorporation of green manural crops.

Incorporation of green manural crops is a function of farm implement. Desirable aspects for decomposition viz., depth of placement (Douglas *et al*. 1980), straw length (Christian and Miller, 1986), homogeneous mixing of soil and biomass (Kollar, 1976) are dependent on incorporation tool characteristics. Achievement of all these aspects in single operation helps in adoption of practice on wider scale. In this view, incorporation with rotary tiller is best option as it facilitates uprooting of biomass, fragmentation, mixing with soil homogenously and placed in soil below the surface in single operation. However, incorporation and chopping efficiency of existing rotary tiller is very low.

Rautary (2004) reported that incorporation efficiency of paddy straw with existing rotary tiller was only 42 per cent, more or less similar efficiency was observed during in-situ green manural crop incorporation (Anonymous, 2004). Entangling of crops on central shaft of rotary tiller is one of the major constraints because of which efficiency of existing rotary tiller is low for *in-situ* green manural incorporation. Keeping this point in view, critical components of rotary tiller have been modified for improving efficiency of biomass incorporation. This paper focused on comparative effect of operational parameters on Incorporation and chopping efficiency of Modified and Existing rotary tiller during *in-situ* incorporation of green manural crops.

MATERIAL AND METHODS

The experiment was conducted in Alfisol at Hayatnagar Research Farm, Central Research Institute for Dryland Agriculture, Hyderabad (AP). Detials of two models tested for *In-situ* incorporation of green manural crops is given below

Modified Rotary Tiller: Modified rotary tiller consisted (i) 'L' blade of horizontal chord with 105°bent in cutting edge of the chord. Bending angle has reduced gradually to 90° to its passive edge (ii) Circular MS sheets were cut in two equal shelves and fixed on central shaft of rotary tiller between two flanges. Modified assembly with L-blade and Discs is shown in Plate-1. (iii) Compression reel has twelve MS flats (1200 x 20 X 3 mm) fixed longitudinally on five circular MS plates (170 mm Ø). Compression reel is fixed ahead of rotor using extended frame (Plate-2). Compression reel is self-rotary and its rotation is dependent on forward speed of tractor.

Existing Rotary Tiller: Existing rotary tiller consisted 32 L-blades on central shaft arranged in helical manner as shown in Plate-3.

Details of Experiment: Performance of these two models was evaluated at various levels peripheral and forward speed during in-situ incorporation of three green manural crops in similar soil conditions. Incorporation and Chopping efficiency were taken as measure of performance output. Details of

1. Scientist, Senior Scale, Central Research Institute for Dryland Agriculture, Hyderabad, 2. Vice Chancellor, Dr. PDKV, Akola, 3. Professor, Jawaharlal Nehru Technological University and 4 &5. Senior Scientist, CRIDA, Hyderabad

Table 1. Experimental Details

S. N.	Particulars	Details
1.	Machines (2)	Model-1: Modified Rotary Tiller Model-2: Existing Rotary Tiller
2.	Peripheral speeds, m/s (5)	1.6, 2.6, 3.6, 4.6, and 5.6
3.	Forward Speeds m/s (5)	0.44, 0.66, 1.20, 1.78 and 2.67
4.	Green manural crop (3)	Cowpea, Horsegram and Sunhemp
5.	Observations (2)	(i) Incorporation efficiency, % (ii)Chopping efficiency, %

experiment are given in Table-1. All tests were carried out with 45-hp MF tractor. Peripheral speeds of rotary tillers were recorded at different engine speeds in idle run by using Digital Tachometer, and the same engine speed were used to operate rotary tiller in field. For forward speed, rotary tiller was operated in Ist, IInd , IIIrd, IVth and Vth gear. The corresponding forward speeds were measured in field conditions.

Determination of Incorporation Efficiency (η_i) :

The amount of biomass on surface was quantified in each treatment plot before incorporation i.e., before running the machine. The machine was operated for sufficient length i.e., 20-40 m length for each test. After incorporation, 1-m^2 area was selected randomly in each treatment plot. Metal template of size 50 X 50 X 5 cm was used for collection of samplings. The biomass placed on the surface was collected by hand. For collecting biomass at different depth levels care was taken not to disturb the biomass lying at boundaries. Surrounding soil was gently removed by hand trowel and biomass lying at boundaries was collected carefully by using serrated knife. The biomass collected from each depth range was cleaned thoroughly by gentle brushing to remove adhered soil and then plant biomass was weighed by electronic balance. Three replications were taken to calculate mean values. η_i was calculated as given below,

$$\eta_i\% = [(W_a - W_b)/W_a]*100 \quad .....(1)$$

Where W_a is weight of biomass on surface before incorporation (g) and W_b is weight of biomass left on surface after incorporation (g)

Determination of Incorporation Efficiency (η_c): To determine η_c , the sub samples of biomass having chopped length less than 8 cm were collected randomly from 1 m^2 area, cleaned if any adhered soil using brush and weighed. Three samples were taken and the data was averaged to get the mean value. η_c was calculated with equation given below,

$$\eta_c\% = [W_c/W_f]*100 \quad .....(2)$$

Where, W_f is weight of biomass before incorporation (g) and W_c is weight of biomass of chopped length below 8 cm (g). This size was considered to be maximum limit to avoid clogging during sowing operation. Statistical analysis was done using SPSS package.

RESULTS AND DISCUSSION

Effect of peripheral speeds on η_i : Results from Table-2 showed that highest η_i of modified rotary tiller was obtained at 4.6 m/s peripheral speed and it was also true for existing model though incorporation was comparatively lower than modified rotary tiller. At this speed, η_i of modified rotary tiller was 72 per cent (942 g/m2) for cowpea, 74 per cent (779 g/m2) for horsegram, and 63 per cent (881 g/m2) for sunhemp as against 45 per cent (593 g/m2), 51 per cent (543 g/m2) and 35 per cent (493 g/m2), respectively, with existing rotary tiller. Higher η_i in modified rotary tiller was attributed to increased amount of soil stir and interaction between blade and biomass. It was also due to fact that disc inserted along with L-blade in modified rotary tiller reduced biomass entangling on rotor shaft greatly.

In all three crops average η_i ranged from 37 to 71 per cent in modified rotary tiller and 34 to 44 per cent in existing rotary tiller for changing the peripheral speed from 1.6 m/s to 5.6 m/s. Relationship between η_i of these models and peripheral speeds is shown better by polynomial curve of second degree equation (Fig-1). Trend in η_i of these two models for various peripheral speed showed that η_i were increased non-linearly with increase in speed. It is

Table 2. Rotary tiller's performance at different peripheral speed on *in-situ* biomass incorporation

Treatments	Crops	Amount of biomass before incorporation, g/sq. m	Biomass after incorporation (g/sq.m) at different peripheral speeds, m/s				
			1.6	2.6	3.6	4.6	5.6
Amount of biomass incorporated in soil							
Newly Developed	Cowpea	1308	511	684	905	942	948
Rotary Tiller	Horsegram	1056	461	573	768	779	792
	Sunhemp	1396	404	538	821	881	907
Existing Rotary	Cowpea	1308	449	505	581	593	591
Tiller	Horsegram	1056	434	482	537	543	547
	Sunhemp	1396	375	405	515	493	500
Amount of chopped biomass below 80 mm							
Newly Developed	Cowpea	1255	267	621	886	924	912
Rotary Tiller	Horsegram	992	209	491	642	669	659
	Sunhemp	1354	202	514	777	852	835
Conventional	Cowpea	1255	242	323	478	471	456
Rotary Tiller	Horsegram	992	190	274	367	354	340
	Sunhemp	1354	141	236	299	311	303

Table 3. Statistical analysis for Table-2

Source	Type III Sum of Squares	df	Mean Square	F	Significant at P
Amount of biomass Incorporated straw					
Machine (M)	908218.678	1	908218.678	4071.310	<0.001
Speeds (S)	923093.378	4	230773.344	1034.497	<0.001
Crops (C)	125488.422	2	62744.211	281.266	<0.001
M x S	216473.822	4	54118.456	242.599	<0.001
M x C	13672.289	2	6836.144	30.645	<0.001
M x S x C	7560.044	8	945.006	4.236	<0.001
Error	13384.667	60	223.078		
Total	**35021597.000**	**90**			
Amount of chopped straw					
Machine (M)	2161940.011	1	2161940.011	3832.246	<0.001
Speeds (S)	2019310.267	4	504827.567	894.855	<0.001
Crops (C)	280828.022	2	140414.011	248.897	<0.001
M x S	513852.044	4	128463.011	227.713	<0.001
M x C	72982.956	2	36491.478	64.685	<0.001
M x S x C	28311.156	8	3538.894	6.273	<0.001
Error	33848.667	60	564.144		
Total	**25360575.000**	**90**			

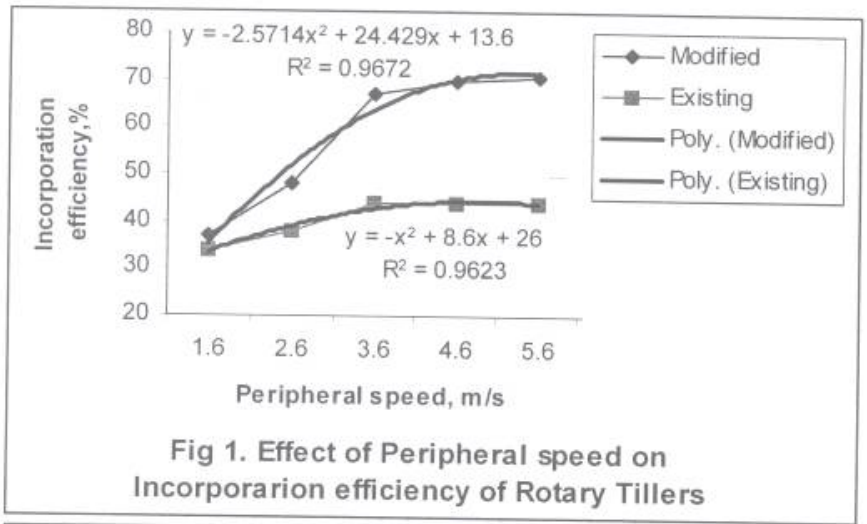

Fig 1. Effect of Peripheral speed on Incorporarion efficiency of Rotary Tillers

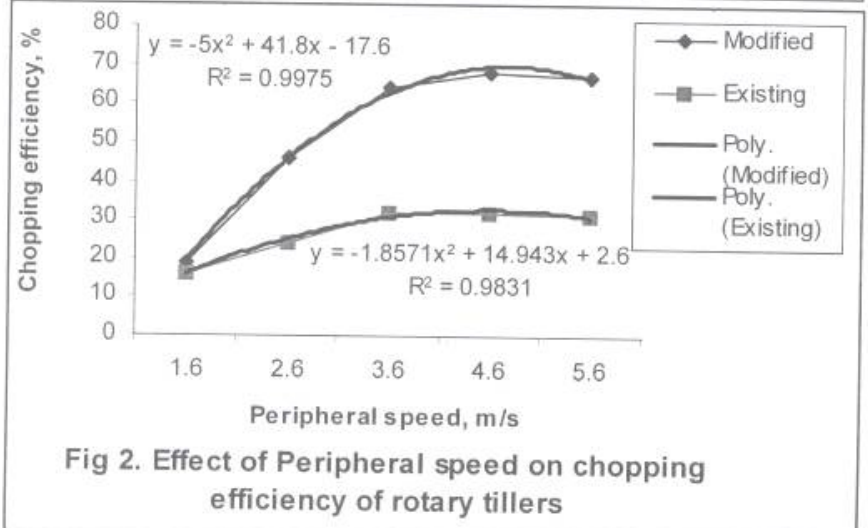

Fig 2. Effect of Peripheral speed on chopping efficiency of rotary tillers

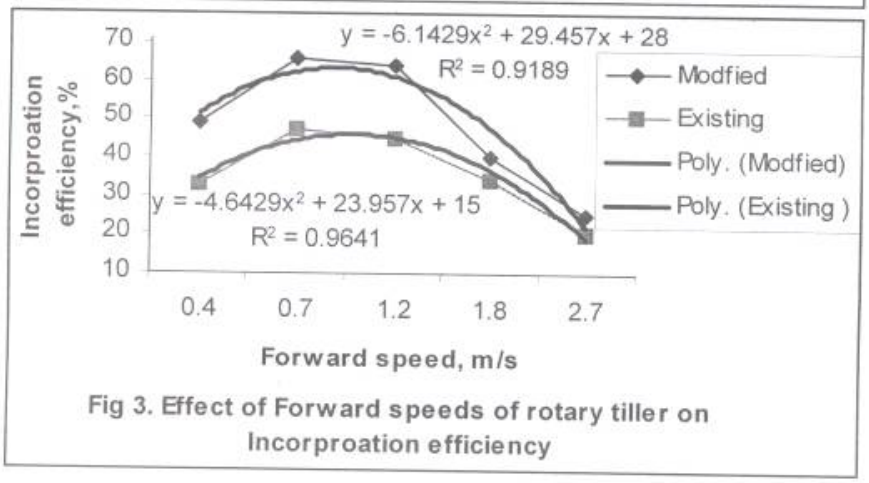

Fig 3. Effect of Forward speeds of rotary tiller on Incorproation efficiency

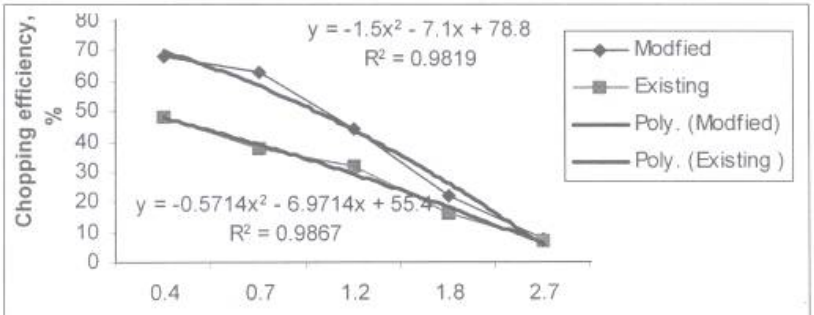

Fig.4 Effect of Forwrads speed of rotary tiller on chopping efficiency

observed that η_i was increased from 37 per cent to 67 per cent in modified rotary tiller and 34 per cent to 44 per cent in existing rotary tiller when peripheral speed increased from 1.6 to 3.6 m/s, which was significantly, but, further increase in peripheral speed had negligible effect on incorporation efficiency and it was true for both models. Significant increase in η_i with increased peripheral speed from 1.6 to 3.6 m/s was mainly due to increase amount of soil stir due to impact of rotary blades along with better mixing of soil and biomass. These observations are in agreement with Sharda and Singh (2004). Although, there was slight improvement after 3.6 m/s benefit of η_i may be ignored to protect engine from overloading (Edmundo 1985). Statistical analysis showed that variation in amount of biomass incorporated in soil is significantly differed with ($P<0.001$) peripheral speed, models of rotary tiller and crop type (Table 3.)

Effect of peripheral speeds on η_c: Results from Table 2 also showed that highest η_c of modified rotary tiller was obtained at 4.6 m/s peripheral speed and it was also true for existing model though broken straw was low. At this speed, η_c of modified rotary tiller was 73 per cent for cowpea (924 g/m2), 67 per cent (669 g/m2) for horsegram and 63 per cent for sunhemp at 4.6 m/s peripheral speed as against η_c of 38 per cent (471 g/m2), 35 per cent (354 g/m2), 23 per cent (311 g/m2) with existing rotary tiller for corresponding crops at peripheral speed. Higher η_c in modified rotary tiller was associated with the fact that compressed biomass ahead of rotary by compression improved greater interaction between rotary blades and biomass so that biomass cut effectively in modified rotary tiller

Effect of peripheral speed on η_c is shown better by polynomial curve with second-degree equation (Fig-2). η_c was increased non-linearly with increase in peripheral speed. In all the three crops average η_c was significantly increased i.e., from 19 per cent to 64 per cent when peripheral speed increased from 1.6 to 3.6 m/s, further increase in peripheral speed negligible effect on η_c. Increased η_c with increase in peripheral speed was mainly due greater impact and shearing action compression reel and rotary blades on biomass. Statistical analysis showed that variation in amount of chopped biomass is significantly differed with ($P<0.001$) peripheral speed, models of rotary tiller and crop type (Table 3)

Effect of Forward speed on η_i Results from Table 4 showed that highest η_i of both modified and existing rotary tiller was obtained at 0.7 m/s forward speed ie., in II gear operation. At this speed, η_i of modified rotary tiller was 68 per cent (893 g/m2) for cowpea, 72 per cent (763 g/m2) for horsegram, and 58 per cent (806 g/m2) for sunhemp as against 46 per cent (606 g/m2), 56 per cent (594 g/m2) and 41 per cent (573 g/m2), respectively, with existing rotary tiller.

Effect of forward speed on η_i is shown better by polynomial curve with second-degree equation (Fig-3). Results showed average η_i was increased significantly from 49% to 66% in modified

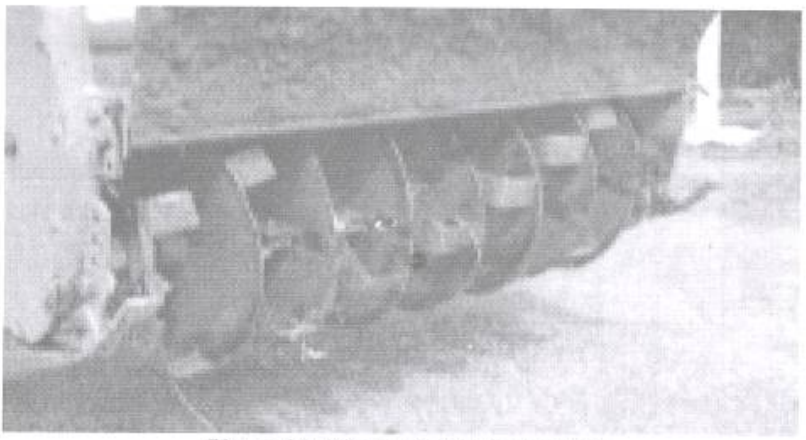

Plate-1. Modified L-blade along with disc

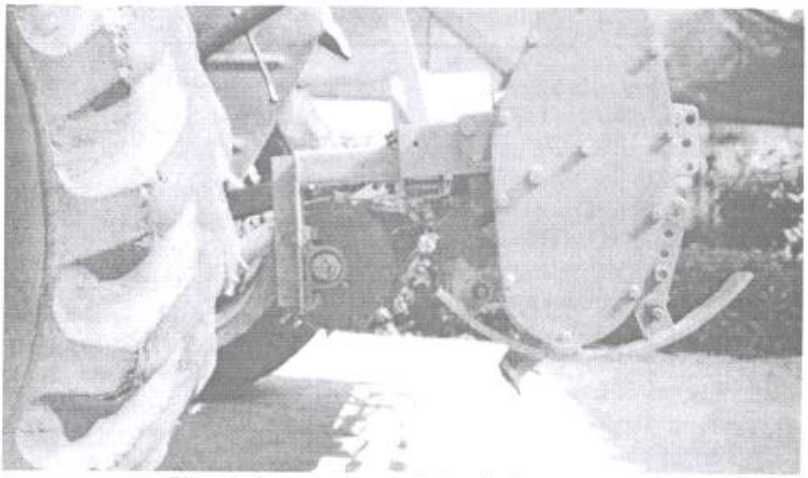

Plate-2. Compression reel ahead of rotary tiller

Plate-3 Existing model of rotary tiller

Table 4: Rotary tiller's performance at different forward speed on *in-situ* biomass incorporation

Machines	Crops	Before Incorporation (gm/sq.m)	Biomass after incorporation (g/sq.m) at different forward speeds, m/s				
			0.4	0.7	1.2	1.8	2.7
Amount of biomass Incorporated in soil							
Modified	Cowpea	1308	695	894	873	568	394
Rotary Tiller	Horsegram	1056	568	763	765	545	354
	Sunhemp	1396	582	806	761	405	205
Conventional	Cowpea	1308	494	606	571	487	301
Rotary Tiller	Horsegram	1056	397	594	572	477	284
	Sunhemp	1396	338	573	538	301	150
Amount of chopped biomass below 80 mm							
Modified	Cowpea	1255	874	853	620	268	116
Rotary Tiller	Horsegram	992	752	679	497	256	128
	Sunhemp	1354	816	738	458	272	41
Conventional	Cowpea	1255	598	476	423	217	102
Rotary Tiller	Horsegram	992	581	455	406	189	96
	Sunhemp	1354	555	426	329	159	41

Table-5. Statistical analysis for Table-4

Source	Type III Sum of Squares	df	Mean Square	F	Significant at P
Amount of Incorporated straw					
Machine (M)	139712.400	1	139712.400	510.375	<0.001
Speeds (S)	1436646.378	4	359161.594	1312.032	<0.001
Crops (C)	262399.489	2	131199.744	479.278	<0.001
M x S	576075.044	4	144018.761	526.107	<0.001
M x C	10976.467	2	5488.233	20.049	<0.001
M x S x C	19890.089	8	2486.261	9.082	<0.001
Error	16424.667	60	273.744		
Total	**23612648.000**	**90**			
Amount of Incorporated straw					
Machine (M)	337579.378	1	337579.378	1208.903	<0.001
Speeds (S)	1534861.489	4	383715.372	1374.120	<0.001
Crops (C)	154516.867	2	77258.433	276.670	<0.001
M x S	487882.511	4	121970.628	436.788	<0.001
M x C	3919.489	2	1959.744	7.018	<0.001
M x S x C	52932.956	8	6616.619	23.695	<0.001
Error	16754.667	60	279.244		
Total	**15833512.000**	**90**			

rotary tiller and from 33 per cent to 47 per cent in existing rotary tiller when forward speed increased from 0.4 to 0.7 m/s. Further increase in forward speed decreased η_i and it was true for both rotary tillers. Lower η_i below forward speed of 0.7 m/s was mainly due to poor mixing of soil and biomass as amount of soil stir was low. For forward speed above 0.7 m/s, amount of soil stir increased by increasing length of slice but at the same time there was increase in biomass length, which led in poor η_i . Statistical analysis showed that variation in amount of biomass incorporated in soil is significantly differed with ($P<0.001$) forward speed, models of rotary tiller and crop type (Table 5.)

Effect of Forward speed on η_c : Results from Table 4 also showed that highest η_c of both modified and existing rotary tiller was obtained at 0.4 m/s forward speed i.e., in I gear operation. It was manly attributed to reduction in bite length of rotary blades. At this speed, η_c of modified rotary tiller was 70 per cent (874 g/m2) for cowpea, 76 per cent (752 g/m2) for horsegram, and 60 per cent (816 g/m2) for sunhemp as against 48 per cent (598 g/m2), 59 per cent (581 g/m2) and 41 per cent (555 g/m2), respectively, with existing rotary tiller.

Effect of forward speed on η_c is shown better by polynomial non-linear curve with second-degree equation (Fig-4). It was observed that average η_c was decreased from 68 per cent to 63 per cent in modified rotary tiller and from 48 per cent to 38 per cent in existing rotary tiller when forward speed increased from 0.4 to 0.7 m/s. There was decrease in η_c for further increase in forward speed. Statistical analysis showed that variation in amount of chopped biomass is significantly differed with ($P<0.001$) peripheral speed, models of rotary tiller and crop type (Table 5.)

Analyzing the effect of forward speed on η_i and η_c it has been observed that in modified rotary tiller although there was 5 per cent decrease in chopping efficiency by increasing forward speed from 0.4 to 0.7 m/s, the benefit of incorporation efficiency was 17 per cent in addition to increase in field capacity by 33 per cent. Similar situation was found with existing rotary tiller. Hence, forward speed of 0.7 m/s is considered to be optimum for biomass incorporation.

CONCLUSION

Incorporation and chopping efficiency of both modified and existing rotary tiller is significantly dependent on peripheral speed and forward speed. For better results of green manural incorporation, peripheral speed of rotary tiller at 3.6 m/s, and forward speed at 0.7 m/s was found to be optimum. Study also revealed that incorporation and chopping efficiency of modified rotary tiller was significantly higher than that existing rotary tiller and it was true for all peripheral speeds and crop type.

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Anthropometric Studies on Agricultural Workers

V. V. Aware[1], A.G. Powar[2], V. A. Shetye[3] and S. L. Rokade[4]

ABSTRACT

An anthropometric survey of agricultural workers from Konkan region was carried out during 2004-2006 in order to investigate suitability of farm equipments with human body. Seventy-nine body dimensions and sixteen strength parameters were measured from 344 male and 164 female workers within the age group of 18 to 60 years. It was observed that mean statures of male and female agricultural workers were observed to be 163.3 ± 6.1 cm and 151.4 ± 5.2 cm, whereas average weights were 51.1 ± 7.8 kg and 43.5 ± 6.5 kg, respectively. Strength data indicated that strength of right hand were greater than left hand. Similarly right leg and foot strengths were higher than leg and foot strength of left side. The strength values reported were higher for male population than females. The data collected can be used for ergonomic design of agricultural hand tools and machinery.

Anthropometry deals with measurement of physical features of human body including linear dimensions, weight and volume. It is critical for the designer to consider the human being intentionally and thoroughly from the conception of design. The man-machine interface decides the ultimate performance of the equipment/work system. Anthropometric measures vary considerably with factors such as gender, race and age playing a dominant role in this variability. Similarly the agro-climatic zone and topography adds to the variability in human characteristics. Sen et al. (1977) found the similarity in anthropometric dimensions of unorganized workers including agricultural workers and that of industrial workers.

Comfort, physical welfare and performance of agricultural workers using farm implements are influenced by relevant features of human body such as body dimensions, range of body movements and strengths. Farm implements are either operated or controlled by human workers. Therefore, it is necessary to design various tools, equipments and work places keeping in to consideration of the anthropometric data of agricultural workers.

Gupta and Sharma (1979) reported that the Anthropometric data are used as a major input to determine the size and shape of the equipment which is operated by man and also to determine the space in which a man has to work.

Woodson (1981) has identified 46 physical dimensions of the body as design input for equipments.

Gupta *et al.* (1983) reported that other body dimensions could be predicted from the standing height due to existence of linear relationships in between them.

Therefore, the study was undertaken to get anthropometric data of agricultural workers from Konkan region of Maharashtra state.

MATERIAL AND METHODS

The group of persons involved in operation and maintenance of engineering product throughout its life is defined as the total user population. Therefore, a smaller group called sample is selected and measurements are carried on the individuals in that sample. Keeping into consideration, the design requirements of hand tools, animal drawn equipment, tractor, power tiller, power operated machines, self-propelled machines and workplaces, a total 79 body dimensions and 16 strength parameters are identified by the coordinating cell of All India Coordinated Research Project (AICRP) on Ergonomics and Safety in Agriculture (ESA) (Gite and Chatterjee, 1999).

Equipments used for data collection

Seventy nine body dimensions were measured using Integrated Composite Anthropometer (ICA) developed at Indian Institute of Technology, Kharagpur (shown in Plate.1) and 16 strength parameters were measured using strength measurement setup developed at Central Institute of Agricultural Engineering (CIAE), Bhopal (shown in Plate.2) . Nova –tech load cells (0-125 kg and 0-40

1. Associate Prof., 2. Associate Dean and 3. & 4 Research Associate, College of Agril. Engg. and Tech., Dapoli. Dist.: Ratnagiri

kg) with indicators were used for measuring different strengths parameters. While measuring strength parameters of subject was asked to apply load for 5 sec duration and maximum value of load is noted. An electronic timer, sounding a beep for 5sec. was used in order to titillate the subject for applying maximum load. Three replications of each strength parameter were taken. Grip dynamometer was used for measuring grip strength. The other measuring instruments like slide calipers, vernier caliper and measuring tapes were also used to take linear and circular measurements.

Sample size and sampling technique

The total population of agricultural workers from Konkan region is 1040668. Sampling was done as per procedure given by Gite and Chatterjee (1999). The random sample should be taken from the user population, however in large-scale anthropometric survey, the ideal random sample procedure is not feasible. It was decided to take sample size as 250 subjects from each district having male to female ratio as 65:35 from each district of Konkan region. Two hundred and forty seven subjects from Thane and 261 subjects from Sindhudurg districts were surveyed. The data were collected considering most of tribes/communities involved in agricultural occupations. Age group for the survey was 18 to 60 years. Anthropometric measurements were taken in correct posture to ensure maximum accuracy. To reduce the physiological fatigue and boredom, the static position of subject was changed after taking 8 to 10 readings. The care was taken so that the subject would feel free and relaxed while anthropometric measurements.

Analysis

The anthropometric and strength data were compiled in MS Excel. The mean, standard deviation, 5th and 95th percentile values were computed.

The standard deviation indicates the width of distribution or the extent to which individual values are scattered about or deviate from the mean. The 5th and 95th percentile values are computed by using the following.

$$X_5 = \overline{X} - s \times z; \quad X_{95} = \overline{X} + s \times z$$

Where

X_5 = 5th percentile of the variable

X_{95} = 95th percentile of the variable

$\overline{X}$ = Mean value of the variable

s = Standard deviation of the variable

z = Constant of the percentile concerned equal to 1.645

RESULTS AND DISCUSSION

The data were collected on 79 anthropometric measurements and 16 strength parameters. The collected data were analyzed and summarized as mean, standard deviation, 5th, 95th percentile, minima and maxima.

The average statures of male and female agricultural workers were observed to be 163.3 ± 6.1 cm and 151.4 ± 5.2 cm, whereas average weights were 51.1 ± 7.8 kg and 43.5 ± 6.5 kg, respectively. The 5th and 95th percentile stature of male agricultural worker were estimated as 153.3 cm and 173.3 cm, respectively while that of female workers' were 142.8 cm and 160.0 cm, respectively. The 5th percentile weights of male and female agricultural worker were 38.2 kg and 32.7 kg, respectively while 95th percentile were 64.0 kg and 54.3 kg, respectively.

Strength data for male subjects indicated that pull, push and grip strengths of right hand were 11.1±3.3, 8.3±3.0, 33.7±6.9 while strength of left hand were 10.4±3.2, 7.5±2.5 and 31.5±6.8 kgf. It was found that push strength was 22.9±6.6 kgf and was greater than pull strength (20.9±4.9 kgf) of both hands in standing posture. Similarly right leg and foot strengths were higher than leg and foot strength of left side. In case of female subjects it was observed that that pull, push and grip strengths of right hand were 7.8±2.1, 5.9±1.8, 19.3±4.6, while strength of left hand were 7.2±2.0, 5.6±1.6 and 17.4±4.2 kgf. It was found that push strength was 15.4±4.2 kgf and pull strength was 14.5±3.0 kgf of both hands in standing posture. The values reported were higher for male population than female.

By using this survey data, designers may be capable to provide improved agriculture equipment, tools and machinery for Indian farm workers with special reference to workers of Konkan region.

Table 1. Summarized anthropometric and strength data of 344 male subjects from Konkan region.

S. N.	Anthropometric parameters	MEAN	S.D.	MINIMA	MAXIMA	5th PER	95th PER
1	Weight, kg	51.1	7.8	30.0	80.0	38.2	64.0
2	Vertical reach	208.5	8.4	181.1	233.0	194.7	222.3
3	Stature	163.3	6.1	145.7	179.6	153.3	173.3
4	Eye height	151.0	6.0	133.2	168.2	141.2	160.8
5	Elbow height	101.3	4.5	88.8	114.0	94.0	108.6
6	Knee height	45.8	2.7	29.3	59.5	41.4	50.2
7	Span	168.3	7.5	146.5	202.2	155.9	180.7
8	Span akimbo	85.3	4.1	73.0	98.7	78.6	92.0
9	Arm reach from the wall	82.9	3.9	71.5	94.3	76.5	89.3
10	Grip diameter (inside)	4.8	0.4	3.0	6.5	4.1	5.5
11	Middle finger-palm grip diameter	2.8	0.3	2.0	3.5	2.3	3.4
12	Sitting height	80.3	3.8	63.7	102.6	74.1	86.5
13	Knee height sitting	51.0	2.5	41.4	64.0	46.9	55.1
14	Hand thickness at metacarpal-III	2.6	0.3	1.7	4.5	2.2	3.1
15	Hand length	17.7	1.0	14.5	21.0	16.0	19.3
16	Palm length	9.9	0.6	5.9	12.0	8.8	11.0
17	Hand breadth at metacarpal-III	7.9	0.4	6.4	8.9	7.1	8.6
18	Functional leg length	95.5	4.4	84.0	110.5	88.3	102.7
	Strength Parameters						
1	Hand grip strength (Right), kgf	33.7	6.9	11.3	50.2	22.4	45.1
2	Hand grip strength (Left)	31.5	6.8	9.7	48.3	20.4	42.7
3	Push strength (both hands) standing, kgf	22.9	6.6	6.7	43.9	11.9	33.8
4	Pull strength (both hands) standing, kgf	20.9	4.9	7.7	35.6	12.9	28.9
5	Push strength (Left hand) sitting, kgf	7.5	2.5	3.3	15.2	3.5	11.6
6	Pull strength (Left hand) sitting, kgf	10.4	3.2	4.2	25.6	5.2	15.7
7	Push strength (Right hand) sitting, kgf	8.3	3.0	3.2	22.7	3.4	13.2
8	Pull strength (Right hand) sitting, kgf	11.1	3.6	5.3	26.0	5.2	17.0
9	Leg strength (Right) sitting, kgf	42.1	10.0	14.0	76.1	25.6	58.5
10	Foot strength (Right) sitting, kgf	29.8	9.0	10.1	60.4	15.0	44.7
11	Leg strength (Left) sitting, kgf	40.3	9.1	13.2	76.2	25.3	55.3
12	Foot strength (Left) sitting, kgf	29.0	8.5	9.4	57.1	15.1	42.9

Table 2.Summarized anthropometric and strength data of 164 female subjects from Konkan region.

S. N.	Anthropometric parameters	MEAN	S.D.	MINIMA	MAXIMA	5th PER	95th PER
1	Weight, kg	43.5	6.5	29.0	69.0	32.7	54.3
2	Vertical reach	189.4	7.4	171.0	208.5	177.3	201.6
3	Stature	151.4	5.2	137.0	166.8	142.8	160.0
4	Eye height	138.9	5.0	126.0	155.4	130.6	147.1
5	Elbow height	94.3	3.8	86.5	106.5	87.9	100.6
6	Knee height	44.1	2.4	35.5	48.5	40.1	48.1
7	Span	153.0	7.3	123.0	169.5	141.0	165.0
8	Span akimbo	75.4	4.0	65.0	84.7	68.9	81.9
9	Arm reach from the wall	76.8	4.0	67.0	87.5	70.2	83.4
10	Grip diameter (inside)	4.4	0.3	3.5	5.2	3.9	5.0
11	Middle finger-palm grip diameter	2.6	0.3	2.0	3.5	2.1	3.1
12	Sitting height	74.8	2.9	66.6	83.0	70.1	79.5
13	Knee height sitting	47.6	2.1	41.0	52.0	44.1	51.2
14	Hand thickness at metacarpal-III	2.2	0.3	1.7	4.6	1.7	2.7
15	Hand length	16.4	0.9	14.5	18.8	15.0	17.9
16	Palm length	9.3	0.7	7.5	10.8	8.2	10.4
17	Hand breadth at metacarpal-III	7.0	0.4	5.6	8.3	6.3	7.7
18	Functional leg length	92.9	4.3	81.0	103.0	85.9	99.9
	Strength Parameters						
1	Hand grip strength (Right), kgf	19.3	4.6	7.3	31.7	11.6	26.9
2	Hand grip strength (Left)	17.4	4.2	8.7	29.0	10.5	24.3
3	Push strength (both hands) standing, kgf	15.4	4.2	7.8	30.8	8.5	22.3
4	Pull strength (both hands) standing, kgf	14.5	3.0	7.1	23.1	9.5	19.4
5	Push strength (Left hand) sitting, kgf	5.6	1.6	2.4	14.6	2.9	8.3
6	Pull strength (Left hand) sitting, kgf	7.2	2.0	3.1	16.0	3.9	10.5
7	Push strength (Right hand) sitting, kgf	5.9	1.8	1.9	11.6	3.0	8.9
8	Pull strength (Right hand) sitting, kgf	7.8	2.1	2.8	16.7	4.3	11.2
9	Leg strength (Right) sitting, kgf	29.0	6.3	15.2	44.4	18.6	39.3
10	Foot strength (Right) sitting, kgf	21.0	5.4	9.2	36.0	12.0	29.9
11	Leg strength (Left) sitting, kgf	28.7	6.6	11.7	45.2	17.8	39.6
12	Foot strength (Left) sitting, kgf	20.0	6.2	7.2	36.6	9.9	30.2

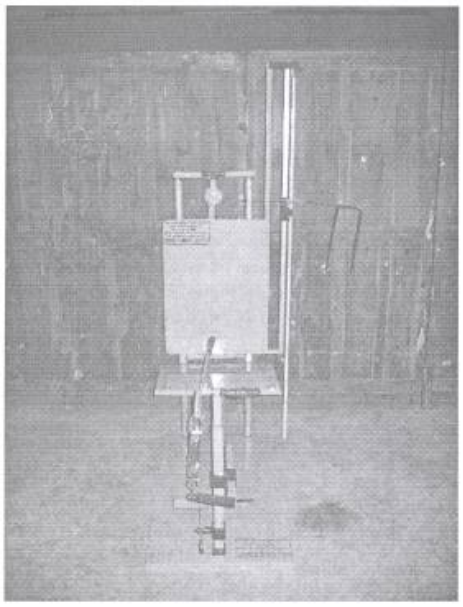

Plate.1 Integrated Composite Anthropometer (ICA)

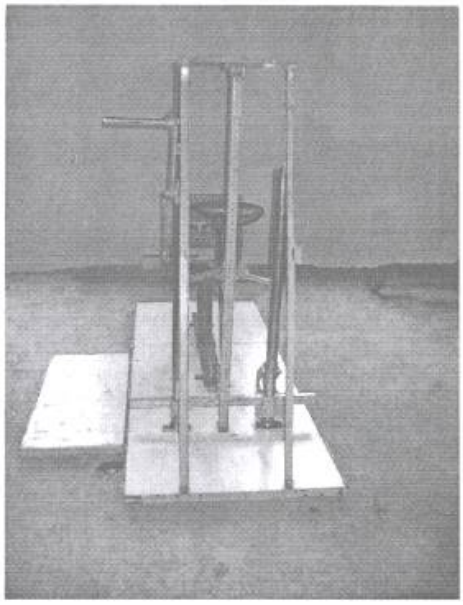

Plate.2 Strength Measurement Set up

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Effect of Tyre Size on Performance of Agricultural Tractor

S. H. Thakare[1], Ajay Kumar Sharma [2] and P.J. Nikam[3]

ABSTRACT

Improving the performance of agricultural tractor has gained a unique importance due to increasing cost of farm inputs and low prices received for agricultural crops. The right choice of tyre size is a matter of great importance in the design and operation in improving the performance of agricultural tractor. Experiments were conducted in sandy loam soil in stubble and ploughed field conditions to study the effect of tyre sizes of agricultural tractor on tractive performance. Three tyre sizes (12.4-28, 13.6-28 and 16.9-28 with R-1 tread) were selected to study the soil-tyre interaction at four levels of drawbar pull (0, 250, 500 and 750 daN) at 2/3rd and full throttle positions. The results indicated that at 2/3rd throttle position tyre size 16.9-28 gave the maximum tractive efficiency in both the soil conditions whereas, at full throttle position 13.6-28 tyre size performed slightly better at lower drawbar pull but as the pull further increased the 16.9-28 tyre performed well compared to all other tyres in ploughed soil.

Much attention has been focused on improving the performance of agricultural tractors because the tractor uses significant proportion of farm's energy input. In India, the tractors in low to medium hp group (up to 35 hp) are fitted with 11.2-28 or 12.4-28 tyres, while those in 35-50 hp group are fitted with 13.6-28 and those above 50 hp group are fitted with 16.9-28 tyre size. The tractive efficiency of these tyres is found to be quite low (about 30-40%) in the soil conditions prevailing in different agro climatic zones of the country. This might be due to inadequate size of tyres used in different hp groups of tractors besides a number of operating parameters not being maintained at their optimum level (Sharma, 1997).

As the tractors increase in power, the main limitation to performance of the traction device is imposed by the terrain over which they travel (Wolfsohn, *et.al.*, 1988). Drive tyres for agricultural tractors are required to provide traction on agricultural soils to support the vehicle and to provide a minimum resistance to movement over the surface in the intended direction of travel. The right choice of tyre size is a matter of great importance in the design and operation of tractor (Gee-Clough, 1980).

A good research work has been reported by several researchers improving the tractive performance of tractor tyres considering various factors. Some of these factors are tyre size (Sharma and Pandey, 1997), the dynamic wheel load (Souza, etal., 1995), inflation pressure (Lohan and Aggrawal, 2001), drawbar pull (Sharma and Pandey, 1997; Lohan and Aggrawal, 2001), wheelslip and available power i.e. part loads to engine (Hansson etal., 2003). Keeping in view the above points this study was undertaken with following objectives;

1. To observe the effect of tyre size on tractive efficiency of agricultural tractor at different drawbar loads in different soil conditions in sandy loam soil.
2. To develop the empirical models to predict tractive efficiency at part loads.

MATERIAL AND METHODS

The experiments were conducted at instructional farm of College of Technology and Engineering, Udaipur, Rajasthan, India using three sizes of commonly used tractor tyres (12.4-28, 13.6-28 and 16.9-28 with R-1 tread) on Indian tractors (Table 1).

The soil-tyre interactions were evaluated at four levels of drawbar pull (0, 250, 500 and 750 daN) at two part loads i.e. 2/3rd and full throttle positions as in India, tractor operates under these conditions for normal agricultural operations (Table 2). A load tractor was used to generate drawbar pull by applying brakes for test tractor and was measured by a load cell and indicator (Fig.1). The tests were conducted on stubbled field after harvest

1. Assosicat Prof., Department of FPM, CAET, Dr. P.D.K.V., Akola, 2. Associate Prof., Department of FMPE, CTAE, MPUAT, Udaipur and 3. Assistant Prof., Shri Shivaji Agriculture College, Amravati

Table 1 Specifications of the experimental tyres

Size with ply rating	Overall diameter D, mm	Width b, mm	Carcass section height h, mm	Maximum recommended inflation pressure, kPa	Lug height, mm	b/D	h/D
12.4-28 (8PR)	1240	320	210	250	32	0.25	0.17
13.6-28 (8PR)	1300	345	235	250	35	0.26	0.18
16.9-28 (12PR)	1400	400	345	130	40	0.28	0.24

of kharif maize crop and ploughed field using factorial RBD design. Statistical analysis was done using SPSS statistical software package. Tractive efficiency was taken as performance parameter for comparing different combinations and was calculated as

$$TE = \frac{output\ power}{input\ power} \quad \ldots(1)$$

Fig.1 Measurement of drawbar pull using load cell and indicator

$$TE = \frac{P \times V_a}{T \times \omega} \quad \ldots(2)$$

where,

TE = Tractive efficiency;
P = pull;
T = wheel torque (input);
ù = wheel rotation; and
V_a = actual speed.
This can be rewritten as

$$TE = \frac{P \times V_a}{T \times V/r} = \frac{P}{F} \times (1 - s) \quad \ldots(3)$$

where,

F = gross thrust force acting on the wheel (P+R);
V_t = theoretical velocity;
r = radius of wheel;
s = slip and
R = rolling resistance.

Thus, $$TE = \frac{P}{P+R}(1 - s) \quad \ldots.(4)$$

The actual forward speed was calculated by recording the time required to cover 25 m distance in the test field while the theoretical forward speed was calculated at zero condition as net traction on plain tar road.

The slip was calculated as

$$s = \frac{Vt - Va}{Vt} \quad \ldots(5)$$

where,

s = slip;
Va = actual speed of tractor in a field, m/s and
Vt = theoretical speed of tractor on hard surface, m/s.

Table 2 Part load combination of test tractor

Throttle position	Rpm of engine	Gear selected	Av. Forward speed, m/s
2/3rd throttle	1350	L-I L-II L-III	0.775
Full throttle	2000	L-I L-II	0.845

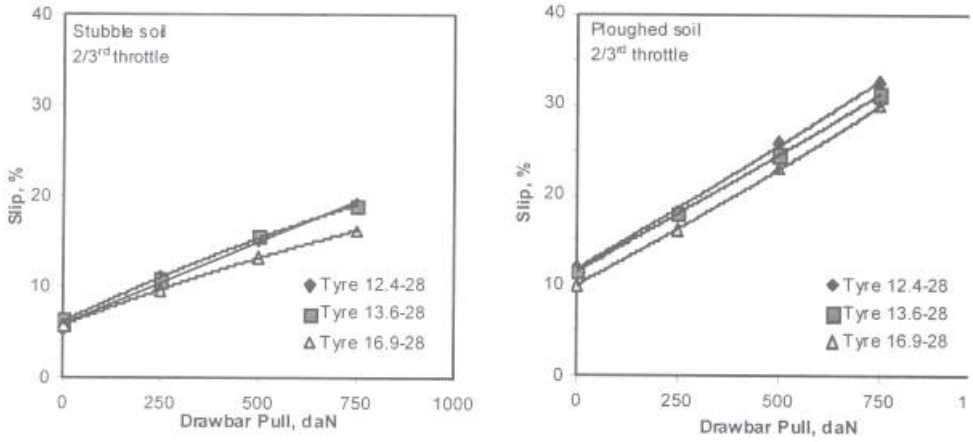

Fig. 2 Relationship between drawbar pull and slip at 2/3rd throttle position for different tyre sizes

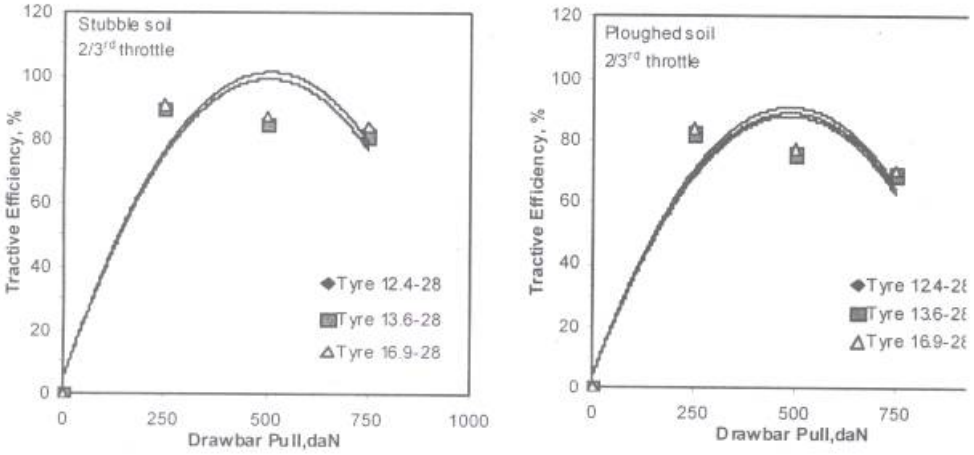

Fig. 3 Relationship between drawbar pull and tractive efficiency at 2/3rd throttle position for different tyre sizes

RESULTS AND DISCUSSION

The relationship between drawbar pull with slip and tractive efficiency for 12.4-28, 13.6-28, and 16.9-28 tyre sizes tested in stubble and ploughed soil condition at 2/3rd throttle and full throttle position is shown in Fig. 2 to 5.

At 2/3rd throttle position

It is observed from the Fig. 3 that the tractive efficiency was maximum at all the levels of drawbar pull for tyre size of 16.9-28, and tyres 12.4-28 and 13.6-28 sizes were at par at 2/3rd throttle position in stubble soil condition. In ploughed soil condition tractive efficiency of 16.9-28 tyres was maximum at all the levels of drawbar pull followed by 13.6-28 and 12.4-28 tyres. The results are similar to the findings of Bashford et al. (1993) that larger tyres perform better than smaller tyres on firm and soft soil. In this study the diameter of tyres increased with the increase in carcass section height.

The mean values observed from ANOVA indicated that tyre sizes 12.4-28 and 13.6-28 showed no significant increase in tractive efficiency, however, the maximum tractive efficiency of 90.47 % was observed for 16.9-28 tyre size in stubble soil condition at drawbar pull of 250 daN. In ploughed soil condition all the three tyre sizes showed significant increase in tractive efficiency with 16.9-28 tyres showing the maximum tractive efficiency of 83.89 per cent at drawbar pull of 250 daN followed by 13.6-28 and 12.4-28 tyres of 82.17 and 81.91 per cent respectively.

The experimental data were analyzed using a non-linear regression technique to obtain the best fit values of the coefficient a_{1TTE}, a_{2TTE}, and a_{3TTE} in the generalized form of a second degree polynomial shown in Table 3 (Eqn 6)

$$TE = a_{1TTE} + a_{2TTE} P + a_{3TTE} P^2 \quad ...(6)$$

Where, TE = tractive efficiency, per cent,

P = drawbar pull, daN and

a_{1TTE}, a_{2TTE}, and a_{3TTE} = regression coefficients for 2/3rd throttle position

The R^2 values reported in the table 3 clearly indicate that the experimental data fit the Eqn (6) well.

At full throttle position

It is observed from the curves that similar to 2/3rd throttle position the tractive efficiency was maximum at lower values of drawbar pull but gradually decreased with the increase in drawbar pull. The Fig. 5 indicates that at lower value of drawbar pull the 13.6-28 tyres performed better than 16.9-28 tyres. The reason might be due weight transfer, which was not as per the recommendations of Casady (1997) i.e. 35 per cent at front and 65 per cent at rear for two wheel drive mounted implements. However, at increased values the performance of all the three tyres seems to be at par in both the soil conditions. It is also revealed from the figure that tractive efficiency was maximum in case of stubble soil compared to ploughed soil condition, which was similar to the findings of Taylor et al. (1976) that the tyres had its greater advantage on firm surfaces and this advantage is gradually lost as soil becomes softer.

The mean values seen from ANOVA table indicated that at drawbar pull of 250 daN the 13.6-28 tyres performed better than 16.9-28 tyres, and as the

Table 3 Coefficient of an estimated multiple regression $TE = a_{1TTE} + a_{2TTE} P + a_{3TTE} P^2$ to describe the response of drawbar pull (daN) on tractive efficiency (%) for different tyres at 2/3rd throttle position

Soil condition	Tyre	a_{1TTE}	a_{2TTE}	a_{3TTE}	R^2
Stubble soil	12.4-28	4.538	0.3436	-0.0004	0.90
	13.6-28	4.439	0.3465	-0.0004	0.91
	16.9-28	4.524	0.3540	-0.0004	0.91
Ploughed soil	12.4-28	4.677	0.3741	-0.0004	0.92
	13.6-28	4.793	0.3734	-0.0004	0.91
	16.9-28	4.738	0.3795	-0.0004	0.92

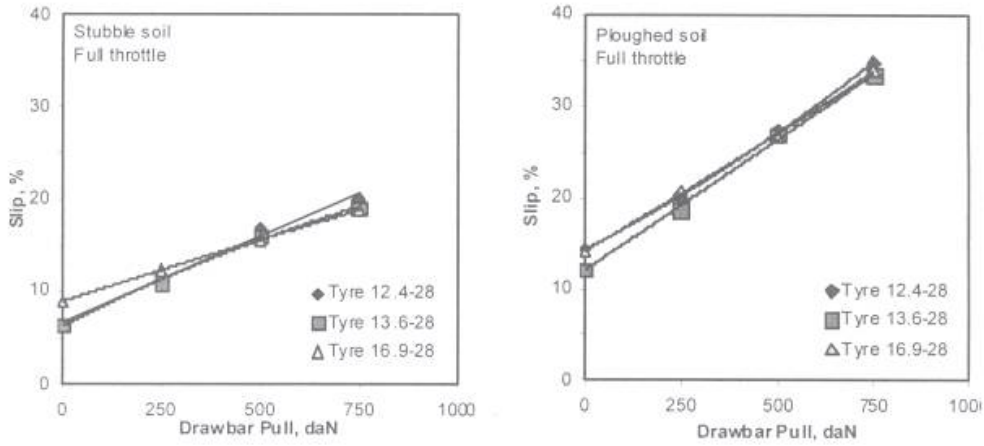

Fig. 4 Relationship between drawbar pull and slip at full throttle position for different tyre sizes

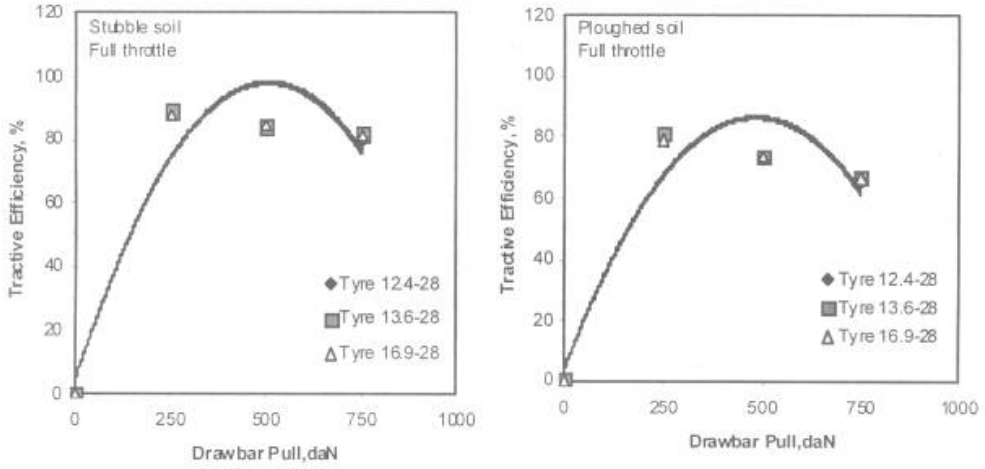

Fig. 5 Relationship between drawbar pull and tractive efficiency at full throttle position for different tyre sizes

Table 4 Coefficient of an estimated multiple regression TE =$a_{1\text{-}TTE}$ +$a_{2\text{-}TTE}$ P+ $a_{3\text{-}TTE}$ P^2 to describe the response of drawbar pull (daN) on tractive efficiency (%) for different tyres at full throttle position

Soil condition	Tyresize	$a_{1\text{-}TTE}$	$a_{2\text{-}TTE}$	$a_{3\text{-}TTE}$	R^2
Stubble soil	12.4-28	4.382	0.3379	-0.0004	0.90
	13.6-28	4.547	0.3406	-0.0004	0.90
	16.9-28	4.198	0.3367	-0.0003	0.91
Ploughed soil	12.4-28	4.137	0.3175	-0.0003	0.90
	13.6-28	4.984	0.3126	-0.0003	0.91
	16.9-28	4.444	0.3398	-0.0003	0.90

pull further increased, the performance of both the tyres was at par followed by 12.4-28 tyres in ploughed soil condition. In stubble soil condition, the performance of 16.9-28 tyres was better than both the other tyres at drawbar pull values of 500 and 750 daN

A non-linear regression technique was used to analyze experimental data to obtain the best-fit values of the coefficient $a_{1\text{-}TTE}$, $a_{2\text{-}TTE}$, and $a_{3\text{-}TTE}$ in the generalized form of a second degree polynomial shown in table 4 (Eqn 7)

$$TE = a_{1\text{-}TTE} + a_{2\text{-}TTE} P + a_{3\text{-}TTE} P^2 \quad \ldots(7)$$

Where,

TE = tractive efficiency, per cent,

P = drawbar pull, daN and

$a_{1\text{-}TTE}$, $a_{2\text{-}TTE}$, and $a_{3\text{-}TTE}$ = regression coefficients for full throttle position

The R^2 values reported in the table 4 clearly indicate that the experimental data fit the Eqn (7) very well.

At 2/3rd throttle position tyre 16.9-28 gave maximum tractive efficiency of 90.47 and 83.89 per cent in stubble and ploughed soil respectively at drawbar pull of 250 daN followed by 12.4-28 and 13.6-28 tyre sizes. Whereas at full throttle position 13.6-28 tyres performed better than 16.9-28 tyres, and as the pull further increased, the performance of both the tyres was at par followed by 12.4-28 tyres in ploughed soil condition. In stubble soil condition, the performance of 16.9-28 tyres was better than both the other tyres at drawbar pull values of 500 and 750 daN.

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Yield and Economics of Bt Cotton as Influenced by Spacing and Nutrition Levels

P. Raghu Rami Reddy[1] and B. Dileep Kumar[2]

ABSTRACT

A field experiment was conducted during the *Kharif* season of 2005-06 and 2006-07 at Warangal (Andhra Pradesh) to study the effect of spacing and nutrition on Bt cotton under irrigation. Adoption of spacing of 90 x 30 cm significantly recorded higher seed cotton yield (21.4%) over 90 x 90 cm. Among the nutritional levels, application of 120 kg N + 26.2 kg P + 50 kg K ha^{-1} found to be optimum for Bt cotton hybrid 'Bunny'. Highest net returns (Rs 44627 ha^{-1}) was obtained with 90 x 30 cm where as maximum benefit cost ratio 2.23 recorded in 90 x 60 cm. Maximum net returns as well as benefit: cost ratio realized with 120 kg N + 26.2 Kg P + 50 kg K ha^{-1}.

Cotton the king of fibres, is one of the most important commercial crop of India. Cotton cultivation has full potential to offer livelihood security to millions of marginal and small farmers; such an enterprise has to be knowledge based and needs to evolve continuously through innovations in frontier sciences to break the yield and pest barriers (Anonymous, 2008). Genetically modified cotton is one such option, which has readily accepted by farmers of India. At present more than 8 m ha area is under Bt cotton. Though good amount of research work was carried out on agronomical aspects of Non Bt cotton (Rao and setty 2008; Kaur and Brar, 2008) but, very few published literature is available on the performance of genetically modified cotton to different agronomical aspects. Dehua *et al*., (2004) emphasized the need for agronomical research on Bt cotton since its vegetative and reproductive growth patterns are changed by the Bt gene. Efficient cotton production packages would explore the avenues for realizing the potential crop yields. Thus, this experiment was undertaken to study the effect of plant spacing and fertilizer levels on yield attributes, yield and economics of Bt cotton.

MATERIAL AND METHODS

A field experiment was carried out during *Kharif* 2005-06 and 2006-07 at Regional Agricultural Research Station, Warangal, situated in Central Telangana Zone of Andhra Pradesh. The farm is situated at 18°03' N latitude, 79°22' E longitude at an attitude of 270 m above mean sea level. The sandy loam soil had pH 7.4 and available N, P and K were 238, 14.8 and 204 kg ha^{-1} respectively. The experiment was laid out in randomized block design (factorial concept) comprising three spacings (90 x 30, 90 x 60, 90 x 90 cm) with three nutritional levels (120 kg N + 26.2 kg P + 50 kg K ha^{-1}, 150 kg N + 32.75 kg P + 62.5 kg K ha^{-1} and 180 kg N + 39.3 kg P + 75 kg K ha^{-1}). The treatments were replicated thrice. The land preparation commenced by ploughing the field with a tractor drawn cultivator followed by harrowing. The seeds of 'Bunny Bt' was sown according to spacing on 25 and 28th June, respectively in first and second year. The seedlings were thinned out to maintain single plant per hill at 10 days after sowing. Full dose of phosphorus was applied at the time of sowing, nitrogen and potash were applied in 3 equal splits at 20 days after sowing, square formation and at peak boll load as per nutritional levels. During the crop season 811.7 mm rainfall in 44 rainy days during first year and 752.7 mm rainfall in 41 rainy days during second year were received. Cotton crop was irrigated at peak boll load and boll maturity stage. Sucking pests viz., aphids, Jassids and thrips were controlled by spraying recommended plant protection chemicals. *Spodoptera* managed by spraying Endosulphan and Chloropyriphos. In both the seasons, *Helicoverpa* incidence was not observed on Bt cotton. Cotton pickings started from 115 days after sowing and completed by first fortnight of January. Biometric observations on yield and yield attributing parameters were recorded at harvest. Economic analysis was done on the basis of prevailing market prices of inputs used and the out put obtained for each treatment. Net returns were calculated by deducting cost of cultivation from gross monetary returns and the benefit: cost ratio was calculated, net returns divided by the total cost of cultivation.

RESULTS AND DISCUSSION

Growth and yield attributes

Number of monopodial branches were significantly affected by different plant spaces

1. Senior Scientist and 2. Scientist, Regional Agricultural Research Station, Warangal (A.P.)

(Table 1). The number of monopodial branches increased by 110 per cent at 90 cm over 30 cm, indicating more vegetative growth at wider spacing. Similar results of increased monopodial number with wider spacing was reported by Kasap and Killi (2004) in non Bt cotton hybrid. Various nutritional levels significantly not influenced number of monopodia. Sympodial number was neither influence by plant spacings nor nutritional levels in both the years. Earlier Reddy *et al.*, (2007) reported similar findings with 'Mallika Bt' in rainfed vertisols.

Number of bolls plant^{-1} was affected by different plant spaces. Wider plant spacing (90 cm) had significantly recorded higher number of bolls plant^{-1} (55.4) which was significantly superior over 30 cm (112%) and 60 cm (32.5%). When cotton plants were grown wide apart, it is common feature to have more number of bolls due to availability of more space and light. Similar increase in bolls per plant under wider plant spacing earlier revealed by Kalaichelvi (2009). Various nutritional levels significantly not influenced number of bolls plant^{-1}. Numerically higher boll number (42.2 plant^{-1}) was recorded with 150 + 32.75 + 62.5 kg NPK ha^{-1}. These results are in contrast to the findings of Sawan (1986).

Boll weight, was not affected by the plant spacings and nutritional levels. Boll weight ranged between 4.42-4.70 g. Similar results with respect to spacing and boll weight was earlier reported by Shuinaway and Mohammad (1985), where as Brar *et. al.*, (2000) reported more boll weight with higher 'N' doses.

Seed-Cotton yield

The seed cotton yield was affected by the plant spacings (Table 2). The seed cotton yield was in the order of 30 cm > 60 cm> 90 cm. Significantly higher seed cotton yield (3376 kg ha^{-1}) was recorded with 90 x 30 cm over 90 x 60 cm (3058 kg ha^{-1}) and 90 x 90 cm (2780 kg ha^{-1}). The percent improvement in seed cotton yield was 21.4% with 90 x 30 cm over 90

Table 1. Influence of spacing and fertilizers on growth and yield attributes of Bt cotton (Pooled analysis of 2005-06 and 2006-07)

Treatments	Number of monopodia plant^{-1}	Number of sympodia plant^{-1}	Boll number plant^{-1}	Boll weight (g)
Spacings				
90 x 30 cm	1.05	26.4	26.1	4.42
90 x 60 cm	1.55	25.9	41.8	4.59
90 x 90 cm	2.20	26.8	55.4	4.70
CD (P=0.05)	0.45	NS	4.8	NS
Fertilizers (N + P + K kg ha^{-1})				
120+26.2+50	1.60	26.3	40.9	4.58
150+32.75+62.5	1.45	26.7	42.2	4.52
180+39.3+75	1.75	25.9	40.5	4.55
CD (P=0.05)	NS	NS	NS	NS

Table 2. Influence of spacing and fertilizers on seed cotton yield, ginning per centage and monetary returns in Bt cotton hybrid (Pooled analysis of 2005-06 and 2006-07)

Treatments	Seed cotton yield (kg ha^{-1})	Ginning percentage	Net returns (Rs ha^{-1})	Benefit : cost ratio
Spacings				
90 x 30 cm	3376	32.24	44627	1.95
90 x 60 cm	3058	32.60	42204	2.23
90 x 90 cm	2780	33.00	38327	2.22
CD (P=0.05)	208	NS	-	-
Fertilizers (N+ P + K kg ha^{-1})				
120+26.2+50	3048	33.11	42102	2.26
150+32.75+62.5	3108	32.01	42494	2.18
180+39.3+75	3058	32.72	40562	1.94
CD (P=0.05)	NS	NS	-	-

x 90 cm. Though the boll number per plant were less in closer spacing, because of higher plants per unit area more seed cotton yield was recorded. Present results confirm the findings of Hake *et al.*, (1992), Heitholt *et al.*, (1992) Yadav *et al.*, (1991) in non Bt cotton hybrids and Giri *et al.*, (2008) in Bt cotton. During both the years, the seed cotton yield was significantly not influenced by various nutritional levels. Increasing the N, P and K levels by 25 per cent and 50 percent over 120 + 26.2 + 50 kg ha^{-1} resulted in no appreciable improvement in seed cotton yields. Earlier Kasap and Killi (2004) significantly recorded higher yield with 250 kg N ha^{-1} in non Bt cotton. Nutritional response depends on soil type, hybrid and climatic conditions. In the given ecosystem, for Bt cotton hybrid 'Bunny' 120+26.25+50 kg NPK ha^{-1} found to be optimum.

Ginning percentage

Ginning percentage was free of treatmental effects. Adoption various plant spacings or nutritional levels significantly not influenced ginning percentage both the years under study.

Economics

Economic analysis showed that highest net returns of Rs. 44627 ha^{-1} was realized with 90 x 30 cm. This spacing earned additional income of Rs. 2423 ha^{-1} over 90 x 60 cm and Rs. 6300 ha^{-1} over 90 x 90 cm. Higher nutrient application of 180 + 39.3 + 75 kg NPK ha^{-1}, resulted in esculating input cost and lesser returns of Rs. 1540 ha^{-1} over 120 + 26.2 + 50 kg NPK ha^{-1}. The higher B:C ratio (2.23) was obtained with 90 x 60 cm. Seed cost esculation for want of more plants under closer spacing (90 x 30 cm) resulted in lower B:C ratio (1.95). Nutrient application of 120 + 26.2 + 50 kg NPK ha^{-1} recorded higher B:C ratio (2.26) mainly due to lower cost of production. Application of 180 + 39.3 + 75 kg NPK ha^{-1} had the lowest B:C ratio (1.94).

It was concluded that for Bt cotton hybrid 'Bunny' spacing of 90 x 60 cm or 90 x 30 cm with 120 + 26.2 + 50 kg NPK ha^{-1}, optimum for higher yields, increased net returns and benefit: cost ratio under Central Telangana of Andhra Pradesh.

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Biochemical Basis of Host Plant Resistance in Rice Genotypes Against Brown Planthopper

D. K. Rana[1] and V.K. Dubey[2]

ABSTRACT

Total, mono and diphenol contents were estimated in 30 and 60 days old plant against brown planthopper *Nilaparvata lugens* (Stal.) in resistant donors of rice germ plasm. Phenol content was more in 60 days old plants as compared to 30 days old plant. Quantity of mono and diphenol was very less as compared to total phenol but amount of diphenol was greater than monophenol both at 30 days and 60 days old plant in test varieties those giving possibility of linkage between resistance and diphenol contents. Evidence from the present study suggested that the phenol content played a key rote in imparting the resistance.

The brown planthopper (BPH) *Nilaparvata lugens* (order-Hemiptera, family – Delphacidare) has in recent years caused extensive damage to the rice crop since 1970, Dyck and Thomas (1970). The first out break was occurred in Kerela in 1973-74 damaging about 50,000 hactre of rice (Bai *et. al*. 1972). In Chhattisgarh region severe out break of BPH was occurred in 1976, resulting in 34.4 percent yield loss (Ganrade *et.al.* 1978). The use of insecticide attempt to control this pest by chemical method give rice to many problem *viz.* resurgence, insecticidal resistance and destruction of natural enemies. The regular occurrence and severe out break of problems there by polluting the rice eco-system.

Chemical profile of host plant resistance is a complex phenomenone. The variety of chemicals are released by the host plant as a defense mechanism under selective environment situation. In most cases host plant resistance bio-chemical in nature and phytochemicals involved are mostly belong to five groups like actogenins alkaloids flavonoids, glycosides and isoprenoids, (Pathak and Dale 1983). These chemical act as feeding deterrents, growth inhibitors, and toxicants against brown planthopper. The following phenolic substances are present in rice plants such as P-coumaric acid, P-hydroxybenzoic acid, Ferulic acid, Vamillic acid, Chlorogenic acid and several flavonoids (Kuwatsuka and Oshima 1961). The Phenolic compound no doubt are responsible for such deterrents phenomenone. Therefore 1100 rice germplasm collection screened against BPH under glass house condition. The estimation of total phenol monophenol and diphenol was a main target in biochemical studies under host plant resistance. Host plant resistance has played an important role in the management of pests successfully during past two decades. Several resistant varieties have been developed and grown in different areas of India (Mathur *et.al.* (1999); Krishnaiah *et. al.*, (1999) as a result it contributed towards the suppression of the pest for nearly last fifteen years. Therefore, there is a need a develop varieties with high resistance is a prime requirement. The land races existing in different areas of India provide enough opportunity to select such donors through proper screening against this pests.

MATERIAL AND METHODS

Total phenol, monophenol and diphenol were estimated from 23 resistant rice accessions as per methodology suggested by Swain and Hill. (1989), Emerson (1993) and Mahadevan (1975) respectively. The standard curve was prepared using different concentration chlorogenic acid, phenol stock and catechol stock solution ($1x10^{-3}$ gm/ml) for total phenol, monophenol and diphenol respectively. To estimate the total phenol, monophenol and diphenol, one gram sample was taken. The phenolic content was expressed as mg gm^{-1} fresh weight sample. Three replications were recorded from 23 resistant rice accession with susceptible (TN-1) and resistant (Ptb-33) check variety. The extraction of total soluble sugar in plant was done in phosphate buffer solution (0.05 M, P^H 7.2) as per methodology.

Thirty days old BPH resistant plant samples of 23 rice accession were washed with

1. Associate Prof. and 2. Principal Scientist. Department of Entomology, IGKV, Raipur (CG)

distilled water and them dried at 50°C for 24 h. For soluble sugar estimation, 0.1 gm each of this sample in 5 ml. of buffer solution was taken and homogenised in glass pistal motor. The suspension was centrifuged at 3,000 rpm for 15 minutes twice and supernatent was collected for estimation of total sugar.

The standard curves were prepared with glucose solution at different concentration of 2×10^{-4}. Standard graphs were drawn by plotting concentration of the standard on the x axis verses absorbance on y axis. The total sugar content was expressed as mg gm^{-1} fresh weight of plant sample.

RESULTS AND DISCUSSION

The total phenol content at 30 days old plant in the twenty three cultivars ranged between 0.33 to 0.83 mg gm^{-1} of weight sample where as 0.40 to 1.42 mg gm^{-1} at 60 days old plant, it indicated high level of phenol content at 60 days old plant as compared to 30 days old plant.

The high level of phenol content at 30 days old plant exhibited by cultivars *viz*. Bhimsen, (0.78 mg gm^{-1}) Budha bhudhi, (0.83 mg gm^{-1}) Benisar, (08 mg gm^{-1}) Bharda (0.72 mg gm^{-1}) and lowest value of 0.33 mg gm^{-1} is exhibited by cultivar Badshah bhog. At 60 days old plant also Badshah Bhog showed lowest total phenol content 0.401 mg gm^{-1} while cultivar Bhagi exhibited total phenol (1.42 mg gm^{-1}) highest amongst all 23 test varieties.

Monophenol content ranged between .022 to .099 mg gm^{-1} at 30 days old plant whereas .021 to .108 mg gm^{-1} at 60 days old plant. In 30 days old plant variety Nawab bhog (N: 635) monophenol content was highest .099 mg gm^{-1} and lowest in the variety Chirai Nakhi (0.22 mg gm^{-1}) sample weight. At 60 days old plant monophenol was highest in variety Bhagi 0.108 mg gm^{-1} while lowest in variety Badshah bhog .021 mg gm^{-1}. Diphenol content ranged between .029 to .250 mg gm^{-1} at 30 days old plant where as .043 to 325 mg gm^{-1} at 60 days old plant. Diphenol content was highest 0.250 mg gm^{-1} in variety Benisar while lowest 0.029 mg gm^{-1} in variety Bhaispath at 30 days old plant. Diphenol content was highest 0.325 mg gm^{-1} in variety Bhagi while lowest .043 mg gm^{-1} in variety Badshah bhog at 60 days old plant. At 60 days old plant quantity of diphenol was more as compared to 30 days old plant.

Total sugar content ranged between 2.59 to 18.44 at 30 days old plant. Highest sugar content was noted in variety Badshah Bhog 18.44 mg gm^{-1} and lowest in Bhagi 2.89 mg gm^{-1}. Resistant check Ptb-33 exhibited least sugar content 4.93 mg gm^{-1} while susceptible check (TN-1) variety contain 10.21 mg gm^{-1} sugar. But test varieties even having higher sugar content observed resistant to BPH insect attack. Most of the scented variety *viz*. Badshah Bhog, Vishnu Bhog, Nawab Bhog and Benisar contain high amount of sugar. Variety Bhagi with lowest sugar content higher phenol content, monophenol and diphenol at 60 days old plant.

In present studies total phenol content was more on 60 days as compared to 30 days old plant. Phenol content have been estimated on resistant donors earlier by various workers, *viz*. Vishwanathan and Kalode (1990), Thayumanvan *et. al.* (1990), and Mansour *et. al.* (1994) pointed out higher amount of phenol content in resistant varieties as compared to susceptible one which is responsible to import resistance to BPH insect. Krishna (1977) clearly pointed out that phenlic compound in resistant and susceptible varieties were not of indicative of any role played by there compound but upon infestation by BPH, resistant varieties were found to react sharply in producing higher amount of phenols, similarly in present studies, all 23 resistant donors posses varying degree of phenols but certainly more than TN-1 susceptible check, however, as such, there is great likelihood to increase contents of phenolic compound on infestation BPH.

Total sugar contents in all 23 test entries were worked out feeding by insect and content of sugar in the varieties. Kalode *et. al.* (1989) also found no differences in sugar content (Sucrose, glucose and frsuctone) and susceptibility. Similar observations were also noticed by Sogawa and Pathak (1970), Peraiah *et. al.* (1982) in Tella, and Jaya. However, Kawabe *et.al.* (1980) and Liu *et.al.* (1995) observed in variations in sugar content at different plant growth stages.

In the presented literature no references was noticed on mono and diphenol contents in different varieties does not pose any significant role in relation to resistance characters expressed phenotypically, because variations in the estimates

Table :- Estimation of total, mono, diphenol and sugar content in BPH resistant donors.

S.N.	Name of Cultivars	Plant damage score	Total Phenol* (mg gm^{-1})		Mono Phenol* (mg gm^{-1})		Diphenol Phenol* mg gm^{-1})		Total Sugar (mg gm^{-1})
			30 days plant	60 days plant	30 days plant	60 days plant	30 days plant	60 days plant	30 days plant
1	Bhamasur	0.57	0.422	0.835	0.050	0.067	0.177	0.198	7.15
2	Badshah Bhog	0.83	0.568	0.427	0.052	0.021	0.061	0.046	8.26
3	Badshah Bhog	0.88	0.652	0.672	0.060	0.032	0.085	0.077	14.43
4	Bhimsen	0.98	0.785	0.790	0.028	0.047	0.055	0.129	8.54
5	Chirai Nakhi	1.16	0.595	0.581	0.063	0.036	0.089	0.080	13.89
6	Chitar Boti	1.28	0.525	0.741	0.043	0.032	0.092	0.075	8.73
7	Budha Budhi	1.29	0.833	1.141	0.071	0.072	0.124	0.178	9.80
8	Bhais Path	1.33	0.530	0.969	0.026	0.103	0.029	0.235	7.67
9	Barma Tripal	1.41	0.368	0.919	0.040	0.065	0.057	0.180	8.65
10	Badshah Bhog	1.48	0.334	0.401	0.052	0.025	0.072	0.043	18.44
11	Wishun Bhog	1.55	0.608	0.453	0.072	0.071	0.122	0.072	14.85
12	Badshah Bhog	1.72	0.478	0.525	0.053	0.037	0.054	0.093	18.30
13	Budhram	1.82	0.693	0.429	0.091	0.037	0.152	0.071	11.93
14	Bhawaile	1.86	0.618	1.004	0.073	0.078	0.114	0.182	7.98
15	Benisar	1.86	0.809	0.616	0.051	0.049	0.250	0.101	15.30
16	Nawab Bhog	1.98	0.735	1.323	0.099	0.074	0.167	0.198	17.97
17	Bharda	2.03	0.722	0.823	0.047	0.034	0.121	0.123	8.26
18	Bhejari	2.05	0.543	0.661	0.037	0.045	0.069	0.106	14.83
19	Budhi Budha	2.16	0.485	0.720	0.078	0.046	0.103	0.118	5.85
20	Chirai Nakhi	2.18	0.472	0.651	0.022	0.058	0.037	0.096	17.94
21	Budhi Budha	2.20	0.666	0.573	0.058	0.030	0.102	0.076	6.45
22	Buda Budi	2.54	0.650	0.654	0.062	0.064	0.123	0.128	12.40
23	Bhagi	2.56	0.640	1.425	0.055	0.108	0.074	0.325	2.59
24	(Susceptible Check) TN-1		0.425	0.299	0.040	0.016	0.060	0.019	10.21
25	(Resistant Check) Ptb-33		0.587	0.439	0.043	0.022	0.064	0.064	4.93

*Data based on averageof 5 replications.

are very small but diphenol content in most of varieties were much more at both 30 and 60 days old plant as compared to monophenol content in test varieties thus giving possibility of linkage between resistance and diphenol contents.

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Inheritance of Male Sterility in Chilli

Abhilasha Kharkar[1], D.T. Deshmukh[2], S.B. Sakhare[3] and Seema Mankar[4]

ABSTRACT

Sixteen sibs and their fertile pollinators obtained from crossing male sterile plants with fertile plant of same population derived from hybrid *Kiran* were evaluated. Results of study indicated that two sibmate progenies viz. AKL-03-1-04-sib-5 and AKL-03-4-sib-2 had monogenic sterility with recessive genetic control.

The male sterility has been exploited in pepper in recent years for breeding F_1 hybrids. It was first documented by Martin and Grawford (1951) and later by Peterson (1958). Thereafter many reports appeared on various aspects including isolation, mutugenic induction, inheritance, cytology and commercial exploitation. Dash *et. al*, (2001) reported commercial use of male sterility in Punjab state. Madhavi Reddy *et. al.*, (2002) reported stable cytoplasmic genic male sterile lines namely MS-1, MS-3 and MS-4 in chilli (*Capsicum annum* L.). At Indian Institute of Vegetable Research, Varanasi, also, a stable CMS line (CCA - 4261) from Asian Vegetable Research and Development Centre, Taiwan is presently being utilized for commercial hybrid development, (Sanjeet Kumar *et. al.*, 2003). The present material of male sterility is being carryforward by sib mating of sterile plant with fertile plant. Therefore, present investigation was planned to study the inheritance of male sterility and to identify the stable progenies to establish the male sterile lines.

MATERIAL AND METHODS

A single male sterile plant was observed in open pollinated bulk of F_5 generation of commercial hybrid, *Kiran*. It was crossed with four fertile plants of same bulk. The seeds obtained from male sterile plants were raised in nursery and designated as AKL-03-1, AKL-03-2, AKL-03-3 and AKL-03-4. The seedlings of all the crosses were transplanted in the main field except the seedlings of Akl-03-3 which were damaged due to soil born pathogen. The simbating was done using sterile and fertile sister plants in each cross and fertile plants were also selfed. Thus, 16 sibmate progenies and 16 selfed fertile plant pergenies were obtained. Sixteen sibs (836 plants) and selfed sixteen fertile plant progenies (371 plants) were grown in field. The count of male sterile and fertile plants in each sib was recorded. Pollen fertility was scored in 1 per cent acetocarmine.

The chi-square test of goodness of fit was used on estimated genetic ratio of male sterility characters in the progenies (Fisher and Yates, 1963).

RESULTS AND DISCUSSION

Fertile plants possessed the white coloured anthers while sterile plants possessed the bluish coloured anthers. Meshram and Narkhede (1982) reported in male sterile plant flowers were white with bluish coloured anthers while normal fertile plant had white anthers. The segregation of fertile and sterile plants in the stixteen sibmate progenies and fertile plant progenies of respective pollinators is presented in Table 1. Occurance of various types of genetic ratios indicated the presence of many genes or modifiers for sterility character in the present material. The observed segregation of 1F : 1S, in two sibs viz. AKL-03-1-04-sib-5 and AKL-03-04-sib-2 in conjugation with ratio of 3:1 in its selfed fertile plant progenies indicates monogenic recessive inheritance of sterility character which agrees to earlier reports (Meshram and Narkhede, 1982 and Sanjeet Kumar *et. al.*, 2003).

The sib no. AKL-03-1-04-sib-9 showed segregation ratio 3:1 and its selfed fertile plant progeny showed segregation ratio 9:7. It indicate complementary gene interaction of two dominant fertility alleles homozygous recessive for any one or both of which lead to male sterility. Novak *et. al.*, (1971) suggested two contradictory digenic interpretations to the data based on the 3:1 and 9:7 (fertile : sterile) ratios in test cross and F_2 population, respectively. Study of pollen sterility and fertility score using one per cent acetocarmine stain (Table

1 & 4 M.Sc. Student, 2.& 3 Associate Prof., Department of Botany, Dr. PDKV, Akola

Table 1. Segregation of fertile and sterile plant and chi-square test on different expectations for inheritance of male sterility characters in sibmate progenies and selfed fertile plant progenies of respective sibmates

SN.	Progenies	Number of plant studied	Observed segregation of fertile and sterile plant		Chi-square based of different expected ratios					Probability of acceptable least x2	Acceptable ratio
			Fertile	Sterile	3 : 1	1: 1	15: 1	13 : 3	9:7		
Sibmate progenies											
1	AKL-03-I-04-Slb-I	28	15	13	5.761905	0.035714	70.4381	13.75092	0.00907	0.0090702	9 : 7
2	AKL-03-I-04-Slb-2	79	40	39	23.73418	0	243.3494	48.23759	0.797468	0	1 : 1
3	AKL-03-I-04-Sib-3	62	34	28	12.3871	0.403226	153.6387	28.0685	0.009217	0.0092165	9 : 7
4	AKL-03-I-04-Slb-4	18	11	7	1.185185	0.5	27.39259	4,561254	0.031746	0.0317460	9 : 7
5	AKL-03-I-04-Slb-5	36	19	17	8.333333	0.027778	96.26667	18.81481	0.063492	0.027777	1 : 1
6	AKL-03-I-04-Sib-6	56	29	27	14.88095	0.017857	161.219	3,1.55495	0.290249	0.017857	1 : 1
7	AKL-03-I-04-Slb-7	74	43	31	10.37838	1.635135	154.4108	25.73319	0.042042	0.042042	9 : 7
8	AKL-03-I-04-Slb-8	35	31	4	2.752381	19.31429	0.84	1.150183	13.57324	0.84	13 : 3
9	AKL-03-I-04-Slb-9	7	52	25	1.909091	8.779221	85.90909	9.345987	3.537621	1.909090	3 : 1
10	AKL-03-I-04-Sib-10	72	36	36	22.66519	0.013889	227.7926	45.7735	0.902998	0.013988	1 : 1
11	AKL-03-:-04-Sib-Il	68	41	27	7.078431	2.485294	124.251	19.34842	0.302521	0.30252100	9 : 7
12	AKL-03-2-04-S!b-I	26	18	8	0.20512	3.115385	22.65641	2.329389	1.291819	0.20512820	3 : 1
13	AKL-03-2-04-S!b-2	49	20	19	4.25170	2.040816	83.00544	12.65829	0.311305	0.576980	9 : 7
14	AKL-03-2-04-Slb-3	90	45	45	28.68148	0.011111	286.5807	57.31111	1.185891	0.01111	1 : 1
15	AKL-03-4-04-Slb-I	50	44	6	3.84	27.38	1.9253333	1.41862	19.21143	0.23365	13 : 3
16	AKL-03-4-04-Slb-2	16	8	8	4.083333	0.0625	45.06667	i.891026	0.063492	0.802587	1 : 1
Selfed fertile plant progenies of respective sibmate											
1	AKL-03-I-04-Self-I	17	13	4	0.019608	3.764706	5.964706	0.214178	2.062558	0.888637	3 : 1
2	AKL-03-1-04-Self-2	42	24	18	6.2222	0.59523	89.91111	15.7326	0.001512	0.969985	9 : 7
3	AKL-03-1-04-Self-3	17	13	4	0.017608	3.764706	5.964706	0.214178	2.062558	0.88863	3 : 1
4	AKL-03-1-04-Self-4	17	11	6	0.490196	0.941176	19.76863	2.868778	0.210084	0.646701	9 : 7
5	AKL-03-1-04-Self-5	14	10	4	0	1.785714	8.4	0.787546	0.76644	1	3 : 1
>	AKL-03-1-04-Self-6	32	29	3	3.375	19.53125	0.13333	1.740385	I4	0.715000	13 : 3
7	AKL-03-1-04-Self-7	27	21	6	0.012346	7.259259	9.187654	0.182336	4.247501	0.911528	3 : 1
8	AKL-03-1-04-Self-8	16	11	5	0.08333	1.5625	13.06667	1.50641	0.571429	0.772829	3 : 1
9	AKL-03-1-04-Self-9	24	14	10	2.72222	0.375	45.51111	8.004274	0	1	9 : 7
10	AKL-03-1-04-Self-10	27	14	13	6.530864	0	73.89877	14.96676	0.071135	1	1 : 1
11	AKL-03-1-04-Self-11	16	13	3	0.083333	5.0625	2.4	0.019231	3.111111	0.889706	3 : 1
12	AKL-03-2-04-Self-I	21	15	6	0.015873	3.047619	14.25079	1.223443	1.397581	0.99741	3 : 1
13	AKL-03-2-04-Self-2	24	20	4	0.5	9.375	2.84444	0.055556	6.095238	0.8136637	13 : 3
14	AKL-03-2-04-Self-3	3	28	7	0.2380	11.4285	9.06857	0.0293	7.0861	0.8640	13 : 3
15	AKL-03-4-04-Self-I	24	18	6	0.55556	5.041667	11.37778	0.551282	2.708996	0.8136657	3 : 1
16	AKL-03-4-04-Self-2	18	14	4	0	2.72222	16.8	0.868946	1.273369	1	3 : 1

Table 2. Pollen sterility and fertility score in per cent under microscopic for sixteen sibmate progenies and selfed fertile plant progenies of respective sibmates

S. N.	Sibmate Progenies	Number of plant studied	Sterile plant (blue coloured anther)		Male Pollinator (Fertile Plants) (white coloured arither)			
			Number of plant	Pollen sterility score (%)	Number of plant	Pollen fertility score		
						70 to 80	81 to 90	91 to 100
	Sibmate progenies							
1	AKL-03-l-04-Sib-l	28	13	100	15	-	2	13
2	AKL-03-l-04-Sib-2	79	39	100	40	2	7	31
3	AKL-03-l-04-Sib-3	62	28	100	34	4	11	19
4	AKL-03-l-04-Sib-4	18	7	100	11	-	1	10
5	AKL-03-l-04-Sib-5	36	17	100	19	-	5	14
6	AKL-03-l-04-Sib-6	56	27	100	29	-	15	14
7	AKL-03-l-04-Sib-7	74	31	100	43	-	11	32
8	AKL-03-l-04-Sib-8	35	4	100	31	7	5	19
9	AKL-03-l-04-Sib-9	77	25	100	52	-	18	34
10	AKL-03-l-04-Sib-10	72	36	100	36	-	4	32
11	AKL-03-l-04-Sib-ll	68	27	100	41	5	7	29
12	AKL-03-2-04-Slb-l	26	8	100	18	-	2	1
13	AKL-03-2-04-Sib-2	49	19	100	30	-	10	20
14	AKL-03-2-04-Sib-3	90	45	100	45	4	2	39
15	AKL-03-4-04-Sib-l	50	6	100	44	-	-	44
16	AKL-03-4-04-Sib-2	16	8	100	8	-	-	8
	Total			-	**496**	**22**	**100**	**374**
	Selfed fertile plant progenies of respective sibmatess							
1	AKL-03-l-04-Self-l	17	03	100	14	2	-	12
2	AKL-03-1-04- Self-2	42	18	100	24	-	3	21
3	AKL-03-1-04- Self-3	17	4	100	13	2	1	10
4	AKL-03-1-04- Self-4	1	6	100	11	-	-	11
5	AKL-03-1-04- Self-5	14	4	100	10	-	4	6
6	AKL-03-1-04- Self-6	32	3	100	29	-	4	25
7	AKL-03-1-04- Self-7	27	6	100	21	-	-	21
8	AKL-03-1-04- Self-8	16	5	100	11	-	-	11
9	AKL-03-1-04- Self-9	24	10	100	14	-	-	14
10	AKL-03-1-04- Self-10	27	6	100	21	-	4	17
17	AKL-03-1-04- Self-11	16	3	100	13	-	4	9
12	AKL-03-2-04- Self-l	21	10	100	11	-	1	10
13	AKL-03-2-04- Self-2	24	4	100	20	-	-	20
14	AKL-03-2-04- Self-3	35	7	100	28	-	-	28
15	AKL-03-4-04- Self-l	24	5	100	19	-	-	19
16	AKL-03-4-04- Self-2	18	5	100	13	7	-	6
	Total	**371**	**99**	-	**272**	**11**	**21**	**240**

2) indicated that in case of blue coloured sterile anther (340 plants in sibmate progenies and 90 plants in selfed fertile plant progenies), there was absence of pollen grains. Irregular meiosis of I, II and non-dehiscence of pollen has been reported to be the reasons for male sterility (Kumar *et. al.*, 2001). Murthy and Lakshmi (1979) indicated that there was a inhibition of normal meiotic process resulting in non formation of pollen grain. When white anther coloured flowering plants (496 plants in sibmate progenies and 292 plants in fertile plant progenies) were observed under microscope, there was presence of pollen grain. Pollen fertility in fertile white anthers in different pollinator progenies as well as in segregates in sibs was in the range of 70 to 100 per cent.

On the basis of results obtained, it was concluded that the male sterility was under control of single recessive gene in two sibmate progenies. Viz., AKL-03-1-04 sib-5 and AKL-03-4-04-Sib-2 and these sibmates may prove useful as source of genetic male sterility for further use in breeding programme.

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Mapping of Quantitative Traits Loci for Relative Water Content of Leaf in Rice

M. S. Dudhare[1] and S. K. Mishra[2]

ABSTRACT

A double haploid mapping population consisting of 75 lines of a cross between the irrigated *indica* variety IR64 and the upland *japonica* variety Azucena was used in the present experiment. The complete set of double haploid lines along with parents was evaluated under two sets of conditions, 1. Transplanted with water stress and 2. Transplanted with no stress over two years. Leaf relative water content, a good indicator of the plant water status, was measured on the stressed plots. Sampling was done at 12 days after the beginning of the stress. Water stress was imposed at flowering and observations were recorded for two traits. A total of two putative QTLs for relative water content were detected, which were found to be explaining a minimum of 13.5 per cent to maximum of 14.1 per cent of phenotypic variation, individually. These QTLs were mapped on the rice genome and linked DNA markers have been validated for use in the marker assisted breeding program.

Rice wheat, and maize are the three major food crops in the world. Among them, rice is cultivated in 148 million ha and 85 per cent of its total production is used for human consumption. With the rapidly increasing population in these areas and the limited ground water available for rice cultivation, there is an urgent need to improve the rice plant by increasing its tolerance for biotic and abiotic stresses. Drought is a major abiotic stress, which limits plant growth and productivity, and is a major cause of yield instability. However, most measures of agricultural productivity, such as size, shape, yield and quality are influenced by many genes (polygenes), so that traits in a population do not fall into discrete classes, but show a continuous range of phenotypes. Quantitative variation in phenotype can be explained by the combined action of many discrete genetic factors, each having a rather small effect on the overall phenotype, and the influence of environments. As a result, breeding for quantitative traits tends to be a less efficient and time-consuming process. These genes cannot be studied individually using the methods of classical Mendalian genetics because their effects are lost in the statistical fog of all other background variation. Recently QTL mapping studies in rice revealed two important results on the genetic basis of quantitatively inherited traits. First, identification of few QTLs each having relatively large phenotypic effect and second, the complex phenotype tend to show greater QTL X E interaction, which makes marker-aided selection (MAS) for QTL to genetic improvement of complex trait difficult. Considering this aspect in view, a study of identification and molecular mapping of QTLs for relative water content of leaf in rice was undertaken.

MATERIAL AND METHODS

A population of 75 Double Haploid (DH) lines derived from a cross between the irrigated *Indica* variety IR64 and the upland *Japonica* variety Azucena (Guiderdoni *et al.* 1992) developed at IRRI, was used in the present investigation. IR64 is high yielding improved semidwarf *Indica* rice variety suitable for irrigated habitats, where as Azucena is a more drought tolerant *Japonica* rice variety. Populations of 75 Double Haploid (DH) lines were grown in randomized complete block design with two replications under two different environmental conditions viz., 1. Transplanted with water stress (TD) and 2. Transplanted with irrigated conditions (TI). In both conditions, the seeds were sown in a bed and seedlings were transplanted to a paddy field 31 days latter, with single plant $^{-1}$ hill spaced at 15 X 20 cm. Each plot included three lines with ten plants per line. All normal packages of practices were followed to raise a good crop. The drought condition was imposed by stopping irrigation at 50 per cent flowering stage (Fig 1). Leaf relative water content, a good indicator of the plant water status, was

1 Assistant Prof., Department of Agril. Botany, Dr. PDKV, Akola and 2 Professor, Pt. Ravishankar Shukla University, Raipur (CG).

measured on the stressed plots. Sampling was done at 12 days after the beginning of the stress. Leaf samples were collected early in the morning after dew had disappeared and placed in polythene bags. In the lab, leaf sample weight were taken, after which the sample was immediately hydrated to full turgidity for 4 hour by floating on de-ionized water in a close Petri dish under normal room light and temperature. After 4 hours the samples were taken out of water and were well dried with filter paper and immediately turgid weight were taken. Samples were then oven dried at 80°C for 24 h and weighed to determine dry weight. All weighing was done to the nearest mg and calculation was done by using following formula:

$$RWC\ (\%) = [(W\text{-}DW) / (TW\text{-}DW)] \times 100,$$

Where, W – sample fresh weight; TW – sample turgid weight; DW – sample dry weight.

Observations were recorded on ten plants in each replication. The mean values over ten plants was considered for analysis. The mean data for two replications under transplanted with water stress condition were analyzed for QTLs identification. MAPMAKER / QTL 1.1 was used for interval mapping (Locating the QTLs between flanking molecular marker by maximum – likelihood estimation) (Lander *et al.*, 1987), and to estimate the percentage of the total phenotypic variance explained by each QTL. A threshold of LOD > 1.5 was used[1] test to claim the presence of a QTL.

RESULTS AND DISCUSSION

A total number of QTLs detected under different environmental condition and different seasons is presented in Fig 2. The identified QTL can be classified in two types, first type represent major gene that affect quantitative traits, which are detected with large LOD score (>10). The second type includes most of QTL identified in rice, which have relative small effect. In this study, 2 QTLs were identified and had small phenotypic effect and LOD score of <10 this is expected as a different characters are under different genetic control and depend on its complexity along with variable level of QTL X E interaction. This is in agreement with the Li *et al.*, (1999) who reported that more than 80 per cent of loci identified in rice are of this type. Number of QTLs identified in this study has been reported by other workers to be presented on the different rice chromosome. e.g. Tripathy *et al.* 2000; Yan *et al.* 1998; Jinhua *et al.* 1998; Wu-WeiRen *et al.* 1999. The identification of QTLs at same position by different workers in different populations has significant implication and can be inferred as real. These QTLs, which are common, stable and if their relative contribution is also high can be the real candidate for MAS and even the map based cloning. Apart from these QTLs number of other small QTLs were also detected in the present study, which are not reported. The difference in location of QTLs for various traits may be because of different cross

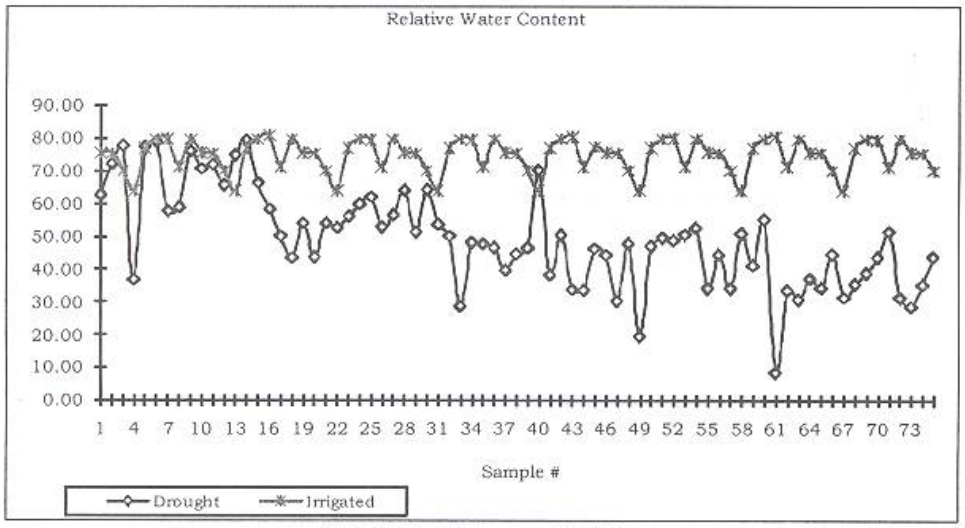

Fig 1 Field performance of DH lines

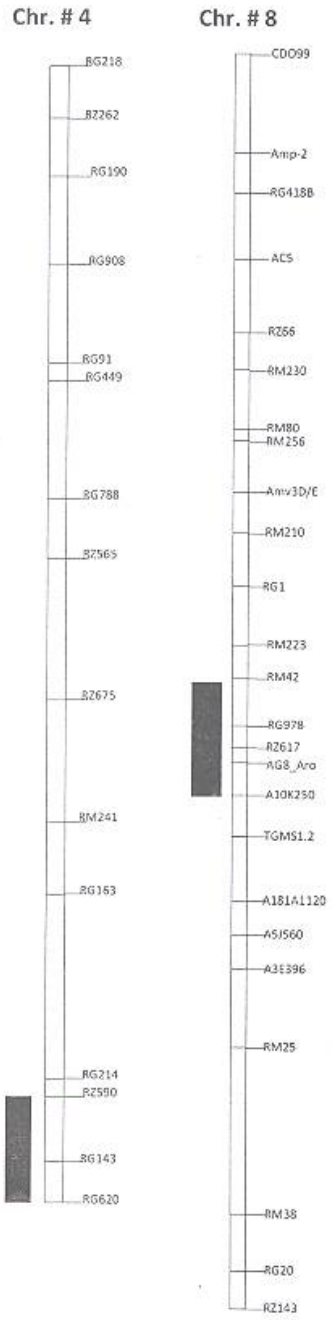

Fig. 2 Putative QTLs for Relative Water Content

combination used in this analysis, as the detection of QTL is based on allelic differences between parental lines, different population size, statistical threshold for detecting putative loci, the number of markers used in the analysis (Yano and Sasaki, 1997).

Nature of Inheritance

The nature of inheritance was studied for said characters with double haploid population consisting of 75 lines, originally developed from a cross between IR 64, an *Indica* variety and Azucena, a *Japonica* variety and the field performance of double haploid lines were graphically presented in Fig. 1.

QTLs Analysis

For this character, two QTLs were detected one each on chromosome number 4 and 8. One QTL was found on chromosome number 4 with LOD score of 2.3 between RZ590 - RG620 marker with negative additive effect and explained 13.5 per cent of phenotypic variation. Whereas, second QTL was detected with LOD score of 2.3 between RM42 - A10K250 marker on chromosome number 8 with positive additive effect and explained 14.1 per cent of phenotypic variation (Subramaniam and Madhava Menon 1973; Yan *et al.* 1998; Jinhua *et al.* 1998; Wu-WeiRen *et al.* 1999). The identification of QTLs for this important trait will be useful in breeding for the improvement of drought tolerance in rice.

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Heterosis and Combining Ability in Safflower

N.S. Parde[1], S.S. Lande[2], M.M. Wakode[3] and S.N. Deshmukh[4]

ABSTRACT

Combining ability and heterosis were studied in safflower which include both way crosses between five genetically diverse parents using approach of diallel analysis. The cross AKS-207 X Bhima exhibited highest heterosis (Over mid parent) (134.25%), heterobeltiosis (106.56%), and standard heterosis (105.54%) for seed yield plant^{-1} and other yield contributing characters viz, number of primary branches plant^{-1}, number of capitula plant^{-1} and seeds capitula^{-1}. The crosses NARI-6 x SSF-674 (97.67%), NARI-6 x Bhima (71.47%), Bhima x SSF-674 (56.50%) and reciprocal crosses SSF-674 x Bhima (71.92%), N-7 x SSF-674 (60.19%) had heterotic effect for yield and other characters studied. Hence, it can be successfully exploited through heterosis breeding. AKS-207 (3.59) was identified as good general combiner for seed yield and other traits. SSF-674 (0.63) and NARI-6 (0.61) were best general combiners for oil content. These parents could be used in crossing programme and for development of hybrids for various object. The crosses AKS-207 x Bhima (21.11), NARI-6 x SSF-674 (12.35) and reciprocals Bhima x AKS-207 (26.91) and Bhima x NARI-6 (18.95) recorded high specific combining ability effect in desirable direction for seed yield and most of the characters studied. These cross combinations could effectively be used for commercial cultivation after testing its performance at different locations with check varieties and hybrids.

Safflower is important *Rabi* oilseed crop which contains polyunsaturated fatty acid i.e, linoleic acid (70%) which reduces the cholesterol level in human blood. Safflower contains 28 to 33 per cent oil. Safflower is drought resistant and also requires less costly inputs. Hence, it has been gaining increasing popularity specially in semi-arid regions for dryland farming. Seed yield is a complex character involving number of component characters, each of which is polygenically controlled. Selection of parents for hybridization is, therefore, a complex phenomenon. In order to have full utilization of heterosis, initial selection of the parents for hybridization is more important. General and specific combining ability effect provides the guidelines to exploit the selected parents in breeding programme for particular purpose. In these views, the present investigation was undertaken to determine the heterosis and combining ability for various economic traits in safflower.

MATERIAL AND METHODS

The experimental material comprised of five genetically diverse parents viz., AKS-207, NARI-6, Bhima, SSF-674 and N-7. The crosses were done in diallel fashion (including reciprocals) in *Rabi* 2006-2007, the resultant 20 hybrids along with 5 parents were sown in randomized block design in three replications during *Rabi* 2007-2008. All the cultural operations were undertaken as per recommendations. The observations were recorded on the characters viz., days to 50 per cent flowering, days to maturity, plant height (cm), number of primary branches plant^{-1}, number of capitula plant^{-1}, number of seeds capitulum^{-1}, 100 seeds weight (g), oil content (%) and seed yield plant^{-1}(g). Heterosis, heterobeltiosis and standard heterosis were calculated following the standard procedure. The data were also subjected to combining ability analysis suggested by Griffing (1956).

RESULTS AND DISCUSSION

The analysis of variance (Table 1) indicated that the mean sum of squares due to treatments were highly significant for all the characters studied. Thereby indicating presence of variability for all the characters. Mean sum of squares due to parents were highly significant for all the characters except number of capitula plant^{-1}, while hybrids were highly significant for all the characters studied. Similarly the mean sum of squares due to parents vs hybrids were highly significant for all the characters except number of primary branches per plant and oil content.

The phenomenon of heterosis was of general occurance for all the characters. Top ranking cross combinations for different traits have been listed in table 2, along with *per se* performance, sca effect, gca effect of parents with all three types of heterosis. AKS-207 X Bhima was the highest yielding (105.87g) cross combination on the basis of *per se* performance and standard heterosis. This cross also

1. M.Sc. Student, 2. Ph.D. Scholar, 3. Junior Res. Asstt. and 4. Senior Res. Scientist, Oilseeds Research Unit, Dr.PDKV, Akola

Table 1. Analysis of variance

Source of variation	d.f.	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of primary branches plant^{-1}	No. of capitula plant^{-1}	Seeds capitulum^{-1}	100 seed wt.(g)	Oil content(%)	Seed yield plant^{-1}(g)
Replication	2	4.44	0.09	0.26	1.49	24.77	1.95	0.16	0.84	69.10
Treatments	24	71.98**	59.02**	333.50**	10.28**	219.19**	41.27**	2.59**	3.96**	681.44**
Parents	4	219.93**	91.90**	727.72**	4.00**	38.55	60.78**	6.24**	6.65**	314.72**
Hybrid	19	42.00**	36.22**	260.17**	12.09**	224.08**	36.98**	1.93**	3.57**	685.41**
Parents x Hybrid	1	49.61**	360.80**	150.09**	1.12	848.74**	44.85**	0.58**	0.70	2072.91**
Error	48	1.49	1.78	1.39	0.68	18.45	1.08	0.06	0.57	71.36

* Significant at 5% level ** Significant at 1% level

Table 2. Performance of best selected hybrids for yield and yield components

Crosses	Yield performance (g plant^{-1})	Heterosis			sca effect for yield	gca effect for yield		Significant heterosis shown for other characters in desirable direction		
		H_1	H_2	H_3		P_1	P_2	H_1	H_2	H_3
AKS-207 x Bhima	105.87**	134.25**	106.56**	106.54**	21.11**	3.59*	2.063	2,3,4,5,6	1,2,3,4, 5,6	3,4,5,6
NARI-6 x SSF-674	69.54*	97.64**	53.50**	35.68**	12.35**	2.059	-4.208	3,4,5,7	1,4,5	3,5,6,8
Bhima x NARI-6 (as reciprocal)	58.96	39.65**	30.14**	15.02	18.95**	2.063	2.059	1,3,5,7	1,4,5	3,5,6,8
Bhima x AKS-207 (as reciprocal cross)	52.06	15.19*	1.57	1.56	26.91**	2.063	3.598	3,5,6,7	1,3,6	3,6

* Significant at 5% level ** Significant at 1% level

1. Days to 50% flowering, 2. Days to maturity, 3. Plant height, 4. Number of primary branches plant^{-1}, 5. Number of capitula plant^{-1}, 6. Seeds capitula^{-1}, 7. 100 seeds weight, 8. Oil content

Table 3: Estimates of general combining ability effect of parents for different characters

Parents	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of primary branches plant^{-1}	No. of capitula plant^{-1}	Seeds capitulum^{-1}	100 seed wt.(g)	Oil content (%)	Seed yield plant^{-1} (g)
AKS-207	-2.03**	0.01	-0.08	0.34*	2.36**	-1.59**	0.45**	-0.28*	3.59*
NARI-6	4.01**	1.38**	9.92**	0.34*	0.99	1.73**	0.32**	0.61**	2.06
Bhima	2.04**	1.51**	0.56**	0.31*	-0.89	0.69**	-0.02	-0.26*	2.06
SSF-674	-3.33**	-2.52**	-5.40**	0.01	0.95	1.82**	0.78**	0.63**	-4.21**
N-7	-0.69**	-0.39	-4.99**	-0.99**	-3.41**	-2.65**	0.66**	-0.70**	-3.51**
SE(m)gi	0.19	0.218	0.19	0.13	0.70	0.17	0.04	0.12	1.38
CD (P=0.05)	0.40	0.44	0.39	0.27	1.41	0.34	0.09	0.25	2.77
CD (P=0.01)	0.54	0.59	0.52	0.36	1.88	0.46	0.11	0.33	3.70

* Significant at 5% level ** Significant at 1% level

Table 4. Superior cross combinations for yield and yield components

Crosses	*Per se* performance for yield	sca effects for yield	gca effect for parents		Significant sca effect for other components
			P1	P2	
AKS-207 x Bhima	105.87**	21.11**	3.59*	2.06	2,3,4,5,6
NARI-6 x SSF-674	69.54*	12.35**	2.06	-4.21	
SSF-674 x N-7	42.82	6.05*	-4.20	-3.51	2,3,4,5,6,8

Superior reciprocals for yield and yield components

Crosses	*Per se* performance for yield	sca effects for yield	gca effect for parents		Significant sca effect for other components
			P1	P2	
Bhima x AKS-207	52.06	26.91**	2.06	3.59*	2,3,4,5
Bhima x NARI-6	58.96	18.95**	2.06	2.05	2,3,7
SSF-674 x NARI-6	34.50	7.15*	-4.20	2.05	3

* Significant at 5% level ** Significant at 1% level

2. Days to maturity, 3. Plant height, 4. Number of primary branches plant^{-1}, 5. Number of capitula plant^{-1}, 6. Seeds capitula^{-1}, 7. 100 seeds weight, 8. Oil content

Table 5. High heterotic F_1 crosses for yield and yield components

Crosses	*Per se* performance for yield	Heterosis for yield	Heterobeltiosis for seed yield	Useful heterosis for seed yield	Significant heterosis for other components
AKS-207 x Bhima	105.87**	134.25**	106.56**	106.54**	2,3,4,5,6
NARI-6 x SSF-674	69.55**	97.46**	53.50**	35.68**	3,4,5,7
NARI-6 x Bhima	72.40**	71.47**	59.80**	41.24**	1,4,5,6,7
Bhima x SSF-674	50.29	56.50**	28.51**	-1.89	5,6,8

High heterotic reciprocal crosses for yield and yield components

Crosses	*Per se* performance for yield	Heterosis for yield	Heterobeltiosis for yield	Useful heterosis for yield	Significant heterosis for other components
SSF-674x Bhima	55.25	71.92**	41.16**	7.78	3,5,6,7,8
N-7 x SSF-674	58.22	60.19**	22.43**	13.58	3,5,6,8

* Significant at 5% level ** Significant at 1% level

had significant heterobeltiosis and standard heterosis for days to maturity, plant height, number of primary branches plant^{-1}, number of capitula plant^{-1} and seeds capitulam^{-1}.

Another cross NARI-6 X SSF-674 exhibited standard heterosis for seed yield plant^{-1} (35.68%). It was second on the basis of *per se* performance. This cross also showed significant standard heterosis for days to maturity, number of capitula plant^{-1}, seeds capitulam^{-1} and oil content. High extent of heterosis coupled with high sca effect for seed yield indicated bright prospect for developing commercial hybrids in safflower. The significant levels of all three types of heterosis along with gca, sca effect for seed yield and yield contributing characters in safflower were also reported earlier by Sadanshio *et. al.*(1999), Anonymous (2001), and Patil *et al.* (2004). The gca effect of parents are presented in Table 3. AKS-207 exhibited significant gca effect (3.59) for seed yield plant^{-1}; also showed significant gca effect for other characters viz., number of primary branches plant^{-1}, number of capitula plant^{-1} and 100 seeds weight. Parent SSF-674 and NARI-6 exhibited significant gca effect (0.63 and 0.61, respectively) for oil content.

Six out of 20, promising specific cross combinations have been listed in Table 4. The reciprocal cross Bhima X AKS-207 showed highly significant reciprocal effect (26.91) for seed yield plant^{-1}, followed by AKS-207 X Bhima (21.11) also showed the significant sca effect for days to maturity, plant height, number of primary branches plant^{-1} and number of capitula plant^{-1}. The crosses Bhima X NARI-6 (18.95), NARI-6 X SSF-674(12.35), and SSF-674 X NARI-6 (7.15) also showed significant sca effect for seed yield plant^{-1} and yield contributing characters. Similar results for gca, sca effects were also reported earlier by Patil *et al.* (1992), Fokmare (2001), Wandhare *et al.* (2003) and Patil *et. al.* (2004).

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Effect of Seed Soaking Treatments on Growth Function and Yield in Soybean

Swati Thawale[1], S.U. Kakade[2], Sapna Joshi[3] and G.S. Jeughale[4]

ABSTRACT

The entitled experiment was conducted in factorial randomized block design with three replication on the field of Seed Technology Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during Kharif 2006-07. Main treatments were fresh seed lot and revalidated seed lot and sub treatment consisted of six-invigoration treatments including control. At 45-60 DAS and 60-75 DAS, fresh seed lot L_1 recorded higher RGR values than the revalidated seed lot L_2. Treatment like T_5 (Vitavax-200@3 g Kg^{-1} seed) and T_3 (hydration for 2 hrs. followed by dry dressing with Thirum) recorded higher values than rest of the treatments. Interactions Viz. L_1T_5, L_1T_3 & L_2T_5 recorded more RGR values. Net assimilation rate was recorded at 30-45 DAS, 45-60 DAS, 60-75 DAS. Treatments like T_5 and T_3 recorded higher values of NAR. The Leaf Area Index was maximum at 60 DAS. Maximum LAI was recorded in treatments T_5 & T_3 and recorded higher values of NAR in treatment T_5 and T_3 i.e. 6.68 and 6.61, respectively. Among the invigoration treatments, the soaking of seeds in Vitavax – 200 recorded significantly higher chlorophyll content than control and other treatments. All invigoration treatments and seed lot (L1) recorded more number of pods $plant^{-1}$, 100 seed wt., Seed yield $plant^{-1}$ over control. Seed treatment with Vitavax –200 (L_1T_5) recorded significantly highest seed yield per plant among all the treatments . The increase in seed yield is mainly through increase in growth parameters like Leaf Area, Leaf Area Index, Total Dry Matter, RGR, NAR, and growth attributes and not alone by any invigoration treatment, which have helped in the field condition , giving booster effect for the development of the linked process in plants of soybean.

The importance of Soybean is increasing day by day due to its higher oil content, nutritive value and its industrial grain legume and also withstand in adverse condition as compared to other kharif crops. Soybean is called as 'Poor Mans Meal' de to its high nutritive value.

Seed is the basis of agricultural and agricultural is the foundation of national economy of India. An invigoration treatment brings about a qualitative improvement in seed. It also provides protection against stress and act as an efficient carrier of nutrients in early stage of growth . Soybean is one of the most sensitive agronomic seed for deterioration of quality, carryover seeds are generally poor in seed quality and they are discarded as they do not meet minimum seed certification standards. Several attempts have been made in this aspect to make use of carry over seeds either by increasing seed rate or by invigoration treatment The study indicates that the marginally low grade seeds can be improved unto desired (MSCS) level by pre-soaking treatments of H. D. chemicals.

MATERIAL AND METHODS

The experiment was carried out at the Seed Technology Research Unit Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S) during 2006-07

Experimental Details :

1. Design : Factorial Randomized Block Design
2. Replication : Three
3. Variety : JS-335

The experiment was conducted in Factorial Randomized Block Design with three replications and variety JS-335 , The crop was sown at spacing of 45 x 5cm. There were two main treatments i.e.

L_1 – Fresh seed lot (seed having higher level of germination than MSCS)

L_2 – Old or revalidated seed lot (seeds having germination marginally below MSCS).

The seeds were obtained from Seed Technology Research Unit of NSP, Dr. PDKV, Akola for experiment. The seed of soybean were subjected

1. M.Sc. Student, 2.Assistant Prof. of Agronomy, 3. Agril.Asstt. and 4. Junior Res. Asstt., Seed Technology Research Unit, Dr. P D K V, Akola

to invigoration (soaking) treatments with regulators and fungicides. The growth regulator namely GA_3 was obtained from Department of Botany, Post Graduate Institute Dr. PDKV, Akola.

Treatments Details :

T_0 : Untreated

T_1 : Hydration for 2 hrs and surface drying at room temperature (below 25c)

T_2 : Hydration with 50 ppm GA_3 for 2hrs and surface drying at room temperature (RT)

T_3 : As in T_1 followed by dry dressing with Thiram @0.25 percent

T_4 : 0.4% polykote T^M followed by dry dressing with Thiram @0.25 percent

T_5 : Vitavax-200 @ 3g kg^{-1} of seed

Total treatments – Seed lots (2) x Seed soaking treatment (6) = 12

RESULTS AND DISCUSSION

Physiological seed soaking treatment comprises of seed treatment for maintenance of vigor and pre-sowing treatment for improved fields performance. Productivity is a result of interaction between genetic make up and environmental conditions and efficiency of physiological process operating within the plant. The morphological characters associated with productivity are leaf area, Leaf Area Index and dry matter production etc. Development of above characters depends on source as it provides assimilates for growth. The rate of photosynthesis is manipulated to some extent by manipulating leaf area. It was observed that in all the treatments the LA increases rapidly from 30 to 45 DAS and 45 to 60 DAS of age as indicated in Table-1. Leaf area was noted to be higher in fresh seed lot than the revalidated seed lot. Among the soaking treatments Vitavax-200 gave significantly higher hydration and then dry dressing with thirum as compared to control. Similar pattern of leaf area development was also reported by Rao *et al* (1976), Maske *et al* (1998) & Rao and Singh (1997) in Soybean.

Total dry matter $plant^{-1}$ includes dry matter accumulation in leaves, DM accumulation in stem and pods and were recorded at various growth intervals (Table 2). The data indicates that DM accumulation increases slowly at 30 and 45 DAS, however, a fast increases was noted from 60 DAS, may be due to increases in number of pods, pod filling which had occurred due to increases in number of DM from stem to pod. In these studies, the total DM accumulation was significantly more in L1 seed lot than L2. Thus, seed soaking of fresh seed lot with Vitavax-200 and by hydration with dry dressing of thirum have produced maximum total DM than untreated due to increase in LAI, RGR & NAR seeds. Similar type of finding were also reported by Dave and Gaur (1970), and Lakshmi and Singh (1996). They noted maximum total DM by various invigoration treatments in Soybean .

The chlorophyll content in leaves is one of the factor in determination of rate of photosynthesis in plant. In this study the leaf chlorophyll contents was estimated. In fresh seed lot the chlorophyll was significantly higher than revalidated seed lot The invigoration treatment by Vitavax- 200 observed better for enhancing maximum value for total chlorophyll content, followed by hydration with dry dressing of thiram as compared to control. These results are in agreement with Lee (1990), Shivkumar *et al* (2001) and Wahyuni *et al* (2003).

Growth analysis gives an idea about physiological basis of yield variation and enables us to understand the influence of soaking treatment in Soybean. RGR and NAR which indicates, the increase in dry weight of plant on unit basis and rate of photosynthesis $unit^{-1}$ basis and the rate of photosynthesis per unit. Leaf Area Index (LAI) denotes the solar radiation capacity of plants In present investigation seed soaking with Vitavax-200 exhibited highest LAI, followed by hydration with dry dressing of thiram, These result are in agreement with Maske *et al* (1998) in Soybean.

Seed yield is the complex character governed by polygenes. In the present study it was observed that the seed lot and soaking treatment definitely added for higher and uniform germination and better yield.

The data on seed yield $plant^{-1}$ and yield m^{2-1} follows similar patterns indicated in Table -5. The fresh seed lot (L_1) recorded significantly higher yield than revalidated seed lot (L_2). Similarly the treatment Vitavax-200 (T_5) and treatment hydration followed by dry dressing with Thirum(T_3) exhibited significantly higher seed yields i.e. 21.5 g $plant^{-1}$ and 20.25 g $plant^{-1}$, respectively.

Table1: Effect of seed soaking treatments on leaf area plant^{-1} (dm^2) in Soybean

Treatments	30 DAS			45 DAS			60 DAS			75 DAS			90 DAS		
	L_1	L_2	Mean	L_1	L_2	Mean	L_1	L_2	Mean	L_1	L_2	Mean	L_1	L_2	Mean
T_0	2.16	2.15	2.15	9.94	9.05	9.49	12.96	12.09	12.52	14.25	12.42	13.33	9.33	8.97	9.15
T_1	2.83	2.69	2.76	10.21	9.90	10.06	13.53	12.51	13.02	14.28	12.76	13.52	9.73	9.09	9.41
T_2	2.80	2.78	2.79	10.48	10.21	10.34	13.74	12.85	13.30	14.38	13.18	13.78	9.75	9.38	9056
T_3	3.84	2.87	3.35	10.57	10.43	1.050	15.16	14.58	14.87	15.51	14.97	15.24	9.95	9.74	9084
T_4	3.83	2.80	3.32	10.53	10.32	10.43	14.64	13.31	13.98	14.92	13.61	14.26	10.15	9.46	9.80
T_5	3.91	3.23	3.57	10.99	10.62	10.80	15.30	14.79	15.04	15.69	15.12	15.40	10.40	9.84	10.21
Mean	3.22	2.75	-	10.45	10.08	-	14.22	13.35	-	14.84	13.68	-	9.88	9.41	
	L	T	LxT	L	T	LxT	L	T	LxT	L	T	LxT	L	T	LxT
'F' Test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	N.S.	N.S.	N.S.
SE (m) ±	0.025	0.043	0.062	0.047	0.081	0.115	0.037	0.064	0.091	0.055	0.096	0.136	0.190	0.330	0.467
CD at 5%	0.074	0.128	0.182	0.138	0.239	0.338	0.108	0.188	0.266	0.163	0.282	0.399	—	—	—

Table 2: Effect of seed soaking treatments on total dry matter accumulation (g plant^{-1}) at different growth stages in Soybean

	30 DAS			45 DAS			60 DAS			75 DAS			90 DAS		
Treatments	L_1	L_2	Mean	L_1	L_2	Mean	L_1	L_2	Mean	L_1	L_2	Mean	L_1	L_2	Mean
T_0	1.84	1.62	1.73	6.86	6.26	6.56	15.18	14.05	14.61	24.42	21.04	22.73	35.25	32.91	34.08
T_1	2.09	1.69	1.89	7.24	6.62	6.93	16.04	14.93	15.48	25.83	22.34	24.08	36.33	33.79	35.06
T_2	2.23	1.92	2.07	7.58	7.01	7.29	16.82	15.38	16.10	26.71	23.88	25.29	37.77	35.63	36.70
T_3	2.50	2.29	2.39	8.61	8.22	8.42	18.94	17.50	18.22	28.95	26.70	27.82	40.21	38.37	39.29
T_4	2.36	2.18	2.27	7.87	7.37	7.62	17.46	16.39	16.92	27.95	25.39	26.67	38.69	36.35	37.52
T_5	2.60	2.38	2.49	8.91	8.49	8.70	20.22	17.74	18.98	30.55	28.71	29.63	41.59	40.49	41.04
Mean	2.26	2.00	-	7.84	7.33	-	17.44	16.00	-	27.40	24.67	-	38.31	36..26	-
	L	T	LxT	L	T	LxT	L	T	LxT	L	T	LxT	L	T	LxT
'F' Test	Sig.	Sig.	N.S.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE(m)±	0.023	0.040	0.057	0.005	0.008	0.012	0.032	0.056	0.079	0.071	0.124	0.175	0.028	0.048	0.0699
CD at 5%	0.068	0.119	—	0.014	0.025	0.036	0.095	0.165	0.233	0.210	0.364	0.515	0.082	0.143	0.2033

Table 3 : Effect of seed soaking treatment on relative growth rate (g day^{-1})

Treatments	RGR (g day^{-1})			NAR(gdm^{2}day^{-1})			LAI		
	L1	L2	Mean	L1	L2	Mean	L1	L2	Mean
T_0	0.0267	0.0226	0.0246	0.0462	0.0460	0.0461	6.33	5.52	5.92
T_1	0.0283	0.0249	0.0262	0.0482	0.0453	0.0467	6.34	5.67	6.00
T_2	0.0284	0.0246	0.0266	0.0469	0.0464	0.0466	6.39	5.85	6.12
T_3	0.0303	0.0268	0.0285	0.0528	0.0501	0.0514	6.89	6.65	6.77
T_4	0.0289	0.0261	0.0275	0.0488	0.0484	0.0486	6.63	6.04	6034
T5	0.0317	0.0289	0.0303	0.0550	0.0514	0.0532	6.97	6.72	6.84
Mean	0.0290	0.0254	-	0.0496	0.0479	-	6.59	6.08	-
	L	T	LxT	L	T	LxT	L	T	LxT
'F' Test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE(m)±	0.00015	0.00022	0.00046	0.0002	0.0004	0.0006	0.024	0.042	0.060
CD at 5%	0.00046	0.00064	0.00114	0.0007	0.0013	0.0019	0.072	0.125	0.176

Table 4 : Effect of seed soaking treatment on leaf chlorophyll contents of Soybean

Treatments	30 DAS			45 DAS			60 DAS			75 DAS		
	L1	L2	Mean	L1	L2	Mean	L1	L2	Mean	L1	L2	Mean
T_0	1.50	0.97	1.24	1.93	1.29	1.61	1.92	1.39	1.65	0.86	0.64	0.75
T_1	1.57	0.98	1.28	2.00	1.43	1.72	2.10	1.54	1.82	0.92	0.87	0.90
T_2	1.53	1.32	1.42	2.05	1.49	1.77	2.14	1.58	1.86	1.00	0.84	0.92
T_3	2.36	1.95	2.16	2.90	2.43	2.66	2.97	2.52	2.75	1.09	0.98	1.03
T_4	1.89	1.50	1.70	2.10	2.00	2.05	2.39	2.42	2.40	0.99	0.96	0.98
T_5	2.43	2.34	2.38	3.09	2.50	2.79	3.19	2.59	2.89	1.13	0.90	1.04
Mean	1.88	1.51	-	2.34	1.85	-	2.45	2.00	-	101	0.86	-
	L	T	LxT	L	T	LxT	L	T	LxT	L	T	LxT
'F' Test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	N.S.	N.S.
SE(m)±	0.005	0.008	0.012	0.005	0.008	0.012	0.003	0.005	0.007	0.042	0.073	0.104
CD at 5%	0.015	0.025	0.036	0.015	0.026	0.036	0.009	0.016	0.023	0.124	—	—

Table 5: Effect of seed soaking treatments on no. of pods plants^{-1}, 100 seed weight, seed yield plant (g),and seed yield (g/m2)$^{-1}$

Treatments	No. of pods plant^{-1}			100 seed wt			Seed yield plant^{-1}(g)			Seed yield (g/m2)$^{-1}$		
	L1	L2	Mean	L1	L2	Mean	L1	L2	Mean	L1	L2	Mean
T_0	68.43	48.00	58.21	10.25	10.16	10.22	16.34	13.59	14.97	1350	1080	1210
T_1	71.42	55.80	63.61	10.30	1018	10.24	18.80	15.43	17.11	1300	1200	1290
T_2	73.10	57.98	65.54	10.38	10.42	10.40	19.72	15.91	17.81	1620	1300	1460
T_3	78.10	66.76	72.43	10.71	10.52	10.61	22.52	17.98	20.25	1690	1330	1510
T_4	75.86	63.93	69.90	10.61	10.41	10.51	20.73	16.48	18.60	1670	1310	1490
T_5	84.00	69.86	76.93	11.12	10.82	10.97	24.83	18.28	21.56	1720	1390	1550
Mean	75.15	60.39	-	10.56	10.42	-	20.49	16.28	-	1570	1270	-
	L	T	LxT	L	T	LxT	L	T	LxT	L	T	LxT
'F' Test	Sig.	Sig.	Sig.	Sig.	Sig.	N.S.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE(m)±	0.265	0.459	0.649	0.045	0.078	0.110	0.087	0.150	0.213	0.898	1.556	2.201
CD at 5%	0.778	1.347	1.906	0.132	0.228		0.225	0.442	0.625	2.696	4.566	6.458

The seed soaking treatments were beneficial for increasing the seed yield and yield attributing characters, more specially for revalidated seed lot's. Among the soaking treatments Vitavax-200 produced significantly higher number of pods plant^{-1}, 100 seed weight and seed yield plant^{-1} than the other soaking treatments These observation was similarly to that of reported by Shetter *et al* (1978), and Alam *et al* (1983).

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Effect of Organics on Seed Production and Soil Status

Priti. A. Sonkamble[1], S.P.Patinge[2] and R.T.Kausal[3]

ABSTRACT

On the organically developed plots the groundnut crop was grown during *kharif* 2008-09 and 2009-10. The results indicated that, due to application of organic treatments, the soil status was enriched significantly especially as regard to Nitrogen, Phosphorus, Potash and iron content. The crop productivity was also found to increase considerably quantitatively and qualitatively. The results of the present investigation revealed that the soil status can be improved considerably by organic treatments. The crop productivity and seed quality were also found superior over the control.

Organic farming is the form of agriculture that relies on crop rotation, green manure, compost, biological pest control and mechanical cultivation etc. Adoptions of organic farming practices for better crop production have been increasing in India by keeping away the chemical fertilizers and pesticides, which are causing large scale pollution to the environment and soil. In respect to maintain the soil productivity and control of pests, it may prove a tool to improve the fertility status of the soil along with maintaining ecological balance.

The improvement in soil productivity and soil fertility is not a sudden process but it becomes a today's need to look into an alternative to escape from the future risk. Indiscriminate use of inorganic fertilizers has deteriorated soil badly with deficiency of macro and micro- nutrients (Bhattacharya and Chakraborty.2005). We need to bring awareness among the farmers about the disadvantages of unbalanced and excessive use of chemical fertilizers and encourage organic micronutrient application. Organic agriculture may be an one of the tool for such kind of problems.

Groundnut (*Arachis hypogaea* L.) is an important oil seed crop and food grain legume, it contains about 50 per cent oil, 25-30 per cent protein, 20 per cent carbohydrate and 5 per cent fiber and ash which make a substantial contribution to human nutrition. Groundnut crop naturally enriches the soil through symbiosis process of nitrogen fixing bacteria. With the increasing degradation of the soil through chemical fertilizers, there is need to replace them with organic sources which are good for improvement of soil properties, besides supplying nutrients for longer period of time without leaving ill effects on soil, has been realized. Therefore, present study was planned to find out the response of groundnut under varying levels of organic sources of nutrients alone on status of soil micronutrients, on growth, quality and yield.

When organic manure added to soil, it supplies nutrients such as nitrogen, phosphates etc. and in addition to organic matter which goes to build up humus required for the building of soil structure and fertility. The NPK came from organic source such as FYM, vermicompost and green manure can be used as a sole source or as a substitute for part of inorganic fertilizers.

The aim of the present investigation was to replace chemical fertilizers by organic manures for getting non-chemical agricultural product plus increased yield and quality component as well as improving biological, physical and chemical properties of soil.

MATERIAL AND METHODS

The organic plots were developed during the year 2005-06, 2006-07 and 2007-08 at Seed Technology Research Unit, Dr. PDKV, Akola by applying organic treatments. The soil status was tested for NPK and micronutrient before developing the organic plots. The organic plot were developed by giving organic treatments like,

1. Associate Prof., 2. Junior Res. Asstt. and 3. Seed Research Officer, Seed Technology Research Unit, Dr. PDKV, Akola.

F1 : FYM (20 t ha^{-1}) + *Rhizobium* inoculation (5 Kg ha^{-1}).

F2 : Vermicompost (3t ha^{-1}) + *Rhizobium* inoculation (5 Kg ha^{-1})

F3 : Green manuaring (10 t ha^{-1}) + *Rhizobium* inoculation (5 Kg ha^{-1}).

F4 : A controlled inorganic plot was considered separately..

A groundnut variety TAG-24 was used for this experiment and plot size of 1.5 x 5.0 m with spacing 30 x 15 cm having three replications were designed. The seed treatment of *Trichoderma viride* @2 g kg^{-1} seed (S2) was given before sowing to one set and other set was of untreated seed. The crop protection measures of Eco- neem spray were applied on organic plot and the recommended practices were applied on control plot. All the necessary observations soil status, seed yield and seed quality were recorded during study.

RESULTS AND DISCUSSION

The soil status of the plot before and after application of organic treatment are presented in Table 1 revealed that the organic carbon, Nitrogen, phosphorous, potassium, iron, zinc and copper were found to be enhanced in the soil of organic plot. The reduction in EC reveals that due to the application of organic fertilizer the deterioration of the soil status was reduced up to some extent which reflect on the increasing soil fertility. Organic carbon, Nitrogen and

Table 1: Soil micronutrients status of before and after organic treatments.

Soil	ph	ECds m^{-1}	Org. C.%	NKg ha^{-1}	PKg ha^{-1}	KKg ha^{-1}	Feppm	Znppm	Cuppm
Beforetreatment	7.60	0.298	0.50	249.12	19.56	315.15	2.00	0.68	2.94
Aftertreatment	7.42	0.254	0.55	265.48	25.54	336.98	2.65	0.70	3.14

Table 2: Effect of organic treatments on plant stand in groundnut.

Treatment	Initial plant stand			No. of plants sq. m^{-1}		
	S_1	S_2	Mean	S_1	S_2	Mean
F1	123.66	122.33	123	20.61	20.39	20.50
F2	125	125.66	125.33	20.83	20.94	20.88
F3	124.33	127.33	125.83	20.72	21.22	20.97
F4	126.00	125.00	125.5	20.60	21.04	20.82
Mean	124.75	125.08		20.69	20.89	
	F	S	F x S	F	S	F x S
SE(m)+	1.15	0.82	1.64	0.23	0.16	0.33
CD 5%	NS	NS	NS	NS	NS	NS

Table 3 : Effect of organic treatments on test weight and yield in groundnut.

Treatment	100 seed wt.(g)			Raw Seed Yield (q ha^{-1})			Graded Seed Yield (q ha^{-1})		
	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean
F1	28	36	32	9.33	11.63	10.48	7.79	10.33	9.06
F2	36	36	36	10.69	13.79	12.24	9.19	12.99	11.89
F3	32	38	35	10.93	13.19	12.06	9.89	11.29	10.19
F4	28	28	28	8.96	10.13	9.54	7.13	8.34	7.78
Mean	31	34.5		9.98	12.18		8.30	10.74	
	F	S	F x S	F	S	F x S	F	S	F x S
SE(m)	0.64	0.45	0.91	0.10	0.07	0.14	0.08	0.05	0.11
CD 5%	1.96	1.38	2.77	0.30	0.21	0.43	0.24	0.17	0.34

Phosphorous content in the soil was found to be increase significantly due to the application of organic treatments. The findings of Bhattacharya and Chakraborty (2005) are in agreement of the results of the present investigations.

The data indicated in the Table 2 shows that the difference was found to be non-significant as regard to initial plant stand and no. of plant stand per unit area.

The data of 100 seed weight and seed yield are presented in Table no.3, which denotes that, the test weight, raw seed yield and graded seed yield was improved significantly by applying organic treatments. Maximum graded seed yield (11.89 q ha^{-1}) was obtained in the treatment F2 i.e. vermicompost (3 t ha^{-1}) + *Rhizobium* inoculation, followed by F3 treatment i.e. green manuaring + *Rhizobium* inoculation. The treatment S2 i.e. *Trichoderma* seed treatment also shows their prominent effect on test weight, raw seed yield and graded seed yield.

Among the different treatment combinations the application of vermicompost @ 3 t/ha along with *rhizobium* inoculation + *trichoderma* seed treatment (F2S2) has recoded significantly highest raw seed yield (13.79 q ha^{-1}.) and highest graded seed yield (12.99 q ha^{-1}) followed by application of green manuaring (10 t ha^{-1}) along with *rhizobium* inoculation + *trichoderma* seed treatment. (F3S2). The findings of Narayanaswamy (2006) support the results of yield and yield contributing characters.

From the Table 4 it is indicated that the treatment F3S2 was significantly superior over control in germination per cent (96.7%), followed by F2S2 (94.7%). But the seedling dry weight (3.57 g)

Table 4 : Effect of organic treatments on seed parameters in groundnut.

Treatment	Germination (%)			Seedling dry wt.(g)			Vigour Index		
	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean
F1	93.0	94.1	93.7	3.50	3.51	3.50	325.16	330.09	327.63
F2	93.3	94.7	94.0	3.28	3.57	3.42	306.00	388.02	322.01
F3	92.1	96.7	94.6	3.39	3.53	3.46	312.07	341.11	326.59
F4	87.6	94.1	91.1	3.21	3.31	3.26	281.06	311.15	296.11
Mean	91.0	94.8	-	3.34	3.47	-	307.31	328.86	-
	F	S	F x S	F	S	F x S	F	S	F x S
SE(m)+	0.93	0.66	1.32	0.007	0.005	0.01	0.71	0.50	1.00
CD 5%	2.84	2.01	4.02	0.02	0.01	0.03	2.06	1.46	2.92

Table 5: Effect of organic treatment on seed quality (oil and protein content) in Groundnut.

Treatments	Seed Oil %			Seed Protein %		
	S_1	S_2	Mean	S_1	S_2	Mean
F1	43.4	48.6	46.9	25.6	26.4	26.0
F2	46.3	47.4	46.9	26.4	26.8	26.6
F3	46.6	48.2	47.9	27.2	27.9	27.5
F4	43.6	44.2	43.1	25.8	25.9	25.8
Mean	45.7	46.6	-	26.3	26.7	-
	F	S	F x S	F	S	F x S
SE(m)	0.09	0.06	0.12	0.051	0.03	0.073
CD 5%	0.27	0.19	0.38	0.15	0.11	0.22

and vigour index (388.02) was found significantly superior in treatment F2S2 among the different treatment combinations. Paramasivam and Balamurugan (2006) studied on organic sources of nutrients on groundnut seed production and reported that the higher germination, vigour , oil and protein content obtained from the seed collected from organic sources.

The data indicated in Table .5 revealed that the crop grown by applying organic treatments shows increased oil and protein content over the control. Among all the organic treatments the highest oil content (47.9%) and protein content (27.9 %) were recorded in the treatment F3, followed by treatment F2 (49.12 %). The findings of Hunje *et. al.*, (2006) supports the results of present investigations. Also the similar results on organic sources were obtained by Paramasivam and Balamurugan (2006). Kramany *et al* (2007) reported that combination of 5 tonn ha^{-1} FYM + 3/4th recommended dose of NPK increase seed protein and oil content.

CONCLUSION

The results of the present investigation revealed that the soil status can be improved considerably by organic treatments. The crop productivity and seed quality were also found superior over the control. Especially the treatment F2 i.e. vermicompost (3 t ha^{-1}) + Rhizobium inoculation (5 Kg ha^{-1}) is found significantly superior over all other treatments. Similarly the treatment F3 i.e Green manuaring 10 t/ha + Rhizobium inoculation (5 kg/ha) shown better performance in seed oil content and seed protein content.

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Productivity and Economics of Soybean – Chickpea Crop Sequence Under Crop Residue Management

P.W. Deshmukh[1], S.M. Bhoyar[2], P.N. Magare[3] and S.M. Shendurse[4]

ABSTRACT

An investigation was carried out for four years (2003-07) to study "Productivity and Economics of soybean –chickpea crop sequence under crop residue management" at Central Research Station, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The experiment was planned in randomized block design during *Kharif* season using nine treatments of crop residues alone and in combination with fertilizers including control with three replications. During *Rabi* season two treatments of fertilizers were superimposed by maintaining *Kharif* layout. There were 18 treatment combinations replicated three times. The results indicated that incorporation of crop residue alone as well as in combination with 50 to 100 per cent RDF to both the crop significantly increased yield of soybean and chickpea. The highest benefit cost ratio was obtained with the application of crop residue treatments as compared to control treatment.

The productive capacity of soil has the direct impact on economy. Cropping sequence depends on economic outcome taken as moisture use efficiency. However, the soils vary widely in their ability to produce crops because of the differences in their qualities. For evaluation of the productivity of identified soil units, it is essential to know the limitations, to achieve the maximum economic production and to suggest the appropriate land options for specific crop and cropping system.

Cropping systems have their unique effects on nutrient availability and cycling. Rotations containing a legume may potentially increase the amount of nitrogen recycled through crop residues (Boswell *et al.*, 1985).

MATERIAL AND METHODS

The present investigation was undertaken during the year 2003-04, 2004-05, 2005-06 and 2006-07 on productivity and economics of soybean – chickpea crop sequence under crop residue management at Central Research Station, Highway Block, Dr. PDKV, Akola. The experiment was planned in randomized block design during *Kharif* season using nine treatments of crop residue alone and in combination with fertilizers including control with three replications. During *Rabi* season two treatments of fertilizer were superimposed by maintaining *Kharif* layout. There were 18 treatment combinations replicated three times. The soils of experimental site was characterized as inceptisol, slightly alkaline in reaction, medium in organic carbon, low in available nitrogen and phosphorus and high in available potassium. For economic evaluation gross monetary returns, net monetary returns, cost of cultivation and benefit cost ratio were computed treatment wise.

RESULTS AND DISCUSSION

Grain and straw yield

The pooled results in respect of soybean presented in Table 1 indicated that highest grain yield (1536 kg ha^{-1}) was observed with the application of wheat straw @ 4 t ha^{-1} + 100 per cent RDF, followed by application of sugarcane trash @ 4 t ha^{-1} + 100 per cent RDF. Similar trend was obtained in respect of stover yield also. In case of chickpea (Table 2) the pooled result indicated that highest grain (1219 kg ha^{-1}) and stover yield (3918 kg ha^{-1}) was observed in T9 treatment i.e. incorporation of wheat straw @ 4 t ha^{-1} + 100 per cent RDF and significantly superior to rest of the treatments along with inorganic fertilizers. The interaction effects found to be significant in respect of grain as well as straw yields. Similar results were also reported by Tolanur and Badanur (2003).

ECONOMICS

Gross Monetary Returns

The highest GMR (Rs. 43838 ha^{-1}) was observed with the application of wheat straw @ 4 t ha^{-1} + 100 per cent RDF, followed by T6 i.e.

1. Asstt. Prof., 2.Associate Prof., 3. Senior Res. Asstt. and 4. M.Sc. Student, Department of Soil Science & Agril. Chemistry, Dr. PDKV, Akola.

Table 1 : Yield of soybean (Kg ha^{-1}) as affected by the various treatments (pooled of four years 2003 to 2007)

Treatments	Grain yield					Straw yield				
	2003-04	2004-05	2005-06	2006-07	Pooled Mean	2003-04	2004-05	2005-06	2006-07	Pooled Mean
T1 - Control (No fertilizer)	709	703	980	985	844	1350	1290	2058	2095	1698
T2 - 50% RDF	730	745	1550	1620	1161	1380	1405	3002	3205	2248
T3 - 100% RDF	765	790	1610	1535	1175	1420	1455	3173	2892	2235
T4 - Incorporation of sugarcane Trash @ 4 t ha^{-1}	710	807	1460	1525	1125	1360	1470	2774	3010	2153
T5 - Incorporation of Sugarcane Trash @ 4 t ha^{-1} + 50% RDF	770	840	1625	1735	1242	1410	1520	3318	3510	2439
T6 - Incorporation of Sugarcane Trash @ 4 t ha^{-1} + 100% RDF	820	870	1720	2398	1452	1450	1560	3784	4374	2792
T7 - Incorporation of Wheat Straw @ 4 t ha^{-1}	711	831	1580	1194	1079	1335	1465	3381	2739	2230
T8 - Incorporation of Wheat straw @ 4 t ha^{-1} + 50% RDF	810	920	1670	1780	1295	1440	1530	3575	3540	2521
T9 - Incorporation of Wheat straw @ 4 t ha^{-1} + 100% RDF	860	980	1840	2460	1536	1510	1609	3864	4033	2754
SE (m) ±	2.80	4.83	62.83	20.00	14.73	3.48	8.60	40.98	39.82	28.78
CD at 5%	7.89	13.59	176.48	60.00	42.20	9.79	24.16	115.11	119.43	86.32

Table 2 : Yield of Chickpea (Kg ha^{-1}) as affected by the various treatments (pooled of Four years 2003 to 2007)

Treatments	Grain yield					Straw yield				
	2003-04	2004-05	2005-06	2006-07	Pooled Mean	2003-04	2004-05	2005-06	2006-07	Pooled Mean
T1 - Control (No fertilizer)	360	356	1188	568	618	755	755	3811	3127	2112
T2 - 50% RDF	377	397	1426	1436	909	780	818	3910	3960	2367
T3 - 100% RDF	405	425	1513	1540	971	810	840	4115	4145	2477
T4 - Incorporation of sugarcane Trash @ 4 t ha^{-1}	390	417	1516	1560	970	895	932	4335	4380	2635
T5 - Incorporation of Sugarcane Trash @ 4 t ha^{-1} + 50% RDF	415	445	1529	1582	993	955	1060	4705	4735	2864
T6 - Incorporation of Sugarcane Trash @ 4 t ha^{-1} + 100% RDF	435	488	1637	1936	1124	1010	1150	5810	6190	3540
T7 - Incorporation of Wheat Straw @ 4 t ha^{-1}	402	422	1554	1574	988	1175	1160	5190	5220	3186
T8 - Incorporation of Wheat straw @ 4 t ha^{-1} + 50% RDF	433	501	1560	1645	1035	1260	1370	5505	5535	3417
T9 - Incorporation of Wheat straw @ 4 t ha^{-1} + 100% RDF	455	540	1705	2176	1219	1350	1515	6165	6642	3918
SE (m) ±	3.32	5.93	17.32	19.11	12.08	2.73	7.69	32.12	6010	36.74
CD at 5%	9.95	17.78	51.94	57.35	36.22	8.18	23.04	96.31	180.28	110.21
F1 – 50% RDF	399	436	1492	1375	925	977	1030	4801	3987	2699
F1 – 100% RDF	417	451	1536	1541	986	1021	1103	4875	4387	2846
SE (m) ±	2.00	1.98	7.23	18.72	11.16	1.93	4.54	19.97	53.40	35.21
CD at 5%	5.94	5.88	21.49	56.16	33.46	5.75	13.50	59.33	160.20	105.62
Interaction (TXF)										
SE (m) ±	6.00	5.95	21.70	56.16	-	5.81	13.64	59.92	160.20	105.62
CD at 5%	17.83	-	-	-		17.26	40.50	-	-	-

Table 3 : Effect of different treatment on Economic of Soybean-Chickpea cropping sequence.

Treatments	GMR (Rs.)	C.C. (Rs.)	NMR (Rs.)	B:C Ratio
T1 - Control (No fertilizer)	23595	9150	14445	1.57
T2 - 50% RDF	32876	12069	20807	1.72
T3 - 100% RDF	34201	13167	21034	1.59
T4 - Incorporation of sugarcane Trash @ 4 t ha^{-1}	33701	11271	22430	1.90
T5 - Incorporation of Sugarcane Trash @ 4 t ha^{-1} + 50% RDF	35868	12369	23499	1.89
T6 - Incorporation of Sugarcane Trash @ 4 t ha^{-1} + 100% RDF	41996	13467	28529	2.11
T7 - Incorporation of Wheat Straw @ 4 t ha^{-1}	34045	11271	22774	2.02
T8 - Incorporation of Wheat straw @ 4 t ha^{-1} + 50% RDF	37812	12369	25443	2.05
T9 - Incorporation of Wheat straw @ 4 t ha^{-1} + 100% RDF	43838	13467	30371	2.25

incorporation of sugarcane trash @ 4 t ha^{-1} + 100 per cent RDF (Rs. 41996 ha^{-1}) which were superior to all the treatments.

Net Monetary returns

Incorporation of wheat straw @ 4 t ha^{-1} + 100 per cent RDF recorded higher NMR followed by incorporation of sugarcane trash @ 4 t ha^{-1} + 100 per cent RDF treatment among all other treatments.

B:C ratio

The B:C ratio was highest in treatment T_9 (2.25) i.e. with the application of wheat straw @ 4 t ha^{-1} + 100 per cent RDF and followed by T_6 (2.11) i.e. with the application of sugarcane trash @ 4 t ha^{-1} + 100 per cent RDF.

The lowest benefit cost ratio was found in control treatment (1.57). It can be inferred that wheat straw was more effective than sugarcane trash in improving the overall soil productivity, crop productivity and ultimately the economic returns, and soybean chickpea cropping sequence. Similar results were reported by Bharambe *et. al.*, (1990) and Raskar *et. al.*, (2000).

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Response of Foliar Application of Zinc and Iron on Yield and Quality of Isabgol

N. S. Dhonde[1], S. N. Ingle[2], S. G. Wankhade[3] and P. N. Magare [4]

ABSTRACT

The present investigation entitled, "Response of foliar application of zinc and iron on yield and quality of isabgol" was carried out at Nagarjun Medicinal and Aromatic Plants Garden, Dr.PDKV, Akola during *Rabi* 2006-07. The experimental soil was slightly calcareous, alkaline in reaction and clayey in texture, sufficient in available potassium and low in organic carbon, available nitrogen and phosphorus. The experiment was laid out in randomized block design with eight treatments comprising three replications. Recommended dose of fertilizer 50:30:0 kg NPK ha^{-1} was applied at the time of sowing. Urea was used as a source of nitrogen and single super phosphate used as a source of phosphorus. Zinc sulphate was applied in three levels, viz, @ 0.15 percent , 0.30 per cent and 0.45 per cent and Iron, it was applied at 0.15 per cent through foliar application in the form of ferrous sulphate. The results indicated that seed yield and straw yield of Isabgol found significantly highest due to foliar application of $ZnSO_4$ @ 0.45 per cent which was stastically at par with 0.30 per cent $ZnSO_4$ and 0.15 percent $FeSO_4$ Growth parameter like number of tillers $plant^{-1}$, number of spikes $plant^{-1}$ and spike length $plant^{-1}$, and quality parameter like husk content (%) and swelling capacity (CC g^{-1}) was found significantly highest due to foliar application of $ZnSO_4$ @ 0.45 per cent.

India is endowed with a rich wealth of medicinal plants. Nearly 8000 medicinal plants having curative properties are used for their medicinal and personal hygiene. The medicinal plant industry is on the verge of entering in to a high growth phase particularly in plants required for production of Ayurvedic medicines as these drugs are popular for its safety, efficacy, cultural acceptability and less side effects. Among various Ayurvedic medicine, Isabgol (*Plantago ovata* forsk) hold a prominent place and is used in Allopathic, Unani and Persian medicines also. Isabgol is a 10-45 cm short stemmed annual herb belonging to the family plantaginaceae and genus plantago which is known by different names such as ashwagalam, ghoda, Indian plantago (Kapoor, 1990). Isabgol has been used in medicines since ancient times but it has only been cultivated as medicinal plant in recent decades (Gupta, 1987). Its seed contains mucilage, fatty oil, the pharmacologically inactive glucosides namely Aucubin ($C_{13}H_{19}O_8H_2O$) and Plantiose sugar (Chevallier, 1996). Isabgol psyllium is one of the most important crops among the cultivated medicinal plants grown for its husk and seed. The mucilage present in its husk has medicinal properties and is used against constipation, irritation of digestive tract, etc. India is a sole exporter of isabgol husk and seed to the world market (Maiti and Mandal, 2000). Isabgol plays an important role in agriculture economy in India and hold a prominent monopoly in production and trade in the world. Psyllium husk is an important herb in India's export basket of medicinal plants. About 30,000 tonnes psyllium husk is obtained which is mostly processed in Gujarat. The husk also called 'Isabgol' is tasteless and swells in water, and is widely used in India as laxative. The seed and husk are used to cure inflammation of the mucus membrane of gastro intestinal and genito-urinary system, deuodernal ulcer, diarrhea and spatic constipation. It is used as "Cervical dilator" for germination of pregnancy. The seed after remaining husk is used as poultry feed which contain about 17-19 per cent protein (Dalal and Shriram, 1995). Isabgol is one of the important medicinal crops having high export potential because of its utility in western countries for further export formation.

MATERIAL AND METHODS

The present investigation was undertaken during the year 2006-07 on response of foliar application of Zinc and Iron on yield and quality of Isabgol. The experiment was planned in randomized

1.M.Sc. Student., 2. Professor., 3. Associate Prof. and 4. Senior Res. Asstt., Department of Soil Science and Agril. Chemistry, Dr. PDKV, Akola.

block design during *Rabi* season having eight treatments replicated three times. The experiment site was medium black and medium fertility status with good drainage. A composite soil sample was collected before sowing for analysis. Sowing was done on flat bed and spacing between row to row was 30 cm with recommended dose of fertilizer 50:30:0 kg NPK ha^{-1} and applied at the time of sowing. Zinc sulphate was applied @ 0 per cent , 0.15 per cent , 0.30 per cent and 0.45 per cent concentration through foliar spray by adding lime and water. Ferrous sulphate was applied @ 0.15 per cent concentration through foliar spraying with water by adding lime to it for neutralizing. Plants were harvested by cutting at ground level and then threshing was done to separate the seed and the seed yield $plot^{-1}$ was recorded. Quality parameters like husk percentage and swelling factor of seed was estimated by chemical method described in the Biannual report of AICRP on medicinal and aromatic plants (Anonymous, 1980).

RESULTS AND DISCUSSION

Growth parameters

Data regarding the number of tillers $plant^{-1}$, number of spikes $plant^{-1}$ and spike length (cm) and quality parameters like husk content and swelling capacity (CC g^{-1}) was recorded significantly highest due to foliar application of $ZnSO_4$ @ 0.45 per cent.

Number of tillers plant^{-1}

The number of tillers $plant^{-1}$ was significantly influenced by various treatments. Data presented in Table 1 indicated that maximum number of tillers $plant^{-1}$ was obtained by foliar application of zinc alone or in combination with iron. On an average the number of tillers per plant was in the range of 5.8 to 7.2. The data also revealed that the significantly highest number of tillers $plant^{-1}$ (7.2) was obtained by the treatment T_4 (0.45% $ZnSO_4$). Treatment T_2, T_3, T_5 and T_6 produced more number of tillers $plant^{-1}$ (6.5, 6.7, 6.4 and 6.3 respectively) and were statistically at par with each other. Whereas T_7 and T_8 showed statistically at par value with each other (6.2 and 6.0, respectively). Data further that the significantly maximum number of tillers $plant^{-1}$ was obtained by application of zinc. It might be due favourable effect of zinc. The results are in agreement with the Sambooranaraman *et. al.*, (1967).

Number of spikes plant^{-1}

The number of spikes $plant^{-1}$ was significantly influenced by foliar application of zinc alone or in combination with iron. The data (Table 1) regarding the number of spikes $plant^{-1}$ revealed that the significantly highest number of spikes $plant^{-1}$ (15.5) was obtained by treatment 0.45 per dent $ZnSO_4$. Treatment T_2, T_5 and T_6 showed statistically at par value with each other (12.2, 12.0 and 11.9, respectively). Whereas treatment T_7 and T_8 (11.7) produced numerically same number of spikes $plant^{-1}$. Treatment T_1 (Control) recorded lowest number of spikes $plant^{-1}$ (10.2). These results are supported by Samboornaraman *et al.*(1967) and Jiang-Rong-Feng and Zhang-Qigang (1995). They observed that the foliar application of zinc at tillering stage produced more number of fertile spikes $plant.^{-1}$

Spike length (cm)

The data (Table 1) revealed that the significantly maximum spike length (3.64 cm) was found in treatment T_4 receiving foliar application of zinc @ 0.45 per cent which was statistically at par with treatment T_2, T_3, T_5 and T_6. Treatment T_7 and T_8 recorded less length of spike (3.25 and 3.16 cm, respectively) as compared to rest of the treatments except control.

Quality of seed

The Isabgol seeds are being used for inflammatory and functional management of the membranes at the gastro-intestinal and genitourinary system. In the present investigation the quality aspects of seed particularly husk (%) and swelling factor (CC g^{-1}) as influenced by foliar application of zinc and iron was studied and reported. Data regarding the husk content (%) and swelling factor (CC g^{-1}) as influenced by various treatments are presented in Table 2 .

Husk content (%)

The data regarding the husk content (%) indicated significant improvement in husk content (%) by foliar application of zinc alone. The significantly higher value of husk content (30.03%) was obtained by treatment T_4 (0.45% $ZnSO_4$). Treatment T_2, T_3 and T_5 recorded maximum husk content (26.49, 27.80 and 26.26%, respectively) than

Table 1: Effect of foliar application of zinc and iron on growth parameters of Isabgol at harvest stage

Treatments	Number of tillers plant^{-1}	Number of spikes plant^{-1}	Spike length (cm)
T_1 – Control	5.8	10.2	2.9
T_2 – 0.15% $ZnSO_4$	6.5	12.2	3.45
T_3 – 0.30% $ZnSO_4$	6.7	14.6	3.56
T_4 – 0.45% $ZnSO_4$	7.2	15.5	3.64
T_5 – 0.15% $FeSO_4$	6.4	12.0	3.44
T_6 – 0.15% $ZnSO_4$ + 0.15% $FeSO_4$	6.3	11.9	3.39
T_7 – 0.30% $ZnSO_4$ + 0.15% $FeSO_4$	6.2	11.7	3.25
T_8 – 0.45% $ZnSO_4$ + 0.15% $FeSO_4$	6.0	11.7	3.16
'F' test	Sig.	Sig.	Sig.
SE (m) ±	0.11	0.067	0.091
CD at 5%	0.34	0.203	0.276

Table 2 : Effect of foliar application of zinc and iron on Husk (%) and swelling capacity (CC g^{-1}) of isabgol seed

Treatments	Husk (%)	Swelling factor (CC g^{-1})
T_1 – Control	24.46	10.38
T_2 – 0.15% $ZnSO_4$	26.49	10.90
T_3 – 0.30% $ZnSO_4$	27.80	10.90
T_4 – 0.45% $ZnSO_4$	30.03	11.58
T_5 – 0.15% $FeSO_4$	26.26	10.88
T_6 – 0.15% $ZnSO_4$ + 0.15% $FeSO_4$	25.66	10.80
T_7 – 0.30% $ZnSO_4$ + 0.15% $FeSO_4$	25.56	10.72
T_8 – 0.45% $ZnSO_4$ + 0.15% $FeSO_4$	25.16	10.40
'F' test	Sig.	Sig.
SE (m) ±	0.06	0.008
CD at 5%	0.18	0.024

Table 3: Effect of foliar application of zinc and iron on seed yield and straw yield at harvest stage (q ha^{-1})

Treatments	Seed yield (q ha^{-1})	Straw yield (q ha^{-1})
T_1 – Control	7.33	25.62
T_2 – 0.15% $ZnSO_4$	9.11	34.51
T_3 – 0.30% $ZnSO_4$	11.10	34.88
T_4 – 0.45% $ZnSO_4$	11.60	35.83
T_5 – 0.15% $FeSO_4$	10.83	34.21
T_6 – 0.15% $ZnSO_4$ + 0.15% $FeSO_4$	9.11	31.77
T_7 – 0.30% $ZnSO_4$ + 0.15% $FeSO_4$	7.73	30.81
T_8 – 0.45% $ZnSO_4$ + 0.15% $FeSO_4$	7.76	26.29
'F' test	Sig.	Sig.
SE (m) ±	0.58	0.306
CD at 5%	1.65	0.930

rest of the treatments except treatment T_4. Whereas treatment T_6, T_7 and T_8 recorded statistically at par value with each other (25.66, 25.66 and 25.16%, respectively). The minimum content of husk (24.46%) was recorded by treatment T_1 (control).

Swelling capacity (CC g^{-1})

The data regarding swelling capacity (CC g^{-1}) indicated significant improvement in swelling capacity by foliar application of zinc and iron. On an average the swelling capacity (CC g^{-1}) was in the range from 10.38 to 11.58 (CC g^{-1}). The data revealed that the significantly superior value of swelling capacity (11.58 CC g^{-1}) was obtained by treatment T_4 (0.45% $ZnSO_4$) than rest of the all treatments. The lowest value (10.38 CC g^{-1}) of swelling capacity was recorded by treatment T_1 (control).

Yield parameter

The data regarding the seed yield and straw yield (q ha^{-1}) of isabgol as influenced by various levels of zinc and iron are presented in Table 3.

Seed yield (q ha^{-1})

On an average the seed yield of Isabgol was in the range from 7.33 to 11.60 q ha^{-1}. The data on seed yield indicated significant improvement by foliar application of zinc and iron. The significantly highest seed yield 11.60 q ha^{-1} was recorded by treatment T_4 (0.45% $ZnSO_4$), which were statistically at par with treatment T_3 and T_5 (11.10 and 10.83 q ha^{-1}, respectively). Treatment T_1 (Control) recorded lowest value of seed yield (7.33 q ha^{-1}). From the above data, further it was observed that maximum seed yield was obtained by foliar application of zinc and iron. It may be due to favorable effect of zinc and iron on seed yield. The results are in agreement with Takkar and Bansal (1987). They found that the foliar application of zinc and iron increased seed yield.

Straw yield (q ha^{-1})

On an average the straw yield of isabgol was found in the range from 25.62 to 35.83 q ha^{-1}. The data on straw yield indicated significantly improvement in straw yield by foliar application of zinc and iron. The significantly maximum straw yield (35.83 q ha^{-1}) was recorded in treatment T_4 (0.45% $ZnSO_4$) which was statistically at par with treatment T_3 (0.30% $ZnSO_4$). Treatment T_2 and T_5 recorded more straw yield (34.51and 34.21 q ha^{-1}, respectively) than treatment T_1, T_6, T_7 and T_8. However, treatment T_6, T_7 and T_8 showed statistically at par value with each other. Data also indicated that the maximum straw yield was obtained by application of zinc and iron alone. It might be attributed to favourable effect of zinc and iron on straw yield. This result is supported by Mishra *et al.* (1989). They observed that the foliar application of zinc and iron increased straw yield of crops.

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Efficacy of Neem Products Against Storage Insects and Viability of Pearl Millet Seed During Storage Under Ambient Conditions

U.K. Kadam[1], M. P. Badgujar[2], P. R. Palande[3] and P. D. Khade[4]

ABSTRACT

The present experiment was conducted at Seed Technology Research Unit, MPKV, Rahuri during 2004-05, 2005-06 and 2006-07 on pearl millet starting from June in every year with an objective to avoid environmental hazards of the chemical insecticides and strengthen the use of eco-friendly products in organic seed production, and to find out the efficacy of neem products against major insect pests of stored pearl millet seeds. The results revealed that the germination percentage after nine months of storage period recorded by all insecticidal treatments was above MSCS (75%) level except neem oil @ 5ml kg^{-1} seed and untreated control. The highest germination and least seed damage of lesser grain borer recorded by deltamethrin 2.5WP @1 ppm, followed by neem product nimbicidine @ 5ml kg^{-1} seed after nine months of storage period.

Pearl millet is an important dryland crop. It is grown in about 78.89 lakhs ha area (Summer & *Kharif*) of marginal lands in the country (Anonymous, 2006). The pearl millet seeds are attacked in storage by stored grain pest to such an extent that seed storage has become a difficult problem. *Rhyzopertha dominica* Fab. is a key stored grain pest of pearl millet. The infestation of lesser grain borer may commence from fields or threshing floors where mature grains of pearl millet are exposed to the pests (Prem Kishore *et al.*, 2000). Control of such insects by insecticides has serious drawbacks such as development of resistance, toxic residue, workers safety and increasing cost. Biopesticides are eco-friendly. In recent years several plants have been identified which can be used as safe and renewable sources of insecticide. (Dethier 1947, Jacobson 1977, Singh and Pant 1980, Verma *et al.*1980., Verma and Pandey, 1981). Use of plant extract is now-a–days gaining importance because of its safety, non toxic to natural enemies, biodegradable, easily available and cheaper.

MATERIAL AND METHODS

The storage trial was conducted for three years from 2004 -05, 2005-06 and 2006-07 at Seed Technology Research Unit, MPKV, Rahuri in Factorial CRD design. One kg of freshly harvested certified seed of pearl millet *var. Shraddha* having high percentage of germination and less than 10 per cent moisture was taken for each treatment. Required quantity of pesticides was diluted in 5 ml water to treat 1 kg of seed for proper coating. After drying in shade, seed was packed in gunny bag-lets of 2 kg capacity and kept in room temperature under ambient conditions. The temperature and relative humidity of the room was recorded on standard week basis.

Samples of treated seed were drawn and observations on per cent infestation, per cent germination and per moisture were recorded at three months interval i.e. 0 month, 3 month, 6 month and 9 months. The experiment was carried out for three consecutive years.

Germination and moisture were determined as per ISTA rules (Anonymous, 1985). Insect infestation was carried out by counting the damaged seed and percent damage was worked out. The data were analyzed using factorial completely randomized design.

RESULTS AND DISCUSSION

Seed Damage:

The different neem based products and deltamethrin 2.5WP @ 1ppm controlled the seed damage when compared with untreated control. The per cent infestation was negligible at 0, 3, 6 and 9 months of storage period when treated with deltamethrin 2.5 WP @ 1ppm, followed by Nimbicidine @ 5ml kg^{-1} seed which was followed by Neem INDIA @ 5ml kg^{-1} seed, Econeem @ 5ml kg^{-1} seed and Neem INDIA @ 2.5 ml kg^{-1} seed. The seed

1.Assistant Seed Res. Officer, 2 & 3.Senior Res. Asstt. and 4. Seed Res. Officer, Seed Technology Research Unit, MPKV, Rahuri

Table1 : Pooled mean of Insect Infestation in Pearl Millet seeds under storage condition (2004-05, 2005-06 & 2006-07)

Tr. No.	Treatments	Insect infestation (%)			
		0 month	3 months	6 months	9 months
T_1	NSK Powder @ 5.0g kg^{-1} seed	0.00	1.89	3.89	6.44
		(0.00)	(1.08)	(2.23)	(3.70)
T_2	Neem cake @ 5.0g kg^{-1} seed	0.00	3.78	5.56	7.89
		(0.00)	(2.16)	(3.19)	(4.53)
T_3	Neem dry leaf powder @ 5.0g kg^{-1} seed	0.00	2.78	4.11	6.11
		(0.00)	(1.59)	(2.35)	(3.51)
T_4	Neem oil @ 5.0 ml kg^{-1} seed	0.00	7.11	7.89	6.44
		(0.00)	(4.08)	(4.53)	(5.42)
T_5	Neem INDIA @2.5ml kg^{-1}	0.00	2.00	3.11	4.22
		(0.00)	(1.14)	(1.79)	(2.42)
T_6	Neem INDIA @ 5.0ml kg^{-1}	0.00	1.33	1.78	1.89
		(0.00)	(0.76)	(1.02)	(1.08)
T_7	Econeem @ 2.5ml kg^{-1} seed	0.00	3.33	4.56	5.34
		(0.00)	(1.91)	(2.61)	(3.05)
T_8	Econeem @ 5.0ml kg^{-1} seed	0.00	0.56	1.11	2.11
		(0.00)	(0.32)	(0.63)	(1.21)
T_9	Nimbicidine @ 5.0ml k^{-1}g seed	0.00	0.33	0.67	1.44
		(0.00)	(0.19)	(0.38)	(0.83)
T_{10}	Deltamethrin 2.5 WP @ 1 ppm (40 mg kg^{-1} seed)	0.00	0.00	0.00	0.67
		(0.00)	(0.00)	(0.00)	(0.38)
T_{11}	Untreated control	0.00	8.89	13.67	15.44
		(0.00)	(5.10)	(7.86)	(8.89)
Interaction (T x Months)		**S.E. (m) ±**		**C.D. at 5 %**	
		0.23		0.65	

Figures in parentheses are weighted means.

treated with Deltamethrin 2.5WP @ 1ppm recorded least insect infestation (0.67%) which was at par with neem products nimbicidine @ 5ml kg^{-1} seed (1.44%) after nine months of storage period. Use of extracts of such plants like Neem (*Azadirachta indica*) is now gaining momentum because several active insecticidal Neem compounds including azadirachtin are feeding inhibitors and growth disruptors for most insect orders (Schmutterer, 1990). Thus from Table 1, it is revealed that pearl millet seed treated with Deltamethrin 2.5 WP @ 1ppm and neem products, nimbicidine @ 5ml kg^{-1} seed were found effective for control of stored grain pest of pearl millet. These results are in conformity with the results of mixing neem oil at 30 ml kg^{-1} seed was found effective against the lesser grain borer, *Rhyzopertha dominica* recording 57.95 per cent mortality of the borer, followed by neem leaf dust at 30 per cent (50.90 % borer mortality) (Kathirvelu and Ezhilkumar, 2003) (Table1).

Seed Germination:

From the pooled mean it is observed that the germination percentage was highest at 0 month then afterwards the germination percentage was lowered at 3,6 and 9 months of storage period. The seed treated with deltamethrin 2.5WP @ 1ppm, followed by nimbicidine @ 5ml kg^{-1} seed recorded highest germination at 0, 3, 6 and 9 months of storage period. (Table2).

Table2: Pooled mean of Germination in Pearl Millet seeds under storage condition (2004-05, 2005-06 & 2006-07)

Tr. No.	Treatments	Germination (%)			
		0 month	3 months	6 months	9 months
T_1	NSK Powder @ 5.0g kg^{-1} seed	94.55	93.22	91.67	84.44
		(79.30)	(69.06)	(66.57)	(58.02)
T_2	Neem cake @ 5.0g kg^{-1} seed	97.44	92.11	90.33	86.67
		(78.37)	(67.23)	(64.81)	(60.45)
T_3	Neem dry leaf powder @ 5.0g kg^{-1} seed	97.67	92.33	90.67	86.67
		(78.97)	(67.66)	(65.20)	(60.33)
T_4	Neem oil @ 5.0 ml kg^{-1} seed	97.56	88.33	83.00	72.78
		(78.92)	(68.76)	(56.13)	(46.70)
T_5	Neem INDIA @2.5 ml kg^{-1}	97.55	93.00	91.00	86.56
		(79.87)	(68.84)	(65.84)	(60.10)
T_6	Neem INDIA @ 5.0ml kg^{-1}	87.78	94.22	91.89	88.33
		(78.89)	(70.81)	(66.90)	(62.24)
T_7	Econeem @ 2.5 ml kg^{-1} seed	97.22	91.33	87.56	85.33
		(76.74)	(66.14)	(61.19)	(58.63)
T_8	Econeem @ 5.0 ml kg^{-1} seed	97.11	95.00	91.44	88.89
		(76.63)	(72.13)	(66.26)	(62.79)
T_9	Nimbicidine @ 5.0ml kg^{-1} seed	97.56	95.56	93.67	90.56
		(79.74)	(73.08)	(69.78)	(65.10)
T_{10}	Deltamethrin 2.5 WP @ 1 ppm (40mg kg^{-1} seed)	97.78	97.11	95.00	93.11
		(79.19)	(76.87)	(72.17)	(68.83)
T_{11}	Untreated control	98.00	85.22	80.00	71.33
		(79.51)	(58.53)	(53.58)	(45.52)
Interaction (T x month)		**S.E. (m)±**		**C.D. at 5 %**	
		1.93		5.45	

Figures in parenthesis are weighted means.

Seed Moisture:

There was no effect of all the treatments on moisture content. However, the moisture content ranged from 7.80 to 8.83 after 9 months of storage period (Table3).

It is concluded that, the pearl millet seed treated with deltamethrin 2.5WP @ 1ppm and the neem product nimbicidine @5ml kg^{-1} seed are most effective in checking the seed damage caused by *Rhyzopertha dominica* in pearl millet upto 9 months of storage period without affecting the germination adversely in Rahuri area.

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Table3 : Pooled mean of moisture in Pearl Millet seeds under storage condition (2004-05, 2005-06 & 2006-07)

Tr. No.	Treatments	Moisture (%)			
		0 month	3 months	6 months	9 months
T_1	NSK Powder @ 5.0g kg^{-1} seed	9.66	11.88	10.00	8.35
		(5.54)	(6.83)	(5.74)	(4.79)
T_2	Neem cake @ 5.0g kg^{-1} seed	9.65	12.20	9.90	8.10
		(5.54)	(7.00)	(5.68)	(4.65)
T_3	Neem dry leaf powder @5.0g kg^{-1} seed	9.65	11.99	10.13	8.11
		(5.53)	(6.89)	(5.82)	(4.65)
T_4	Neem oil @ 5.0 ml kg^{-1} seed	9.75	11.87	10.23	7.80
		(5.60)	(6.84)	(5.87)	(4.47)
T_5	Neem INDIA @2.5 ml kg^{-1}	9.67	12.19	10.25	8.10
		(5.55)	(7.00)	(5.88)	(4.65)
T_6	Neem INDIA @ 5.0 ml kg^{-1}	9.68	11.98	10.31	8.83
		(5.56)	(6.88)	(5.92)	(5.07)
T_7	Econeem @ 2.5 ml kg^{-1} seed	9.68	11.94	10.62	8.37
		(5.55)	(6.86)	(6.10)	(4.80)
T_8	Econeem @ 5.0 ml kg^{-1} seed	9.49	12.31	10.35	7.90
		(5.44)	(7.07)	(5.94)	(4.53)
T_9	Nimbicidine @ 5.0ml kg^{-1} seed	9.61	12.28	10.85	8.41
		(5.51)	(7.06)	(6.23)	(4.82)
T_{10}	Deltamethrin 2.5 WP @ 1 ppm (40 mg kg^{-1} seed)	9.77	11.61	10.53	8.49
		(5.61)	(6.67)	(6.04)	(4.87)
T_{11}	Untreated control	9.68	11.95	10.55	8.70
		(5.55)	(6.86)	(6.06)	(4.99)
Interaction (T x Month)		**S.E. (m) ±**		**C.D. at 5 %**	
		0.12		**0.33**	

Figures in parentheses are weighted means.

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Quality of Farmers Saved Groundnut Seeds with Special Reference to Insect Infestation in Gujarat

Y. H. Ghelani[1], K. K. Dhedhi[2], H. J. Joshi[3] and C. J. Dangaria[4]

ABSTRACT

Survey was conducted to assess the level of *Caryedon serratus* (Olivier) infestation and quality of farmers' saved groundnut seed in Gujarat state during *Kharif* season of 2006 to 2009. The groundnut seed samples revealed that 48.5, 87.9, 63.6 and 87.5 per cent were found infested with *C. serratus* during the year 2006, 2007, 2008 and 2009, respectively. Of the collected samples 28.6 per cent were absolutely free from bruchid damage during 2006 to 2009. The average seed damage was observed 2.64 per cent in the farmers' saved seed samples. All the seed samples recorded less than prescribed seed moisture percentage and mean percentage of field germination was 75.6 per cent which is above the prescribed limit (70 %). Seed was stored in gunny bags which was kept in common residential room without mixing of insecticides or fumigation. This is the traditional method of the storage in this region and there were no special facility for seed storage.

Groundnut *(Arachis hypogaea* L.) is the most important oilseed crop introduced to India in 1856 by traders from Central America; first in to the erstwhile North Arcode district of Tamil Nadu. About 89 per cent of the total area and production of groundnut is confined to Gujarat, Andhra Pradesh, Tamil Nadu, Karnataka and Maharashtra. In Gujarat, it is mainly grown in *Kharif* season. Generally, farmers of Gujarat state use their own seed harvested in the last season, which are stored in gunny bags and kept in common residential room, a traditional method of storage in the region. The groundnut seed are stored hi the form of pods as well as kernels. Both are susceptible to attack of insects during storage. The primary damage in stored groundnut is mainly caused by the groundnut seed beetle, *Caryedon serratus* (Olivier), followed by secondary attack of other insect pests. Presently, *C. serratus* is occurring through out India causing considerable damage to groundnut at farmers, traders and millers levels. The losses in groundnut due to this insect varied from 19 to 60 per cent when the groundnut was stored for five months (Dick, 1987). In Gujarat state, this bruchid caused heavy losses up to 84 per cent during storage of groundnut (Anonymous, 1991). Therefore, the survey was conducted to know the level of infestation of *C. serratus* and quality of farmers' saved groundnut seeds in Gujarat.

MATERIAL AND METHODS

To estimate the level of infestation of groundnut bruchid *C. serratus* and quality of farmers' saved groundnut seeds, survey was conducted before sowing *of Kharif* season of 2006, 2007, 2008 and 2009. About 500 g seeds of groundnut were collected from farmers of different villages of Jarnnagar, Junagadh, Rajkot and Kutch districts. Total 66, 58, 44 and 56 seed samples were collected during the year 2006, 2007, 2008 and 2009, respectively. While collecting samples, questionnaire was filled to know variety, period and condition, method of storage, treatment if any and source of seed. Collected samples were brought to the laboratory and first tested for insect infestation by visual counting later on the moisture content of seed was determined by hot-air oven method (Anonymous, 1996). Two hundred seeds were counted and sown in field in two rows each of 10 meters and containing 100 seeds with inter and intra raw spacing of 60 cm X 10 cm during *Kharif* season of 2006 - 2009 and the per cent seed germination was recorded.

RESULTS AND DISCUSSION

The detail analysis of the groundnut seed samples presented in Table 1 revealed that the 48.5, 87.9, 63.6 and 87.5 per cent samples were found infested with groundnut seed beetle, *C. serratus* during the year 2006, 2007, 2008 and 2009, respectively. The mean seed damage was noticed 2.58 (2006), 4.63 (2007), 1.23 (2008) and 2.13 per cent (2009). The highest mean seed damage 5.73 per cent was observed in the samples collected from the Jamnagar district during 2007 while it was lowest 1.23 per cent in samples of Jamnagar district during 2008. Of the 224 samples collected, 64 samples were absolutely free from insect damage during 2006 to 2009. The overall average seed damage was observed 2.64 per cent in the farmers' saved seed samples.

1. & 2. Assistant Seed Research Officer (PL Br.), 3. Seed Research Officer and 4. Research Scientist, Pearl Millet Research Station, Junagadh Agricultural University, Jamnagar (Gujarat)

Table 1: Level of C. *serratus* infestation and quality parameters of farmers' saved groundnut seed

Year	District	No. of samples collected	No. of samples found infested	Seed damage (%)	Moisture (%)	Germination (%)
2006	Jamnagar	20	12 (60.0)*	3.36(0.0-6.0)"	6.30	73.6
	Rajkot	29	14 (48.3)	2.24(0.0-5.0)	6.10	77.7
	Junagadh	17	6 (35.3)	2.15(0.0-5.0)	6.90	73.1
		66	***32 (48.5)***	***2.58***	***6.40***	**75.9**
2007	Jamnagar	15	15 (100.0)	5.73(0.0-14.0)	7.17	67.6
	Rajkot	17	14 (82.4)	4.47(0.0-10.0)	6.86	72.3
	Junagadh	26	22 (84.6)	3.69(0.0-7.0)	6.93	75.7
		58	***57 (87.9)***	***4.63***	***6.97***	***71.9***
2008	Jamnagar	*44*	*28 (63.6)*	*1.23(0.0-5.0)*	*5.00*	*82.5*
2009	Jamnagar	8	6 (75.0)	1.90(0.0-5.0)	4.60	73.9
	Rajkot	37	33 (89.2)	1.86(0.0-5.0)	3.70	74.6
	Kutch	11	10 (90.9)	2.64(0.0-6.0)	4.70	71.3
		56	***49 (87.5)***	***2.13***	***4.33***	***733***
	Total	**224**	**160 (71.4)**	**2.64**	**5.68**	**75.6**

* = percentage of samples found infested, # = min - max

The minimum mean percentage of seed moisture content (3.%) was recorded in samples collected from Jamnagar district in year 2009, whereas the maximum mean percentage of seed moisture content (7.17 %) was found in the samples collected from Jamnagar district during 2007. All the 224 farmers' saved seed samples recorded seed moisture percentage less than prescribed maximum seed standard (9 %). Insect damaged as well as damage free samples had recorded per cent germination above minimum standard (70 %) except the samples collected from the Jamnagar district (67.6 %) during 2007. The highest mean percentage of field germination (82.5 %) was reflected in samples collected from Jamnagar district during 2008. The lower field emergence (67.6 %) in the samples collected Jamnagar district during 2007 was probably due to the higher insect damage during the storage.

Both the mean moisture content of seeds (7.17 %) and the mean percentage of insect damage (5.73 %) were maximum in seed samples collected from Jamnagar district during 2007. On the other hand, during 2008, the lowest mean insect damage (1.23 %) in seed samples collected from Jamnagar district were due to low mean percentage of seed moisture content (5.0 %). The results indicated that there was a direct relationship between the high moisture content of the seed and an increased insect infestation with a corresponding decrease in germination. Dhedhi *et. al.* (2007) reported that 93 per cent of groundnut seed samples met the requirement of prescribed limit for germination and seed damage due to *C. serratus* was noticed up to 4.25 per cent. A survey on bruchid damage in groundnut storage was carried out in Amreli (Gujarat) and Jalgaon (Maharashtra) districts exposed 4 and 25 - 90 per cent damage, respectively (Anonymous, 1991). Further, the questionnaire filled during the survey indicated that the majority of the farmers were adopted recommended groundnut variety, few farmers were also using local variety i.e. *Samudri* and *Sandhiya.* Seed was stored in gunny bags which was kept in common residential room without mixing of insecticides or fumigation. This is the traditional method of the storage in this region and there were no special facility for seed storage.

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Bio-efficacy of Some Bioagents and Botanicals Against Sorghum Stem borer

H.G. Kandalkar[1], P.N. Mane[2], U.P. Barkhade[3] and R.B. Ghorade[4]

ABSTRACT

Some, bioagents, namely *Trichogramma chilonis, Metarhizium anisopliae, Beauveria bassiana, Nomerea riley* and botanicals *Neem* seed extract 5 per cent, Nimbodi Harbo Paste were evaluated in *Kharif* season of three consecutive years i.e. 2005, 2006 and 2007 at Sorghum Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. *Trichogramma chilonis* recorded minimum leaf injury (7.83 %), penduncle damage (32.60 %) and higher grain yield (40.76 q ha^{-1}) and also recorded highest ICBR i.e. 10.91.

Stem borer *Chilo partellus* Swinhoe (Order: Lepidoptera, Family: Pyralidae) is one of the important insect pests, which causes severe damage to sorghum crop. Yield loss of 53 - 83 per cent, due to stem borer infestation has been recorded in Northern India (Jotwani *et. al.,* 1971). Appearance of small elongated windows in young whorl leaves is the first damage indication of this pest. Subsequently larvae bore into the stem and short holes appear in whorl leaves, which lead to dead heart. After head emergence the stalk just below or on the panicle is often bored, resulting in breaking of the panicle or complete or partial chaffy seeds. There is often extensive tunneling of the stem. Though insecticidal interventions are reported to check this pest effectively, the increasing environmental pollution and residue problems necessitate the search for biosafery means to control. Hence to tackle this pest through the use of some bioagents and botanicals was attempted.

MATERIAL AND METHODS

A field experiment was conducted in randomized block design with 8 treatments including untreated control, replicated thrice in *Kharif* season of three consecutive years i.e. 2005-2006, 2006-2007 and 2007-2008 at Sorghum Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola with 3.00 x 2.25 m plot size. The trial was laid using CSH-9 variety and plants were spaced 45 cm between and 15 cm within rows under recommended agronomic practices. Crop was sown on 4th July 2005, 30th June 2006 and 2nd July 2007. Treatments used were *Trichogramma chilonis* 1.5 lakh eggs ha^{-1}, *Neem* seed extract 5 per cent, Nimbodi Harbo Paste 5 ml l^{-1}, Goneem 5 ml l^{-1}, *Beauveria bassiana* 2.5 g l^{-1}, *Metarhizium anisopliae* 2.5 g l^{-1} and *Nomerea riley* 2.5 m l^{-1} of water. Treatments were imposed on 30th and 40th days after emergence of crop. Leaf injury was recorded on 60th day after emergence of crop and peduncle damage was recorded at harvest by counting total plants and damage plants in each plot.

RESULTS AND DISCUSSION

Leaf Injury

Significant differences were observed within the treatments. All the biopesticides and botanicals were significantly superior over untreated control. Minimum 7.83 per cent leaf injury was recorded in the treatments *Trichogramma chilonis* which was at par with all other biopesticides and botanicals. While amongst treatments, maximum i.e 10.37 per cent leaf injury was recorded in *Metarhizium anisopliae* (Table 1).

Peduncle Damage

Three years pooled results given in table 1 revealed that all the bioagents and botanicals were significantly superior over untreated control. Minimum 32.60 per cent peduncle damage was observed in the treatment *Trichogramma chilonis* and it was at par with all other bioagents and botanicals except *Nomerea riley.* Maximum peduncle damage (38.36 %) was recorded in treatment of *Nomerea riley.*

Grain Yield

Regarding grain yield of sorghum, significant differences were observed within the treatments and all the bioagents and botanicals were

1. Assistant Prof., 2, Assistant Prof. Sorghum Res. Unit, 3. Head, Department of Entomology and 4. S.R.S., Sorghum Research Unit, Dr. PDKV, Akola

Table 1: Effect of some bioagents and botanicals against sorghum stem borer *chilo partellus* (Average pooled mean)

S.N.	Treatments	Dead hearts (%)	Leaf injury (%)	AV. Peduncle damage (%)	Grain yield q ha^{-1}	ICBR
1	*Trichogramma Chilonis* 1.5 lakh eggs ha^{-1}	0.12	7.83 (15.85)	32.60 (34.76)	40.76	10.91
2	Neem seed extract 5 %	-	8.29 (16.34)	33.69 (35.41)	38.39	5.94
3	Nimbodi Harbo Paste 5 ml l^{-1}	0.11	9.00 (16.82)	31.10 (33.82)	38.74	4.78
4	Goneem 5 ml/l	-	7.96 (15.90)	32.91 (34.96)	38.72	0.86
5	*Beauveria bassiana* 2.5 g l^{-1}	0.11	9.01 (16.70)	33.12 (35.11)	37.25	5.10
6	*Metarhizm anisopliae* 2.5 g l^{-1}	-	10.37 (17.82)	34.94 (36.17)	37.08	4.67
7	*Nomerea riley* 2.5 m l^{-1}	0.11	8.83 (16.87)	38.36 (38.21)	34.22	2.86
8	Untreated control	-	16.19 (23.38)	48.76 (44.29)	28.99	-
	'F' test	-	Sig	Sig	Sig	-
	SE (m) ±	-	1.01	1.36	1.13	-
	CD at 5 %	-	2.84	3.83	3.18	-

Figures in the parentheses are arc sine value

found significantly superior over untreated control. Maximum 40.76 q ha^{-1} grain yield was observed in the treatment *Trichogramma chilonis* and it was at par with all the botanicals and bioagents except *Metarhizium anisopliae* which recorded 37.08 q ha^{-1} of grain yield.

ICBR

The highest i.e 10.91 ICBR was observed in the treatment *Trichogramma chilonis* as compared to other bioagents and botanicals.

The results of this study are more or less comparable with study of Kumar Suneel and Khan (2005), Singh *et. al.*, (2007), Narasimha Rao *et.al.* (2006), Viji and Bhagat (2001).

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Efficacy of Bioagents on Seed Mycoflora, Seed Germination, Seedling Vigour Index and Field Emergence in Sunflower

S. B. Gawade[1], V. K. Mandhare[2], D. N. Padule[3], B. C. Game[4] and V. A. Chavan[5]

ABSTRACT

The seeds of sunflower (cv. Morden) was treated with bioagents i.e. talc powder formulations of *Pseudomonas fluorescens* (0.6%), *Trichoderma viride* (0.6%), *Pseudomonas fluorescens* + *Trichoderma viride* (0.6%) each and thiram + carbendazim (0.2%) each as a recommended fungicide. The seed treatment with *P. fluorescens* + *T. viride* was effective in reducing seed mycoflora i.e *Alternaria alternata, Fusarium semitectum, Fusarium oxysporum, Fusarium moniliforme, Aspergillus niger, Aspergillus flavus* and *Botryodiplodia theobromae* by 75, 91, 100, 67, 79, 41 and 100 per cent, respectively over untreated control. The seed germination, seedling vigour index and field emergence of sunflower was increased by 23.13, 42.75 and 67.10 per cent, respectively. The mean seed germination, seedling vigour index and field emergence in untreated sunflower was 67.60 per cent, 1884.8 and 48.04 per cent, respectively.

Sunflower *(Helianthus annus* L.) has great potential of oil production among the oil seeds in India. The seeds of sunflower were found to be constantly associated with a number of pathogenic and non-pathogenic microorganisms. Seed-borne mycoflora often responsible for the loss of viability of seeds. Treatment of thiram + carbendazim to the seeds of sunflower and safflower are effective to reduce seed mycoflora, increase the seed germination, seedling vigour index and field emergence (Abraham *et. al.*, 1976 and Singh *et. al.*,1987).Voisard *et al.* (1989) suggested that *Pseudomonas* have the ability to synthesize hydrogen cyanide and known to inhibit the pathogenic fungi. The present study was therefore, undertaken with a view to determine the effect of bioagents on seed mycoflora, seed germination, seedling vigour index and field emergence in sunflower.

MATERIAL AND METHODS

Seeds of sunflower (cv. Morden) were collected from Agricultural Research Station, Savlivihir (Dist. Ahmednagar) during *Kharif* 2003-2004, 2004-05, 2005-06, 2006-07 and 2007-2008.The seeds were treated with talc powder formulations of *P. fluorescens* @ 0.6 per cent, *T. viride* @ 0.6 per cent, *P. fluorescens*+ *T. viride* @ 0.6 per cent each in the form of slurry and thiram + carbendazim @ 0.2 per cent each. The untreated seeds served as control. After 24 hours of treatment, the seeds were air dried and subjected to blotter test, seed germination, seedling vigour index and field emergence.

Seed mycoflora

Four hundred seeds of the sunflower were used to record the per cent infection of seed mycoflora by standard blotter method (ISTA, 1993).

Seed germination

Treated seeds (400) were placed between paper rolls in four replicates of 100 seeds each for germination. The rolls were kept at 23 ± 2°C in seed germinator. The first count of normal seedlings was taken on the 3rd day and the second count on the 7th day. The germination per cent was calculated.

Seedling vigour index (SVI)

Normal seedlings were evaluated for seedling vigour index. The root and shoot length of the normal seedlings were measured and seedling vigour index (SVI) was calculated (Abdul Baki and Anderson, 1973) by using formula ;

Seedling vigour index (SVI) = [Mean root length (cm) + mean shoot length(cm)] x percentage germination

The laboratory studies on seed mycoflora, seed germination and seedling vigour index were

1.Assistant Seed Res. Officer, 2. Sr. Scientist, STRU (NSP), 3. Professor of Plant Pathology, Agriculture College, Dhule, 4. Junior Wheat Pathologist, ARS, Niphad and 5. Assistant Prof, Seed Cell, M.P.K.V., Rahuri

conducted in seed pathological laboratory with completely randomised block design.

Field emergence

The field emergence were tested continuously during the year 2003-2004 to 2007-08 on Research Farm of Seed Technology Research Unit (NSP), M.P.K.V., Rahuri in randomized block design. The field was prepared with fine tilth, fertilizers i.e. N, P and K were applied at the rate of 60:30:30 kg ha" . Seeds of sunflower were treated with bioagents i.e *P. fluorescens* @ 0.6 per cent, *T. viride*, @0.6 per cent, *P. fluorescens* + *T. viride* @ 0.6 per cent each and thiram + carbendazim @ 0.2 per cent each .The untreated seeds served as control with four replications. One hundred seeds were used for each replication. They were sown in four rows which were distributed randomly with spacing of 45 cm between rows and 22.5 cm between plants. The fields were irrigated immediately after sowing. The field emergence was recorded 21 days after sowing.

The data in respect of seed germination, seedling vigour index and field emergence were tabulated and mean percentage was worked out. The per cent observations were converted into arc-sin transformed values and subjected to statistical analysis

RESULTS AND DISCUSSION

The results (Table-1) indicated that the treatment of sunflower seeds with recommended fungicides and bioagents significantly reduced the mycoflora associated with the seeds of sunflower. Thiram + carbendazim @ of 0.2 per cent each reduced the infection of seed mycoflora by 71 to 100 per cent. Abraham *et al.* (1976) and Vijayalakshmi and Rao (1984) reported effective control of pathogens associated with sunflower seed by thiram and carbendazim. Among the bioagents, seed treatment with *Pseudomonas fluorescens* + *Trichoderma viride* @ 0.6 per cent each was found effective in reducing the seed mycoflora, followed by *T. viride* over untreated control. There was 75, 91, 100, 67, 79, 41 and 100 per cent reduction in *Alternaria alternata, Fusarium semitectum, Fusarium oxysporum, Fusarium moniliforme, Aspergillus niger, Aspergillus flavus* and *Botryodiplodia theobromae*, respectively, with the seed treatment of *Pseudomonas fluorescens* + *Trichoderma viride* @ of 0.6 per cent each.

Seed germination

The seed germination of sunflower was significantly increased with the treatment of recommended fungicides and bioagents over untreated control (Table-2). There was 25 per cent increase in seed germination with the treatment of thiram + carbendazim @ of 0.2 per cent each. Among the bioagents, *Pseudomonas fluorescens* + *Trichoderma viride* @ 0.6 per cent each increased the seed germination by 23.13 per cent followed by *T. viride* (16.12%) over untreated control. The mean seed germination in untreated control was 67.60 per cent. The mean seed germination was 83.36 and 78.50 per cent with the treatment *of P. fluorescens* + *T. viride* and *T. viride,* respectively. Leeman *et al.,* (1995) reported that the seed germination in radish increased in commercial green houses with the treatment of *P. fluorescens* .Singh (2000) reported in sunflower that thiram, bavistin and dithane M-45 showed enhanced germination and reduced seedling mortality due to *Fusarium* and *Scerotium.* The Minimum seed certification standards (MSCS) for germination in sunflower is 70 per cent. Therefore, this treatment was efficient for increasing the seed germination in sunflower.

Seedling vigour index

Seedling vigour index was increased by 52.86 per cent with the treatment of thiram + carbendazim @ of 0.2 per cent each. Among the bioagents, treatment of seeds with *P. fluorescens* + *T. viride* @ 0.6 per cent each increased the seedling vigour index by 42.72 per cent followed by *T. viride* (28.46%). Raju *et. al.,* (1999) reported the effectiveness of *P. fluorescens* formulations for increasing the seedling vigour index in sorghum.

Field emergence

Treatment of sunflower seeds with thiram + carbendazim @ of 0.2 per cent each increased the field emergence by 54.35 per cent. Among the bioagents, combination of *P. fluorescens* + *T. viride* @ of 0.6 per cent each and *Trichoderma viride* @ 0.6 per cent alone increased the field emergence by 67.10 and 48.31 per cent, respectively over untreated control. Raju *et. al.,* (1999) reported effectiveness of

Table 1. Effect of bio-agents on mean seed mycoflora (%) in sunflower, (cv. Morden) during 2003-04 to 2007-08.

Treatments	Year	Sunflower mycoflora							
		A. a.	*F. sent.*	*F. oxy*	*P.m..*	*A.n*	*A.f*	*A. t..*	*B.t.*
P. fluorescens @0.6%	2003-04	1	6	0	0	10	0	0	0
	2004-05	0	0	1	0	17	0	2	0
	2005-06	10	6	4	4	0	0	1	0
	2006-07	0	0	1	0	19	4	2	0
	2007-08	11	0	0	0	7	0	0	0
	Mean	4.4	2.4	1.2	0.8	11	0.8	1.0	0.0
	% reduction	**46**	**48**	**45**	**55**	**28**	**82**	**0.0**	**100**
T. viride @ *0.6%*	2003-04	0	0	0	2	2	0	1	0
	2004-05	0	0	3	0	3	0	1	0
	2005-06	12	2	2	0	0	0	0	0
	J>006-07	0	0	1	1	7	5	1	0
	2007-08	3	0	3	0	4	4	0	0
	Mean	3.0	0.4	0.4	0.0	4.2	2.4	0.0	0.0
	% reduction	**63**	**91**	**82**	**100**	**79**	**41**	**100**	**100**
P. fluorescens + *T. viride* @ 0.6 % each	2003-04	0	0	0	0	4	3	0	0
	2004-05	0	0	1	0	2	0	1	0
	2005-06	7	2	0	2	0	0	0	0
	2006-07	0	0	0	1	10	6	4	0
	2007-08	3	0	0	0	5	3	0	0
	Mean	2.0	0.4	0.0	0.6	4.2	2.6	1.0	0.0
	% reduction	**75**	**91**	**100**	**67**	**79**	**41**	**0**	**100**
Thiram + carbendazim @ 0.2 % each	2003-04	2	2	0	0	0	0	0	0
	2004-05	0	0	0	0	0	1	3	0
	2005-06	5	2	0	0	0	0	0	0
	2006-07	3	0	0	0	0	0	1	0
	2007-08	2	0	2	0	0	0	0	0
	Mean	2.4	0.8	0.4	0.0	0.0	0.0	0.0	0.0
	% reduction	**71**	**82**	**82**	**100**	**100**	**100**	**100**	**100**
Untreated control	2003-04	0	23	0	0	14	1	0	0
	2004-05	0	0	6	4	15	2	2	0
	2005-06	27	0	5	5	0	0	0	5
	2006-07	1	0	0	0	19	19	3	0
	2007-08	13	0	0	0	28	0	0	0
	Mean	8.2	4.6	2.2	1.8	15.2	4.4	1.0	1.0

Where :

A. a : Alternaria alternata.
F. ox : Fusarium oxysporum
A. n : Aspergillus niger
A.t. : Aspergillus terrus
F. sem : Fusarium semitectum
F. m. : Fusarium moniliforme
A.f: Aspergillusflavus
B. t. : Botryodiplodia theobrome

Table2. Efficacy of bio-agents on seed germination and seedling vigour index in sunflower, (cv. Morden) during 2003-04 to 2007-08.

Treatments	Mean seed germination (%)							Mean seedling vigour index					Mean field emergence (%)					
	2003 -04	2004 -05	2005 -06	2006 -07	2007 -08	Pooled Mean	Per cent increase Over control	2004 -05	2005 -06	2006 -07	2007 -08	Pooled Mean	2003 -04	2004 -05	2005 -06	2006 -07	2007 -08	Pooled Mean
P. fluorescens @0.6%	72.00	84.00	86.20	62.50	76.00	76.14	12.63	1663	2248	2521	1725	2053.6	60.25	55.25	80.80	65.25	71.25	66.56
	(58.03)	(66.77)	(68.32)	(52.35)	(60.71)	(61.24)							(50.92)	(48.08)	(64.08)	(53.90)	(57.90)	(54.98)
I *viride@ 0.6%*	68.50	84.00	83.00	74.00	83.00	78.50	16.12	1863	2000	2493	2197	2421.3	58.75	67.75	78.00	79.75	72.00	71.25
	(55.86)	(66.44)	(65.77)	(59.35)	(65.79)	(62.64)							(50.04)	(55.45)	(62.11)	(63.44)	(58.05)	(57.82)
P. fluorescens + *T. viride*	82.50	85.00	88.80	75.50	85.00	83.36	23.13	2080	2367	2634	2032	2690.0	67.50	66.75	83.80	83.25	76.00	75.46
@0.6 % each	(65.50)	(67.30)	(70.47)	(60.48)	(67.25)	(66.20)							(55.38)	(55.00)	(66.39)	(65.86)	(60.67)	(60.66)
Thiram + carbendazim	75.50	90.50	89.00	81.50	86.00	84.50	25.0	1711	2339	2589	2098	2881.1	68.75	63.50	77.00	84.50	77.00	74.15
@ 0.2% each	(60.40)	(72.17)	(70.72)	(64.68)	(68.07)	(67.21)							(56.17)	(52.85)	(61.35)	(67.09)	(61.35)	(59.76)
Untreated control	58.50	66.50	78.00	67.50	67.50	67.60	-	1278	1853	2013	1742	1884.8	57.00	53.25	69.20	61.75	56.00	48.04
	(49.96)	(54.74)	(62.10)	(55.36)	(55.21)	(55.49)							(49.03)	(46.87)	(56.34)	(51.80)	(48.45)	(50.50)
S.E. (m) ±	1.75	1.79	1.31	2.10	1.20	1.24	-	67.36	155.05	96.02	112.85	154.77	1.66	2.07	" 1.15	1.50	1.02	1.27
C.D at 5%	5.27	5.41	3.94	6.34	3.61	3.70	-	203.03	467.38	289.23	339.95	466.23	5.11	6.39	3.56	4.63	3.15	3.81

Figures in the parentheses are arc-sin transformed values.

P. fluorescens formulations for increasing the field emergence of sorghum.

In recent years much attention has been given to non-chemical systems for seed treatment as well as to achieve the protection against seed borne pathogens. The present study has shown that biological agents like *P. fluorescens, T. viride* and *P. fluorescens* + *T. viride* were eco-friendly, effective and can be used in place of chemical fungicides.

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Disease Survey of Soybean in Yavatmal District of Maharashtra

S.W. Khodke[1] and R.S. Wankhede[2]

ABSTRACT

To know the prevalence of rust and other major diseases of soybean, a survey was undertaken in July sown *Kharif* soybean crop in 16 tahasils of Yavatmal district during 2001-2002 to 2007- 2008. Incidence of root rot/collar rot, bacterial pustules, *Myrothecium* leaf spot, pod blight were recorded from most of the growing areas. Infection of rust and mosaic was not observed. *Rhizoctonia bataticola, Sclerotium rolfsii, Myrothecium roridum, Xanthomonas axenopodis* pv *glycine and Colletotrichum truncatum* were isolated from infected root and collar region of plant, leaves pods and seeds. Per cent disease intensity of Bacterial pustule was positively significant with rainfall and evening relative humidity.

Soybean *(Glycine max* (L) Merril) is an important oilseed and pulse crop in India. In recent years soybean proved to be a boon in changing the economy of cultivators. Area under soybean is now fast increasing in Vidarbha region of Maharashtra. In the year 2006-07, the area was 15.71 lakh hectare in Vidarbha and 2.68 Lakh hectare in Yavatmal District (Anonymous, 2008). Bacterial pustule caused by *Xanthomonas axenopodis* pv. *glycines* (Nanko) Dye. Fr., rust caused by *Phakopsora pachyrhizi* Syd, *Rhizoctonia* root / stem rot caused by *Rhizoctonia bataticola* (Taub) Butl., collar rot caused by *Sclerotium rolfsii* Sacc, *Cercospora* leaf spot caused by *Cercospora kikuchi,* anthracnose caused by *Colletotrichum truncatum, Myrothecium* leaf spot caused by *Myrothecium roridum* Tode.ex.Fr. and soybean mosaic are some of the important diseases of Soybean. Manglekar and Raut (1997), have reported 31.27 per cent, 30.00 per cent and 26.66 per cent yield loss due to bacterial pustules. Bacterial pustule is a destructive disease, can cause upto 38 per cent reduction in yield and considerable reduction in the protein content in the seeds of susceptible varieties (Thapliyal and Dubey, 1986.) Looking into regular occurrence and destructiveness of bacterial pustule in the region, an epidemiological studies were undertaken during 2005-2006 to 2007-2008. *Rhizoctonia* root / stem rot and *Cercospora* leaf spot, were severe in Vidarbha region of Maharashtra. Patil and Anahosur (1998), reported serious loss in soybean i.e. 20-30 per cent in Karnataka due to rust. Therefore to collect information on soybean rust and other diseases in the-Yavatmal District, the present studies were undertaken.

MATERIAL AND METHODS

During the year 2001-02 to 2007-08, survey of July sown soybean crop was undertaken in 16 tahasils of Yavatmal District. In soybean field, 1 x 1m area at two locations was marked for recording disease observations. Regarding root diseases, in marked area total number of plants and infected plants were counted and per cent incidence was worked out. For foliar diseases, intensity of diseases was worked as per the scale 1-9, given by XVII Annual soybean work shop held at Indore (1986-87). As regards to pod blight, 10 plants were selected randomly from the marked area, total number of pods and infected pods were counted and per cent incidence was worked out. Samples of diseased plant were collected and brought into laboratory for confirmation of organisms involved. To know the correlation of bacterial pustule with environmental factors responsible for disease development, a study was undertaken at Research farm of Zonal Agricultural Research Station, Yavatmal during *Kharif* 2005-2006 to 2007-2008 with a variety JS-335. The variety was grown in 10 m x 10 m plot under natural field conditions following recommended package of practices. Weekly observations on disease intensity were recorded as per the prescribed scale. The weekly averages of rainfall, maximum and minimum temperature and morning and evening relative humidity was taken for correlation study.

1. Assistant Prof. and 2. S.R.A. Zonal Agricultural Research Station, Yavatmal

RESULTS AND DISCUSSION

The survey revealed that leaf spot, bacterial pustules and root rot /collar rot were commonly observed in the district (Table 1). Among foliar diseases, leaf spot and bacterial pustules were observed in the district. Intensity of *Myrothecium* leaf spot and bacterial pustle was 8.89 to 23.70 per cent and 12.59 to 31.85 per cent, respectively. High incidence of bacterial pustule was noticed in the village Dhanki of Umarkhed tahsil during 2005-06 on cv. PK 472, with 31.85 per cent disease intensity. Occurrence of bacterial pustule in soybean was observed in the varieties grown on the farm of College of Agriculture, Nagpur have been reported (Gaikwad *et al.,* 1995). Manglekar and Raut (1997) reported prevalence of bacterical pustule in Vidarbha and variety Pk-472 was found susceptible. These results are on the line of present observations. Infection of powdery mildew was observed during 2002-03 on self sown crop in the month of December and January and on *Kharif crop* in traces during 2003-04.

Pod blight incidence was severe i.e. 25.40 per cent in 2003-04 (Table 1). The higher disease incidence may be attributed to continuous rain fall during 39 MW 43 MW i.e. at pod development to crop maturity stage of crop.

Among root diseases, root / collar rot was noticed at seedling and pod development stage on Cv.JS-335 and TAMS-38 and showed 3.00 to 13.00 percent disease incidence. Borkar (1992) reported that root rot and collar rot cause wilting particularly at young stage of soybean. Infection of root rot was reported in Vidarbha by Manglekar and Raut (1997).

Table 1 : Occurrence of Soybean diseases in Yavatmal district during 2001-02 to 2007-08

Years	Name of disease and their intensity (%)						
	Collar /root Rot	*Myrot hecium* Spot	Bacterial pustule	Rust	Mosaic mildew	Powdery blight	Pod
2001-2002	3-12	11.8-12.26	15.5-28.9	-	-	-	3-12
2002-2003	4-10	9.44-13.13	13.13-17.04			Severe on self sown crop December /January	-
2003-2004	Traces	13.13-23.7	18.52-20.74			Observed in traces	14.37-25.40
2004-2005	0-3	8.89-13.33	12.59-14.81	-	-	-	-
2005-2006	2-11	13.33-14.81	12.59-31.85	-	-	-	-
2006-2007	0-9	14.00	16.30-28.15	-	-	-	0-4.2
2007-2008	10-13	11.48-3.33	12.59-16.30	-	-	-	-

- Not observed

Table-2 Correlation between weather factors and intensity of bacterial pustule (2005-2006 to 2007-2008)

Variety	Rainfall (mm)	Temp(c)		Relative Humidity (%)	
		Max	Min	Morning	Evening
JS-335	0.424**	0.305	0.296	0.0461	0.435**

r* value at 5 per cent 0.321, r** value at 1 percent 0.413

Myrothecium sp. *Xanthomonas axenopodis* pv. *glycine, Rhizoctonia bataticola, Sclerotium rolfsii, Colletotrichum truncatum* were isolated from different infected leaves, roots, pods and seeds of soybean. Economic importance of soybean diseases caused by *Rhizoctonia bataticola, Sclerotium rolfsii, Colletotrichum truncatum, Pseudomonas* and *Xanthomonas* sp. have been reported (Sinclair and Shurlleff, 1975). Poharkar and Raut (1977) reported association of *Cercospora kikuchi, Colletotrichum truncatum* and *Cwvularia lunata,* with the seeds of soybean samples from Vidarbha. *Erysiphe polygoni* was associated with powdery mildew infected leaves. Khodke *et al. (2006) have* reported powdery mildew of soybean caused by *Erysiphe polygoni* for the first time in Maharashtra.

Non significant correlation of maximum and minimum temperature and morning relative humidity was observed at both the level of significance. Rainfall and relative humidity during evening hours has showed significant correlation with bacterial pustule at both the level on JS-335.

In general, survey indicated continuous occurrence of bacterial pustule and root /collar rot in Yavatmal district. Rust and mosaic were not observed. Khodke *et al.* (2000) reported incidence of rust caused by *Phakopsora pachyrhizi* from Yavatmal district on cv. JS-335 and PKV-1.

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Efficacy of Bio-agents and Botanical Extract Seed Treatments Against Seed Borne Fungi in Soybean

V. K. Mandhare[1], S. B. Gawade[2] and A. V. Suryawanshi[3]

ABSTRACT

The Efficacy of talc based formulation of bioagents *viz*; *Trichoderma viride* @ 0.6 per cent, *Trichoderma harzianum* @ 0.6 per cent, *Bacillus subtilis* @ 0.6 per cent, *Pseudomonas flourescens* @ 0.6 per cent, *Bacillus subtilis* + *Pseudomonas flourescens* @ 0.6 per cent each, botanical extracts (garlic and ginger @ 1 per cent) and recommended fungicide *i.e.* Thiram + Carbendazim @ 0.2 per cent each were evaluated against seed borne fungi in soybean. The results indicated that the treatment of soybean seed with talc based formulation of *Trichoderma viride* @ 0.6 per cent found effective in controlling seed borne fungi by 82 per cent, increased the seed germination, seedling vigour index and field emergence by 7.85, 5.80 and 11.83 per cent, respectively over un-inoculated control. The per cent infection of seed borne fungi, seed germination, seedling vigour index and field emergence of soybean in un-inoculated control was 39 per cent, 70 per cent, 2258 and 65.50 per cent, respectively. The pre-dominant seed borne fungi associated with soybean seeds were *F. moniliforme, A. alternata, M. phaseolina, A. niger and A. flavus.*

Seed borne diseases are one of the most important factors responsible for low yield of soybean (*Glycine max* L.). Seed borne diseases cause losses in terms of seed quality and quantity. Seed borne pathogens reduce seed germination, seedling vigour index and are responsible for causing seed-rot, seedling blight and foliar diseases in soybean (Agrawal and Joshi, 1972).

Effective control of seed borne pathogens in soybean with fungicides like thiram, carbendazim and thiram + carbendazim were documented (Singh, 1992 and Poharkar, 1992). The fungal bio-agents i.e. *Trichoderma* spp. and bacterial *Pseudomonas* have been reported to be effective against several plant pathogens (Upadhyay *et al.*, 2000). The continuous use of chemicals for controlling the diseases may pose several problems like toxicity to non-target organisms, development of resistance among the population of pathogen and environmental resistance. Therefore, the studies were undertaken to see the efficacy of bio-agents, *Trichoderma* spp. *Bacillus subtilis*, *Pseudomonas fluorescens*, botanical extracts *i.e.* garlic and ginger and thiram+carbendazim on seed borne pathogens, seed germination, seedling vigour index and field emergence in soybean

MATERIAL AND METHODS

The experiment on efficacy of talc based formulation of bio-control agents and botanical extracts along with recommended fungicides were conducted on research farm and seed pathology laboratory of Seed Technology Research Unit, MPKV, Rahuri during *Kharif* 2006-07 and 2007-08. The seeds of soybean (Cv.JS-335) were collected from Seed Cell, MPKV., Rahuri. The talc based formulation of *T. viride, T. harzianum, Bacillus subtilis* and *Pseudomonas fluorescens* were received from Project Director, Directorate of Seed Research, MAU (UP). The crude extract of ginger and garlic was obtained as per the method of Bambode and Shukla (1973). In this method, 50 g each of the garlic cloves and ginger rhizome were washed thoroughly with distilled water and crushed in pastle and mortar in 100 ml distilled water. The extract obtained was boiled in order to bring the volume 50 ml. The crushed material was strained through double layer muslin cloth and filter paper (Whatman No.1) under aseptic condition. The filtrate thus obtained was used for seed treatment. The experiment included the seed treatments *viz*; *Bacillus subtilis* + *Pseudomonas fluorescens* @ 0.6 per cent each, *T. viride*, @ 0.6 per cent, *Bacillus subtilis* @ 0.6 per cent, *Pseudomonas fluorescens* @ 0.6 per cent, *T. harzianum* @ 0.6 per cent, garlic extract @ 1 per cent, ginger extract @ 1 per cent, thiram + carbendazim @ 0.2 per cent each and un-inoculated control. The seeds of soybean (Cv. JS-335) were treated with biocontrol agents, botanical extracts and recommended fungicide as per the required concentrations. The seeds were sown in the field having gross plot size 3.0 x 2.15 m at 30 x 10 cm

1. Senior Scientist, 2. Assistant Seed Res. Officer and 3. Senior Res. Asstt., STRU (NSP), MPKV., Rahuri

spacing with four replications in randomized block design. The field emergence was recorded 21 days after sowing.

The seed borne fungi associated with the seeds of soybean were detected by standard blotter test as described by Neergard (1977). The blotters were soaked in distilled water and placed in three layers in transparent plastic petri plates after draining excess moisture. Ten seeds were placed at equidistant from one another in each plate under aseptic condition. Total 400 seeds/treatments were plated. The plates were then incubated at 21± 2°c under near ultra-violet/fluorescent light with an alternate cycle of 12 h light and 12 h darkness in incubation room for 7 days. Thereafter, seeds were examined under stereobinocular microscope for the presence of seed-borne pathogens. The fungi were identified on the basis of morphological characters of fungi / conidia/conidiophores and with help of manual of Illustrated Genera of Imperfect Fungi (Barnett and Barry, 1972). The per cent incidence of seed borne fungi was recorded and the inhibition of seed borne fungi by various treatments over un-inoculated control was calculated.

The effect of bioagents / botanical extracts and fungicides on seed germination and seedling vigour index of soybean was studied by towel paper method. The experiment was laid out in CRD with four replications / treatments in the laboratory. Fifty seeds were placed on each towel paper and rolled carefully to avoid disturbances of seeds from their places. For each treatment eight towels of 50 seeds (400 seeds) were used. The rolled towel papers were kept in slanting position and incubated at 24°c temperature and relative humidity above 85 per cent in a seed germinator (Anonymous, 1999). A count of

Table 1. Effect of bioagents and botanicals extract as seed treatment on seed borne fungi in soybean (Cv. JS-335).

Treatments	Seed borne fungi (%)					Total seed borne fungi (%)	Per cent reduction (%)
	F.m.	*A.a.*	*M.p.*	*A.f.*	*A.n.*		
Bacillus subtilis + *P. fluorescens* @ 0.6% each	0	1	1	7	5	14 (21.93)	64.10
Bacillus subtilis @ 0.6%	0	1	1	7	5	14 (21.93)	64.10
P. fluorescens @ 0.6%	1	1	0	12	6	20 (26.49)	48.71
T. viride @ 0.6%	0	0	0	4	3	7.0 (15.19)	82.05
T. harzianum @ 0.6%	0	0	0	9	9	18.0 (25.07)	53.84
Thiram+ Carbendazim @ 0.2% each	0	0	0	2	0	2.0 (7.99)	94.87
Garlic extract @ 1%	2	2	2	12	6	24.0 (29.32)	38.46
Ginger extract @ 1%	4	2	2	12	6	26.0 (30.63)	33.33
Un-inoculated control	6	6	5	14	8	39.0 (38.64)	—
				SE (m) ±	2.80		
				P=0.05	8.42		

Figures in parentheses are arc-sin transformed values.

Where

F.m = Fusarium moniliforme
A.a. = Alternaria alternata
M.p. = Macrophomia phaseolina
A.f = Aspergillus flavus
A.n = Aspergillus niger

normal seedlings was recorded after 7 days. The mean seed germination was calculated. The seed with full growth of plumule and radical were considered as normal. The root and shoot length (cm) of randomly selected 10 normal seedlings from each towel paper were measured and seedling vigor index was calculated by the formula given by Abdul - Baki and Anderson (1973).

Seedling vigor index = [mean root length (cm) + mean shoot length (cm)] x Germination (%)

The data obtained in respect of seed borne fungi, seed germination, seedling vigour index, and field emergence were transformed into arc-sin values and subjected to statistical analysis.

RESULTS AND DISCUSSION

Significant reduction in seed borne fungi, increased in seed germination, seedling vigor index and field emergence of soybean was recorded with various treatments over un-inoculated control (Table-1&2). The seed borne pathogens *viz; Fusarium moniliforme, Alternaria alternata, Macrophomina phaseolina, Aspergillus flavus* and *Aspergillus niger* were found pre-dominant on seeds of soybean. Pohorkar and Raut (1997) reported similar fungi associated with seeds of soybean. Significant reduction in seed borne fungi *i.e.* 94.87 per cent was recorded with the treatment of thiram +carbendazim @ 0.2 per cent each (Table-1). The results are more or less in agreement with Pohorkar (1992) indicating significant reduction in seed mycoflora of soybean with thiram+carbendazim. Among the biocontrol agent, *T. viride* @ 0.6 per cent found effective in inhibiting the seed borne fungi by 82.05 per cent (Table 1). Gurjar *et al.*, (2004) reported effectiveness of *T. viride* and *P. fluorescens* in management of seed borne pathogens like *F. oxysporum*, *F. moniliforme* and *M. phaseolina* in okra. Soybean seed treatment with *Bacillus subtilis* + *P. fluorescens* @ 0.6 per cent each and *Bacillus subtilis* @ 0.6 per cent alone were found effective in controlling the seed borne fungi by 64.10 per cent over un-inoculated control, respectively. The per cent incidence of seed borne fungi in un-inoculated control was 39 per cent.

Treatment of soybean seed with thiram + carbendazim @ 0.2 per cent each significantly increased the seed germination (83.50%), seedling vigour index (2633) and field emergence (81 %). The seed germination, seedling vigour index and field emergence in un-inoculated control was 70 per cent, 2258 and 65.50 per cent, respectively. Thus, the seed germination, seedling vigor index and field emergence of soybean was increased by 19.28, 16.60 and 23.66 per cent, respectively with the seed

Table-2. Effect of bioagents/botanical extracts as seed treatment on seed germination, seedling vigor index and field emergence in soybean (Cv. JS-335)

Treatments	Seed germin -ation (%)	Increase over control (%)	Seedling vigour index	Increase over control (%)	Field emergence (%)	Increase over control (%)
Bacillus subtilis + *P. fluorescens* @ 0.6 each	74.25(59.53)	6.07	2359	4.47	71.50(57.74)	9.16
Bacillus subtilis @ 0.6	72.00(58.10)	2.85	2313	2.43	70.50(57.28)	7.63
P. fluorescens @ 0.6	71.75(51.90)	2.50	2356	4.34	70.00(56.82)	6.87
T. viride @ 0.6	75.50(60.37)	7.85	2389	5.80	73.25(57.90)	11.83
T. harzianum @ 0.6	73.75(59.19)	5.35	2359	4.47	71.25(57.58)	8.77
Thiram+ Carbendazim @ 0.2 each	83.50(66.07)	19.28	2633	16.60	81.00(64.48)	23.66
Garlic extract @ 1	71.50(57.87)	2.41	2270	0.05	68.25(55.72)	4.92
Ginger extract @ 1	72.25(58.23)	3.21	2313	2.43	66.50(54.70)	1.52
Un-inoculated control	70.00(56.81)	-	2258	-	65.50(54.04)	-
SE(m)±	1.14	-	124.27	-	1.48	-
P=0.05	3.30	-	360.28	-	4.33	-

treatment of thiram + carbendazim over un-inoculated control. Similar results were reported by Poharkar (1992) and Singh *et al.* (2003) showing effectiveness of thiram + carbendazim as a seed treatment for inhibiting seed borne pathogens, increasing seed germination and seedling vigour index in soybean and pearlmillet.

Among the biocontrol agents, seed treatment with talc based formulation of *T. viride* found effective to increase the seed germination, seedling vigour index and field emergence by 7.85, 5.80 and 11.83 per cent, respectively over un-inoculated control followed by treatment *T. harzianum* and *Bacillus subtilis* + *P. fluorescens*. Ramanathan and Sivaprakasan (1992), Jayalakshmi *et al.* (1999) and Mathivan *et al.*, (2000) reported effectiveness of *T. viride* for increasing seed germination and seedling vigour index in soybean, tomato, cotton, okra and sunflower.

In the present study, the seed treatment with botanical extract *viz.* garlic and ginger @ 1 per cent found least effective as compared to biocontrol agents. Therefore, it is concluded that the treatment of thiram + carbendazim to the seeds of soybean was effective for controlling seed borne pathogens and increasing seed germination. The bio-agent *T. viride* was also effective in reducing seed borne fungi, increasing seed germination, seedling vigour index and field emergence of soybean.

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Agronomic Management Practices for Increasing Production of Traditional Cropping Systems

S. N. Potkile[1] and A. A. Choudhary[2]

ABSTRACT

A field trial was conducted for three years from 2001- 02 to 2003-04 under ECF Scheme, in Nagpur and Wardha districts of Central Vidarbha Zone, to study the contribution of agronomic management practices in increasing the productivity of soybean- wheat and cotton- groundnut cropping sequence. Treatments consisted were three farming practices viz. farmer's method (T_1), farmer's method + computed fertilizer dose to make up the RDF (T_2) and improved package of practices (T_3), arranged in RBD with 12 and 8 replications in Nagpur and Wardha districts, respectively. Pooled results indicated that the application of recommended dose of fertilizer and adoption of improved package of practices increased the grain/ fibre yield and monetary benefits in soybean wheat and cotton- groundnut cropping systems, respectively, over traditional practice.

There is a wide gap between the yield harvested by the farmers and yield obtained on the research farms. The major constraints are imbalanced and injudicious use of chemical fertilizer, non adoption of improved varieties and improved package of practices. In order to know the contribution of these factors in the final yield of crop, present investigation was conducted for three years to show the importance of balanced use of fertilizers, improved varieties and popularise the improved package of practices for increasing the monetary benefits of farmer.

MATERIAL AND METHODS

The present study was conducted for three years from 2001- 02 to 2003-04 with 12 and eight replications for soybean- wheat and cotton-groundnut cropping sequences, respectively. The treatments comprised of three farming practices viz. farmer's method with farmers adopted fertilizer dose and choice of variety (T_1), farmer's method + computed fertilizer dose as per soil test to make up the RDF of 30:75:30 kg NPK ha^{-1} for soybean, 100:50:50 kg NPK ha^{-1} for wheat, 50:25:25 kg NPK ha^{-1} for cotton and 25:50:00 kg NPK ha^{-1} for groundnut (T_2) and improved package of practices which included improved variety, fungicidal seed treatment, bio-culture, fertilizer dose as per schedule and need based plant protection (T_3). The experiment was arranged in Randomised Block Design. For calculating economic aspect, price of commodities

Table 1. Crop yields (q ha^{-1}) for individual years due to different treatments in soybean – wheat cropping system. (36 trials)

Treatments	2001-02		2002-03		2003-04	
	Soybean	wheat	Soybean	wheat	Soybean	wheat
T_1- Farmer's Practice	13.16	20.14	16.54	22.33	19.22	24.14
T_2- Farmer's Practice + RDF	16.16	23.77	17.89	27.71	21.75	28.23
T_3 -Improved Practice	18.04	26.74	20.06	31.54	24.33	30.66
SE (m) ±	1.37	2.85	0.81	1.10	0.35	0.39
CD at 5%	3.72	7.59	2.33	3.17	1.00	1.13

Table 2. Crop yields (q ha^{-1}) for individual years due to treatment in cotton – groundnut cropping system. (24 trials)

Treatments	2001-02		2002-03		2003-04	
	Cotton	G nut	Cotton	G nut	Cotton	G nut
T_1- Farmer's Practice	14.49	15.54	12.18	16.25	12.31	14.00
T_2- Farmer's Practice + RDF	15.54	16.86	13.51	17.83	14.66	15.81
T_3 -Improved Practice	17.86	19.65	14.65	19.53	17.00	17.46
SE (m) ±	1.05	0.39	0.22	0.28	0.87	0.44
CD at 5%	3.21	1.20	0.63	0.81	2.63	1.34

1 and 2. Assistant Prof., Section of Agronomy, College of Agriculture, Nagpur

Table 3. Crop yields and monetary benefit due to treatment in soybean – wheat cropping system. (Pooled of three years – 36 trials)

Treatments	Grain yield (q ha^{-1})		Increase in yield (q ha^{-1})		Value of increased yield (Rs ha^{-1})			Expenditure due to treatments (Rs ha^{-1})			Total benefit due to treatments (Rs ha^{-1})
	Kharif Soybean	Rabi wheat	Kharif Soybean	Rabi wheat	Kharif Soybean	Rabi wheat	Total	Kharif Soybean	Rabi wheat	Total	
T_1- Farmer's Practice	16.31	22.20	--	--	--	--	--	--	--	--	--
T_2- Farmer's Practice + RDF	18.60	26.57	2.29	4.37	2578	3430	6008	937	767	1704	4304
T_3 -Improved Practice	20.81	29.65	4.50	7.45	5067	5848	1095	1550	1399	2949	7966
SE (m) ±	0.84	1.45	--	--	--	--	--	--	--	--	--
CD at 5%	2.13	3.30	--	--	--	--	--	--	--	--	--

Table 4. Crop yields and monetary benefit due to treatment in cotton – groundnut cropping system. (Pooled of three years – 24 trials)

Treatments	Grain yield (q ha^{-1})		Increase in yield (q ha^{-1})		Value of increased yield (Rs ha^{-1})			Expenditure due to treatments (Rs ha^{-1})			Total benefit due to treatments (Rs ha^{-1})
	Kharif Cotton	Rabi G. nut	Kharif Cotton	Rabi G. nut	Kharif Cotton	Rabi G. nut	Total	Kharif Cotton	Rabi G. nut	Total	
T_1- Farmer's Practice	12.99	15.26	--	--	–	--	--	–	--	--	--
T_2- Farmer's Practice + RDF	14.57	16.83	1.58	1.57	3173	2526	5699	101	65	166	5533
T_3 -Improved Practice	16.50	18.88	3.51	3.62	7048	5824	12872	709	822	1531	11341
SE (m) ±	0.71	0.37	--	--	–	--	--	–	--	--	--
CD at 5%	1.56	0.92	--	--	–	--	--	–	--	--	--

Rates considered	(Rs q^{-1}):	Soybean-	1126/-	Wheat-	785/-	Cotton-	2008/-	Gr. Nut- 1609/-
	(Rs kg^{-1}):	N-	10.50/-	P_2O_5-	20.0/-	K_2O-	7.50/-	
Fertilizer dose 100 %	(Kg NPK ha^{-1}):	Soybean-	30:75:30	Wheat-	100:50:50	Cotton-	50:25:25	Gr. Nut- 25:50:00
Farmer's Method	(Kg NPK ha^{-1}):	Soybean-	32:38:08	Wheat-	71:41:09	Cotton-	70:29:17	Gr. Nut- 43:35:06

Monetary value of straw are not considered

prevailing in market during preceding year was considered.

RESULTS AND DISCUSSION

Data pertaining to yield and monetary returns as per pooled analysis are presented in Table 3 and 4.

A) Soybean- wheat system

It was observed that farmers, in general, applied a dose of 32:38:8 kg NPK ha^{-1} for soybean and 71:41:9 kg NPK ha^{-1} for wheat i.e. inadequate P and K for soybean and all three elements for wheat, as compared to the RDF. Application of RDF 30:75:30 kg NPK ha^{-1} for soybean and 100:50:50 kg NPK ha^{-1} for wheat (T_2) increased the yield of soybean and wheat significantly over farmer's practice (T_1). The increase was 14 and 20 per cent for soybean and wheat crop, respectively. Total benefit was increased by Rs. 4304 ha^{-1} under this system as compared to traditional farmer's practice. Adoption of improved package of practices (T_3) also increased the yield of soybean and wheat significantly over farmer's practice (T_1) and farmer's practice with RDF (T_2). The increase in soybean was 27 and 12 per cent respectively over farmers practice and farmer's practice with RDF, and for wheat, it was 33 and 11 pre cent, respectively. Improved package of practices increased the monetary benefit by Rs. 7966 ha^{-1} over farmer's practice.

B) Cotton- groundnut system

In general, it was observed that farmers applied a dose of 70:29:17 kg NPK ha^{-1} for cotton and 43:35:6 kg NPK ha^{-1} for groundnut crop i.e. excess N and P and inadequate K to cotton crop, and excess N and inadequate P to groundnut crop, as compared to RDF. Application of RDF (50:25:25 kg NPK ha^{-1} for cotton and 25:50:00 kg NPK ha^{-1} for groundnut) i.e. T_2 increased the cotton and groundnut yields significantly over farmer's traditional practice. The increase was about 12 per cent in cotton and 10 per cent in groundnut, and the total benefit was increased by Rs 5533 ha^{-1} by the system over farmer's practice. Adoption of improved package of practices (T_3) also increased the yield of cotton and groundnut crops over farmer's practice (T_1) and farmer's practice + RDF (T_2). The per cent increase in cotton was 27 and 13 per cent, respectively over farmer's practice and farmer's practice + RDF and 24 and 12 per cent in groundnut. Improved package of practices recorded an increase in monetary benefit by Rs. 11341 ha^{-1} as compared to farmer's practice.

Raut *et al.* (2003) reported that the improved practice of application of 15 kg N, 32 kg P_2O_5 + rhizobium + PSB + molybdenum recorded the highest yield of soybean over other treatments like full RDF, full RDF + biofertilizer, half RDF and seed dressing with biofertilizer alone, etc. On the other hand, Dahatonde and Dahatonde (2008) stated that application of RDF only, through fertilizer to maize was beneficial in maize – chickpea cropping sequence over other INM treatments such as half RDF, half N through leucaena loppings, seed treatment with azatobactor etc in combination with each other. Chavan *et al.* (2008) reported that seed yield was highest with full RDF + micronutrients in soybean – sunflower sequence over other treatments such as application of 50, 100 and 150 per cent RDF, RDF + crop residue and RDF + 5 t FYM.

Therefore, on the basis of pooled data, it is concluded that application of recommended dose of fertilizers and adoption of improved package of practices increase the grain/ cotton yield and monetary benefit of soybean- wheat and cotton-groundnut cropping systems over farmer's practice. It is further concluded that recommended fertilizer doses for soybean- wheat and cotton- groundnut cropping system along with improved package of practices give higher yields and monetary benefits.

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Effect of Nutrient Management on Cotton Based Intercropping System Under Rainfed Conditions

S.M. Nawlakhe[1], R. J. Tengale[2], M. D. Yenpreddiwar[3] and P. M. Choudhari[4]

ABSTRACT

A field experiment was conducted during *Kharif* season of 2007-2008 at Agronomy Farm, Department of Agronomy, Dr. P.D.K.V. Akola, to study the response of four cotton based intercropping systems to varying levels of fertilizer. The results reveled that cotton + blackgram (2:1) and cotton + greengram (2:1) intercropping system was the best for getting maximum seed cotton yield (9.34 q ha^{-1}, 9.24 q ha^{-1}), net monetary return (Rs.14164 ha^{-1}, Rs 14022 ha^{-1}) and B:C ratio (1.98,1.97) over other intercropping systems. Similarly the application of 125 per cent RDF (62.50: 31.25: 31.25 Kg NPK ha^{-1}) found optimum as it gave higher seed cotton yield (9.38 q ha^{-1}), net monetary return (Rs.13841 ha^{-1}) and B:C ratio (1.95) but was at par with 100 per cent RDF (50:25:25 kg NPK ha^{-1}).

Cotton (*Gossypium* spp) is one of the important commercial crop and is grown predominantly under rainfed condition in Vidarbha region of Maharashtra, occupying 12.5 lakh hectar area with a production of 24 lakh bales and productivity of 326 kg lint ha^{-1} (Anonymous, 2007). Major causes of low productivity of cotton in Vidarbha region are erratic rainfall, cultivation on marginal and sub-marginal land and less adoption of improved technologies. Intercropping in cotton is advocated rather than sole cropping for risk aversion in rainfed farming, which may provide stability to total production from unit area and fetch high net returns even under adverse condition. Intercropping is the most remunerative and popular farming practiced under rainfed condition. Simultaneously growing two or more crops having different growth habit, adoption, root system, duration and nutrient requirement provide more returns beside maintaining productivity of major component crop. Cotton is generally grown under wider row spacing and has initially slow growth. Interrow space which remain vacant for about 2 to 2.5 months can be utilized for growing intercrops. Compact, short duration and quick growing legume crop like greengram, blackgram, soybean and pigeonpea are found to be more compatible for intercropping in different regions.(Giri and Upadhyay, 1980, Aziz,1988 and Kalyankar, 2001).

Being a heavy feeder, cotton plant needs proper manuring and fertilization for its successful cultivation. It shows better response to N and P_2O_5 and even K_2O in deficient soils. Therefore, improvement in soil health and timely availability of nutrient is very much essential for increasing production for such valuable crop. An adequate supply of fertilizers and manures under varying fertility levels for intercropping system have been tested by Pothiraj and Shrinivasan (1993) and Kalyankar, (2001). However, the information on fertilizer management of cotton based intercropping system is scarce, particularly for new cotton genotypes and for agroclimatic region of Vidarbha. Hence, the present study was undertaken to find out suitable cotton based intercropping system and its fertilizer need for achieving high yield.

MATERIAL AND METHODS

The field experiment was conducted during *Kharif* season of 2007-08 at Agronomy Farm, Department of Agronomy, Dr. P.D.K.V., Akola in a Factorial Randomized Block Design with three replications. There were twelve treatment combinations having four intercropping systems i.e. I_1- cotton + Greengram (2:1), I_2- cotton + Blackgram (2:1),I_3- Cotton + Soybean (2:1), and I_4- Cotton + pigeonpea (6:2) and three fertilizer levels viz.,F_1-75 per cent RDF (37.5:18 .75:18.75 kg NPK ha^{-1}), F_2-100 per cent RDF(50:25:25 kg NPK ha^{-1}) and F_3-125 per cent RDF (62.50: 31.25: 31.25 kg NPK ha^{-1}). The topography of experimental plot was uniform, leveled and soil was clay loam in texture having slightly

1. Associate Prof., 2. and 4. M.Sc. Student, 3. Senior Res. Asstt., Section of Agronomy, College of Agriculture, Nagpur

alkaline in reaction (PH 7.60), moderate in organic carbon (0.42 %), low in available N(194.10 kg ha^{-1}) and available P(14.20 Kg ha^{-1}) and fairly rich in available K(497 kg ha^{-1}).

The cropwise varieties like AKH-8828 in cotton, Kopargaon in Greengram, - TAU-1 in Blackgram , TAMS-38 in Soybean and ICPL-87119 in Pigeonpea were used for sowing as per recommended seed rate for sole cropping.

Quantity of seed for intercrop was calculated on the area basis. Intercrop was sown by drilling the seed after every two rows of cotton (without change in space of cotton) except cotton + pigeonpea (6:2) treatment where after six rows of cotton two rows of pigeonpea were sown. The sowing of cotton seeds was done by dibbling 3-4 seeds per hill on 30th June 2007. Nitrogen was applied to cotton crop only in two equal splits i.e. at sowing and as top dressing at 30 DAS. However, full dose of P and K was applied at sowing time as per fertilizer treatments.

The total rainfall of 769.5 mm during the cropping period was received in 43 rainy days. The biometric observations were recorded periodically and at harvest. However, yield and yield attributes were recorded at harvest. The data were statistically analysed to test the significance of the treatments.

RESULTS AND DISCUSSION

1. Effect of intercrops

Growth and development : It could be observed from the data presented in Table 1 that, growth attributes such as plant height, number of sympodial branches $plant^{-1}$ and dry matter accumulation $plant^{-1}$ were significantly influenced by various treatments. Cotton + pigeonpea (6:2) intercropping system recorded significantly more plant height (79.66 cm) at harvest than cotton + soybean(2:1) and Cotton + Greengram (2:1), but was at par with cotton+blackgram (2:1) system. As regards to number of sympodial branches $plant^{-1}$ (15.94) and dry matter accumulation $plant^{-1}$ (100.68 g) cotton + pigeonpea (6:2) system was significantly superior than cotton + soybean (2:1) and at par with cotton + greengram (2:1) and cotton + blackgram (2:1) systems.

Yield and yield attributes : Data shown in Table-1 revealed that intercropping system had pronounced effect on yield and yield components. Cotton + pigeonpea (6:2) intercropping system recorded significantly higher number of picked bolls $plant^{-1}$ (8.77) and seed cotton yield $plant^{-1}$ (28.54 g) over cotton + soybean (2:1) and at par with cotton + blackgram (2:1) and cotton + greengram (2:1) systems. However, Cotton + blackgram (2:1) intercropping system recorded significantly higher seed cotton yield ha^{-1} (9.34 q) and cotton stalk yield ha^{-1} (27.81q) over cotton + soybean (2:1) and cotton + pigeonpea (6:2) but were statistically similar with cotton + greengram (2:1). This might be due to more competition of intercrop with main crop for nutrient, moisture, space and light, etc. In cotton + pigeonpea (6:2) system, the less yield might be due to less plant population of cotton plants compared to rest of the treatments. These results are in conformation with Ukey (1999), Deoche (2001), Kalyankar (2001) and Kote *et. al.,* (2005)

Seed cotton equivalent yield:- Data in Table 2 indicated that seed cotton equivalent yield (11.73 q ha^{-1}) was maximum in cotton + blackgram (2:1) but was at par (11.64 q ha^{-1}) with cotton + greengram (2:1) over other intercropping system.

Economics: It could be seen from the data presented in the Table-2 that gross monetary returns (Rs. 28553 ha^{-1}), net monetary returns (Rs. 14164 ha^{-1}) and B:C ratio (1.98) were significantly higher in cotton + blackgram (2:1), followed by cotton + greengram (2:1) over rest of intercropping systems.

2. Effect of nutrient management

Growth and development : The perusal of data (Table 1) revealed that application of 125 per cent RDF(62.5:31.25:31.25 kg NPK ha^{-1}) recorded significantly more plant height (79.95 cm) amongst all and number of sympodial branches $plant^{-1}$(16.16) and dry matter accumulation $plant^{-1}$ (100.82 g) wherein it was at par with 100 per cent RDF (50:25:25 kg NPK ha^{-1}).

Yield and yield components : Data presented in Table-2 indicated that, seed cotton yield $plant^{-1}$ (28.82 g), seed cotton yield ha^{-1} (9.38 q) and cotton stalk yield ha^{-1} (27.94 q) were significantly higher in 125 per cent RDF(62.5:31.25:31.25 kg NPK ha^{-1}) over

Table1: Growth and yield attributes, and yield as influenced by different treatments.

Treatments	Plant height (cm) at harvest	No. of functional leaves plant^{-1} at harvest	No. of sympodial branches plant^{-1} at harvest	Dry matter accumulation plant^{-1} (g) at harvest	No of bolls picked plant^{-1}	Seed cotton weight boll^{-1} (g)	Seed cotton yield plant^{-1} (g)	Seed yield (q ha^{-1})	Stalk yield (q ha^{-1})	Harvest index (%)
Effect of intercropping										
I_1- Cotton + greengram(2:1)	77.92	57.25	15.33	99.11	8.57	3.20	27.47	9.24	27.08	25.29
I_2- Cotton + blackgram (2:1)	78.22	57.45	15.92	100.38	8.73	3.23	28.22	9.34	27.81	26.43
I_3- Cotton + soybean (2:1)	76.33	56.62	13.11	96.11	7.97	3.20	25.58	8.13	26.53	23.52
I_4- Cotton + pigeonpea (6:2)	79.66	57.55	15.94	100.68	8.77	3.21	28.54	8.63	26.71	24.38
SE (m)±	0.55	0.52	0.66	0.55	0.20	0.03	0.68	0.15	0.27	0.34
CD at 5%	1.63	NS	1.94	1.63	0.60	NS	2.00	0.44	0.80	1.02
Effect of Fertilizer levels										
F_1- 75% RDF(37.5:18.75:18.75kg NPK ha^{-1})	75.41	56.61	13.94	96.83	8.25	3.18	26.24	8.10	25.83	24.11
F_2- 100% RDF (50:25:25 kg NPK ha^{-1})	78.33	57.17	15.12	99.56	8.44	3.20	27.29	9.02	27.32	25.16
F_3- 125 % RDF (62.50:31.25:31.25 kg NPK ha^{-1})	79.95	57.87	16.16	100.82	8.85	3.25	28.82	9.38	27.94	25.45
SE(m)±	0.48	0.45	0.57	0.48	0.17	0.02	0.59	0.13	0.23	0.30
CD at 5%	1.41	NS	1.68	1.41	NS	NS	1.73	0.38	0.70	0.88
Interaction effect										
SE(m)±	0.96	0.91	1.14	0.96	0.35	0.05	1.18	0.26	0.47	0.60
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 2: Economics as influenced by different treatments.

Treatments	Seed cotton yield (q ha^{-1})	Stalk yield (q ha^{-1})	Seed cottone quivalent yield (q ha^{-1})	Gross monetary return (Rs.ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Net monetary return (Rs.ha^{-1})	B:C ratio
Effect of intercropping							
I_1 - Cotton + greengram (2:1)	9.24	27.08	11.64	28386	14363	14022	1.97
I_2 - Cotton + blackgram (2:1)	9.34	27.81	11.73	28553	14388	14164	1.98
I_3 - Cotton + soybean (2:1)	8.13	26.53	10.79	27481	14432	13049	1.90
I_4 - Cotton + pigeonpea (6:2)	8.63	26.71	11.30	27852	14488	13364	1.92
SE (m)±	0.15	0.27	0.03	81.91	56.79	80.69	0.007
CD at 5%	0.44	0.80	0.10	240.26	-	236.69	0.02
Effect of Fertilizer levels							
F_1 - 75% RDF (37.5:18.75:18.75kg NPK ha^{-1})	8.10	25.83	11.29	27695	14347	13347	1.93
F_2 - 100% RDF (50:25:25 kg NPK ha^{-1})	9.02	27.32	11.37	28159	14397	13761	1.94
F_3 - 125 % RDF (62.50:31.25:31.25 kg NPK ha^{-1})	9.38	27.94	11.43	28350	14509	13841	1.95
SE(m)±	0.13	0.23	0.03	70.94	49.18	69.88	0.006
CD at 5%	0.38	0.70	0.09	208.07	-	204.98	0.01
Interaction effect							
SE(m)±	0.26	0.47	0.06	141.88	105.97	139.77	0.01
CD at 5%	NS	NS	NS	NS	-	NS	NS

37.50:18.75:18.75 kg NPK ha^{-1} but found at par with 100 per cent RDF (50:25:25 kg NPK ha^{-1}). The increase in yield components and yield might be due to absorption of more amount of nutrients from the soil resulting in better growth and yield of cotton and intercrops. Similar findings were also reported by Solanke *et. al.* (2001), Wankhade *et. al.* (2001), Shrinivasan,(2006) and Moola and Giri (2006).

Seed cotton equivalent yield:- Application of 125 per cent RDF (62.5:31.25:31.25 kg NPK ha^{-1}) recorded maximum seed cotton equivalent yield (11.43 q ha^{-1}) over 75 per cent RDF (37.50:18.75:18.75 kg NPK ha^{-1}) but was at par with 100 per cent RDF (50:25:25 kg NPK ha^{-1})

Economics: Application of 125 per cent RDF (62.5 : 31.25 : 31.25 kg NPK ha^{-1}) recorded higher Gross monetary returns (Rs.28350 ha^{-1}), net monetary returns (Rs.13841 ha^{-1}) and B:C ratio (1.95) over 75 per cent RDF (37.50 : 18.75 : 18.75 kg NPK ha^{-1}), but was statistically similar to application of 100 per cent RDF (50:25:25 kg NPK ha^{-1}).

3. Effect of Interaction

None of the treatments shows significant interaction in respect of growth and yield parameter and also in economics such as GMR, NMR and B:C ratio.

Thus, it is concluded that cotton + greengram (2:1) and cotton +blackgram (2:1) intercropping system is the best for getting maximum seed cotton yield, net monetary return and B:C ratio. Similarly, application of 50:25:25 kg NPK ha^{-1} found

suitable in getting higher yield and B:C ratio as beyond this level the increase was not significant.

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Crop Residue Management in Soybean Based Cropping System

R. M. Deshpande[1], A. N. Chimote[2], P. C. Pagar[3] and V. V. Pattiwar[4]

ABSTRACT

A field experiment was conducted during *Kharif* and *Rabi* season of 2003-04 to 2006-07 on Agronomy Farm, College of Agriculture, Nagpur to study the crop residue management in soybean based cropping system. Addition of FYM as a mulch recorded higher soybean grain and soybean equivalent yields of 1309 and 3426 Kg ha^{-1}, respectively, followed by addition of paddy crop residue. Sequence crop of gram and wheat after soybean recorded similar soybean equivalent yields of 3526 and 3402 Kg ha^{-1}, respectively. Higher B:C ratio of 2.62 was recorded with addition of paddy crop residue. Sequence crop of gram and wheat after soybean recorded higher B:C ratio of 2.89 and 2.73 respectively. Addition of crop residues and FYM conserved more moisture as compared to no crop residue at different depth. Fertility status of soil was improved over initial status with the addition of FYM and crop residue.

Moisture stress at critical growth stages is the important constraint to soybean productivity. Hence, it is necessary to follow moisture conservation practices to conserve moisture in soil. Addition of crop residues and FYM as a mulch will help in conserving moisture which can be useful during critical growth stages of crop whenever stress is occurred. Incorporation of organic matter and FYM in soil improves the physical, chemical and biological properties and moisture holding capacity of soil which results in enhanced crop productivity. Goswami (1998) also reported the beneficial role of FYM and organic residues.

The arable land is a precious and scarce source, so among the options to increase production, the cropping intensity and efficient utilization of available resources seem to be more feasible over increasing area under cultivation. Similarly, sequence crops like gram, wheat, mustard and rajma tried after soybean will also increase the economic returns. Keeping this in view the present research was undertaken to study the effect of crop residues and FYM addition as mulch on the yield of crops and moisture conservation and also nutrient status of soil and further to find out economically suitable soybean based cropping sequences.

MATERIAL AND METHODS

The field experiment was conducted during *Kharif* and *Rabi* season of 2003-04 to 2006-07 on crop residue management in soybean based cropping system on Agronomy Farm, College of Agriculture, Nagpur. The experimental soil was vertisol with initial values of pH-7.8, EC-0.31 (dsm^{-1}), organic carbon 5.20 g Kg^{-1}, available NPK 248.0, 11.34 and 349 Kg ha^{-1}, respectively. The experiment was conducted on same site and with same randomization in a factorial randomized block design with three replications. The treatment were (A) addition of crop residues and FYM for mulching at flower initiation i.e. No crop residue (NCR), wheat crop residue @ 2.5 t ha^{-1} (WCR), paddy crop residue @ 2.5 t ha^{-1} (PCR) and FYM @ 5.0 t ha^{-1} (FYM) (B) Sequence crop after soybean i.e. gram (AKG-46), wheat (AKW-1071), mustard (Pusa bold) and rajma (VL-63). The soybean variety JS-335 was sown at 45 x 5 cm and sequence crop of gram, mustard and rajma at 45 x 10 cm spacing while wheat at 22.5 cm. The fertilizer dose of NPK was applied as per recommendations.

The soil samples were taken to analyse initial status of soil and after harvest of crops. The soil samples were also taken for moisture study at 0-30 and 30-45 cm soil depth before addition of mulch and at harvest. Cost benefit ratio was calculated according to prevailing market rates. The experiment was vitiated during *Kharif* season of 2005-06 due to excessive rains.

RESULTS AND DISCUSSION

Addition of crop residues and FYM

Individual year data and pooled means (Table 1) in respect of soybean grain yield and soybean equivalent yield showed similar trend.

1 & 4 - Associate Prof and 2 & 3. Assistant Prof., Section of Agronomy, College of Agriculture, Nagpur

Table 1 : Effect of addition of crop residues and FYM and sequence crops on yield attributes.

Treatments	Grain yield (Kg ha^{-1})				Soybean yield equivalent (Kg ha^{-1})				Grain yield plant^{-1} (Mean)	Pods /Earheads /Siliqua plant^{-1} (Mean)
	2003-04	2004-05	2006-07	Pooled Mean	2003-04	2004-05	2006-07	Pooled Mean		
Addition of crop residues and FYM										
NCR	1714	407	1135	1086	3348	2416	3039	2934	7.06	30.32
WCR	1757	560	1266	1194	3505	2697	3448	3217	7.39	35.21
PCR	1840	596	1274	1237	3622	2702	3552	3292	7.60	35.84
FYM	1888	648	1391	1309	3714	2806	3773	3426	7.89	35.48
SE(m)±	76.8	13.2	55.5	36.6	80.6	104.6	143.5	81.0	-	-
C.D. at 5%	NS	38.6	162.0	105.5	233.4	301.7	418.9	236.1	-	-
Sequence Crops										
Gram	1363	1498	2062	1641	3558	2390	4648	3526	9.04	33.12
Wheat	2927	3556	3009	3165	3728	2880	3598	3402	6.61	5.25
Mustard	869	1389	1003	1087	3004	2862	2576	2814	6.60	183.20
Rajma	1409	1386	1027	1274	3900	2390	2990	3126	10.97	11.15
SE(m)±	-	-	-	-	80.6	104.6	143.5	81.0	-	-
C.D. at 5%	-	-	-	-	233.4	301.7	418.9	236.1	-	-

Addition of crop residues and FYM influenced the grain and soybean equivalent yield significantly as compared to no crop residue (Control). Addition of FYM @ 5.0 t ha^{-1}, paddy crop residue and wheat crop residue both @ 2.5 t ha^{-1} recorded significantly more soybean grain yield of 1309, 1237 and 1194 Kg ha^{-1}, respectively as compared to control. Addition of FYM, paddy crop residue and wheat crop residue increased the soybean grain yield by 20.5, 13.9 and 9.9 per cent, respectively as compared to control. Mulch of crop residues and FYM might have conserved soil moisture due to reduction in evaporation and less soil temperature. Narendra Kumar and Gautam (2004) also reported that the extended period of moisture availability due to mulching resulted in higher yield.

Similarly, the addition of FYM, paddy crop and wheat crop residues recorded significantly higher soybean equivalent yield over control. The increase was upto 16.8, 12.2 and 9.6 per cent over control by addition of FYM and paddy and wheat crop residues, respectively. Higher production might be on the basis of availability of nutrients through crop residues and organic manure and conservation of more soil moisture. Singh and Rai (2004) also reported similar results.

Regarding monetary returns (Table 2), addition of FYM, paddy and wheat crop residues recorded significantly more gross monetary returns of Rs. 44,699, 42,978 and 41,967 ha^{-1}, respectively over no crop residue (Control).

Table 2 : Effect of addition of crop residues and FYM and sequence crops on economics.

Treatments	GMR (Rs. ha^{-1})				Cost of cultivation (Rs.)	B:C
	2003-04	2004-05	2006-07	Pooled Mean		
Addition of crop residues and FYM						
NCR	40725	30440	43341	38163	15115	2.53
WCR	42739	33881	49283	41967	16365	2.56
PCR	44352	34004	50594	42978	16385	2.62
FYM	45356	35069	53796	44699	18032	2.47
SE(m)±	1032	1244	2199	1039	-	-
C.D. at 5%	3011	3590	6420	3031	-	-
Sequence Crops						
Gram	43109	30594	66118	46605	16088	2.89
Wheat	46227	37453	51859	45139	16522	2.73
Mustard	36298	34745	36196	35748	14757	2.42
Rajma	47446	30602	42839	40332	18530	2.18
SE(m)±	1032	1244	2199	1039	-	-
C.D. at 5%	3011	3590	6420	3031	-	-

Market rates for grain (Rs. $quintal^{-1}$) :	2003-04	2004-05	2006-07
Soybean	1175	1203	1375
Gram	1570	1462	2200
Wheat	770	793	1125
Mustard	1565	1978	1850
Rajma	1760	1687	2300

Table 3 : Moisture content (%) in soil as influenced by mulching treatments (Mean of three years)

Treatments	At flowering		At harvest	
	0-30 cm Depth	30-45 cm Depth	0-30 cm Depth	30-45 cm Depth
Before addition of straw	28.80	29.05	-	-
Mulching treatments				
NCR	-	-	20.68	21.91
WCR	-	-	24.48	25.23
PCR	-	-	24.17	24.84
FYM	-	-	23.78	24.36

Table 4 : Effect of addition of crop residues and FYM as mulch on fertility status of soil after completion of the experiment.

		pH	E.C. (dsm^{-1})	Organic	Available		
				Carbon ($g\ kg^{-1}$)	N ($Kg\ ha^{-1}$)	P_2O_5 ($Kg\ ha^{-1}$)	K_2O ($Kg\ ha^{-1}$)
A)	Initial	7.80	0.31	5.20	248.00	11.34	349.00
B)	After harvest of sequence crops						
	NCR	7.72	0.26	6.22	293.60	22.72	434.37
	WCR	7.59	0.29	6.61	311.94	23.17	446.45
	PCR	7.58	0.28	6.81	321.98	23.83	452.82
	FYM	7.53	0.31	7.05	342.47	24.14	454.46

Addition of paddy crop residue recorded the higher B:C ratio of 2.62, followed by wheat crop residue (2.56). Addition of FYM recorded lowest cost - benefit ratio due to the high cost of FYM. Ghadage *et al.* (2005) also recorded higher benefit : cost ratio by organic mulch.

Sequence crop

Soybean-gram and soybean-wheat sequences recorded significantly more soybean equivalent yield of 3526 and 3402 Kg ha^{-1}, respectively over sequence crop of soybean-rajma and soybean-mustard after soybean. Ramesh and Reddy (2004) reported increased productivity with soybean-wheat cropping system.

Higher gross monetary returns of Rs. 46,605 and 45, 139 were recorded by soybean-gram and soybean-wheat crop sequences, respectively over sequence of soybean-rajma and soybean-mustard.

Maximum B:C ratio of 2.89 was recorded by soybean-gram crop sequence and was followed by soybean-wheat crop sequence (2.73). Bobde *et al.* (1998) also reported more economical returns from soybean- gram and soybean-wheat cropping system.

Addition of crop residue and FYM recorded higher soil moisture content as compared to no crop residue at harvest of soybean crop at 0-30 and 30-45 cm soil depth. Higher moisture content might be due to enhanced water holding capacity of soil as crop residues and organic manure (FYM) decreases bulk density and increases porosity. Favourable effect of crop residues on water holding capacity of soil was also reported by Yadav and Kumar (1993) and Das *et al.* (2001).

Fertility status of soil was improved over initial status by addition of FYM and paddy and wheat crop residues. Addition of FYM recorded 38.1, 112.9 and 30.2 per cent increase in available N, P and

K, respectively over initial fertility status. Addition of crop residues and organic manures to soil might have increased nutrient availability due to increase in humus content and organic carbon content of soil. Singh and Rai (2004) also reported similar results. Das *et al.* (2001) reported beneficial effect of application of wheat and rice straw to soil in improvement of fertility status of soil due to crop residue incorporation.

Hence, it is concluded that application of paddy crop residue (straw) @ 2.5 t ha^{-1} as mulch in soybean at flower initiation followed by sequence crop of gram and wheat after soybean is recommended for getting higher economic returns.

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Response of Rainfed Cotton to Different Sources of Nutrients and Fertilizer Levels

S. M. Nawlakhe[1], D. D. Mankar[2] and P. K. Rananavare[3]

ABSTRACT

A field experiment with a view to access the efficient and optimum organic sources of nutrient and inorganic fertilizer was carried out at Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola to study the response of organic sources of nutrients and inorganic fertilizer levels on growth parameters, quality parameters and nutrient uptake and residual status with yield parameters, yield and monetary returns of rainfed cotton during *Kharif* 2004-05 in FRBD with two factors as organic sources of nutrients and inorganic fertilizer levels. Observation on growth parameters, yield and yield parameters of seed cotton and stalk yield, uptake by the plant and nutrient status indicated significantly higher values with application of vermicompost at the rate of 2 t ha^{-1} treatment and FYM application @ 5 t ha^{-1} was at par with it. The inorganic fertilizer level 50:25:25 indicated significantly higher yield as well as other observation over others. The quality parameters remain unaffected by nutrient sources and fertilizer levels. Leucaena loppings and no fertilizer recorded the lowest seed cotton yield and growth parameters. Interaction effect were significant in respect of number of bolls and seed cotton yield.

India is first in world ranking and, in India, Maharashtra ranks first in respect of acreage. But the productivity of cotton crop, in India, is low i.e. 375 kg ha^{-1} and this is again low in Maharashtra i.e. 191 kg ha^{-1} compared to world average of 620 kg lint ha^{-1}. This productivity is still low in Vidarbha tract of Maharashtra which is major rainfed cotton growing tract. In rainfed condition under moisture stress, nutrient management is one of the major causes for low productivity. Cotton is a cash crop and to increase the yield chemical fertilizers are being used for fulfilling the nutrient need of crop which is becoming a costly input and also continuous use becoming detrimental and disastrous both to soil and environment. To explore the possibilities of reducing the use of inorganic fertilizers and increasing the use of organic sources of nutrients in cotton cropping to minimise the side effect to environment and soil, present study was undertaken with objective of working out optimum organic sources and efficient fertilizer level.

MATERIAL AND METHODS

A field experiment on rainfed cotton to study the response of organic nutrient source and inorganic fertilizers levels was carried out with var. AKA -7 on the Agronomy farm, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *Kharif* season of 2004-05 in factorial randomized block design with two factors as organic nutrient sources and inorganic fertilizers levels in three replication. Average rainfall of location of experiment was 768.5 mm in 42 rainy days and actual rainfall received in the experimental year was 459.2 mm in 35 days.

The soil of experimental field was clayey in texture, slightly alkaline (pH 7.87), low in available N (197.42 kg ha^{-1}) and available P_2O_5 (19.37 kg ha^{-1}) and high in K_2O (422.56 kg ha^{-1}) with electrical conductivity of 0.5 dSm^{-1}

The organic source treatments were FYM at the rate of 5 t ha^{-1} (M1), vermicompost at the rate of 2 t ha^{-1} (M2), sannhemp green manuring 30 days after sowing(M3), leucaena loppings at the rate of 5 t ha^{-1}(M4) and treatment of another factor were control i.e. no fertilizer (I_0), 50 per cent RDF i.e. 25:12.5:12.5 NPK kg ha^{-1} (I_1), and full RDF i.e.50:25:25 NPK kg ha^{-1} (I_2). Crop was sown at 60 X 30 cm spacing.

RESULTS AND DISCUSSION

Response of organic nutrient sources:

The mean plant height at harvest (Table 1) was maximum and significantly higher with application of vermicompost at the rate of 2 t ha^{-1}

1.Associate Prof., 2 . Assistant Prof. and 3 M.Sc. Student, Agronomy section, College of Agriculture, Nagpur, Dr. PDKV, Akola

Table 1 :Growth , yield parameters and yield as influenced by the inorganic fertilizers and organic sources of nutrients .

Treatments	Mean plant height (cm) at harvest	Mean leaf area (dm2)	Mean number of monopodial branches	Mean Number of sympodial branches per plant	Dry Matter per plant (g)	LAIat harvest	Yield parameters		Yield(qha-^{1})		
							Number of bolls picked plant^{-1}	Seed cotton weight boll^{-1}(g)	Seed cotton yield plant^{-1}	Seed cotton yield (q ha^{-1})	Stalk yield (q ha^{-1})
Organic sources											
M_1- FYM @5 t ha^{-1}	121.77	54.56	3.26	18.34	45.49	3.031	14.55	2.98	12.69	8.60	20.50
M_2- Vermicompost @ 2 t ha^{-1}	123.00	54.84	3.32	18.70	45.84	3.046	14.75	3.61	12.88	8.71	20.98
M_3- Sannhemp green manuring	118.09	53.60	3.05	17.68	43.85	2.978	13.81	2.86	11.71	8.19	19.54
M_4 Leucaena loppings	116.08	52.88	2.84	17.02	42.70	2.938	13.45	2.75	11.35	7.98	18.51
S. E (m). +	1.00	0.24	0.06	0.21	0.34	0.013	0.10	0.03	0.07	0.05	0.31
C. D. at 5%	2.94	0.71	0.20	0.64	1.02	0.039	0.30	0.10	0.21	0.17	0.92
Inorganic Fertilizer levels											
I_0-No fertilizer	112.84	51.37	2.68	15.67	40.47	2.853	11.44	2.65	10.44	7.57	16.67
I_1 -Half RDF	119.98	54.15	3.14	17.89	44.59	3.008	14.22	2.87	12.34	8.41	20.46
I_2 -Full RDF	126.39	56.39	3.53	20.24	48.34	3.133	15.76	3.18	13.69	9.13	22.54
S. E (m) ±	0.87	0.21	0.06	0.18	0.30	0.011	0.09	0.03	0.06	0.05	027
C. D at 5%	2.55	0.61	0.17	0.55	0.88	0.034	0.26	0.08	0.18	0.15	0.80
Interaction effect											
S. E(m). ±	1.74	0.42	0.12	0.37	0.60	0.023	0.58	0.06	0.12	0.10	0.54
C. D. at 5%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	0.52	N.S.	0.37	0.30	N.S.

Table 2: Quality parameters, monetary returns nutrient uptake and residual nutrient status of soil at harvest as influenced by organic nutrient source and fertilizer levels

Treatments	Quality parameters					Monetary returns			Nutrient uptake by cotton plant kgha^{-1}			Residual nutrient in soil at harvest NPK kg ha^{-1}		
	Ginning % index (g)	Seed hallow length (mm)	Mean s index (%)	Earlines index (%)	Harvest Rs ha1	GMR Rs ha-1	NMR ratio	B:C	N	P	K	N	P	K
Organic sources														
M_1-FYM@5t/ha	39.81	5.40	22.33	0.62	29.65	22025	11073	2.01	36.24	9.74	32.18	212.29	28.39	434.36
M_2- Vermicompost @ 2 t/ha	39.86	5.52	22.04	0.61	29.34	22333	8131	1.57	37.56	11.00	33.78	214.33	33.45	435.79
M_3- Sannhemp green manuring	39.64	5.59	22.21	0.62	29.63	20977	11725	2.27	34.82	10.30	30.49	208.36	29.66	429.63
M_4 - Leucaena loppings	39.70	5.47	22.44	0.63	30.37	20376	11074	2.19	33.43	9.22	28.71	201.13	25.06	425.00
S. E. (m) ±	0.22	0.25	0.15	0.007	0.88	-	-	-	0.45	0.32	0.55	2.35	1.06	1.47
C. D. at 5%	N.S.	N.S.	N.S.	N.S.	N.S.	-	-	-	1.34	0.96	1.62	6.91	3.12	4.33
Inorganic Fertilizer levels														
I_1-No fertilizer	39.46	5.74	22.32	0.63	31.37	19221	12020	2.67	29.96	8.25	25.99	191,80	20.84	415.41
I_2-HalfRDF	39.75	5.48	21.98	0.62	29.07	21588	13886	2.80	35.64	9.84	31.20	211.70	27.97	433.17
I_3 -Full RDF	40.04	5.26	22.47	0.61	28.80	23476	15474	2.93	40.93	12.11	36.66	223.58	38.61	445.00
S. E(m). ±	0.19	0.22	0.13	0.006	0.76	-	-	-	0.93	0.28	0.47	2.04	0.92	1.28
C. D. at 5%	N.S.	N.S.	N.S.	N.S.	N.S.	-	-	-	1.16	0.83	1.40	5.99	2.71	3.75
Interaction effect														
S. E(m). ±	0.38	0.43	0.27	0.012	1.53	-	-	-	0.79	0.56	0.95	4.08	1.84	2.56
C. D. at 5%	N.S.	N.S.	N.S.	N.S.	N.S.	-	-	-	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Table 3: Interaction effect on number of bolls picked per plant and seed cotton (yield g plant^{1} and q ha-^{1}) as influenced by the inorganic fertilizers levels and organic sources of nutrients.

Treatments	Number of bolls picked per plant			Seed cotton yield (g plant^{1})			Seed cotton yield (qha^{1})		
	I_0-No fertilizer	I_1- Half RDF	I_2- Full RDF	I_0-No fertilizer	I_1- Half RDF	I_2- Full RDF	I_0-No fertilizer	I_1- Half RDF	I_2- Full RDF
Mi.FYM@5t/ha	12.75	15.01	15.88	10.80	12.99	14.30	7.56	8.96	9.27
M_2- Vermicompost @ 2 t/ha	13.15	14.83	16.28	11.49	12.97	14.18	7.97	8.70	9.48
Ms- Sannhemp green manuring	12.31	13.54	15.59	9.95	11.93	13.25	7.57	8.09	8.93
M/t- Leucaena loppings	11.58	13.54	15.28	9.54	11.50	13.03	7.19	7.90	8.86
S. E(m). +	0.18	0.26	0.10						
C. D. at 5%	0.52	0.77	0.30						

application (M_2) and FYM at the rate of 5 t ha^{-1} (Mi) was at par with it. Higher response to vermicompost and FYM obtained might be probably due to nutrients and availability in the beginning, while in case of leucaena loppings and sannhemp incorporation it might have taken some period for decomposition and liberation of nutrients in available form. Similar trend was also found in respect of mean number of functional leaves, mean leaf area, mean number of monopodial as well as sympodial branches $plant^{-1}$ at harvest, dry matter accumulation at harvest and LAI at harvest (Table 1). These results are in conformity with result obtained by Solaiappen and Dason (1998) and Katkar *et. al.* (2002).

The number of bolls picked $plant^{-1}$, seed cotton yield $plant^{-1}$, seed cotton yield (q ha^{-1}) and stalk yield (q ha^{-1}) were reported significantly superior by application of vermicompost at the rate of 2 t ha^{-1} (M_2) treatment over others except FYM at the rate of 5 t ha^{-1} (M1) which was at par with it (Table 1). This might be due to contribution of various growth parameters which were also higher in the same treatments. Similar results are reported by Prakash *et. al.* (2001) and Katkar *et. al.* (2002).

The various organic sources of nutrients did not have any significant effect on the quality parameters viz. ginning, seed index, hallow length, earliness index and also harvest index (Table 2).

The nutrient uptake of nitrogen, phosphorus and potash was significantly influenced by the sources of nutrients and was maximum and significantly higher with application of vermicompost at the rate of 2 t ha^{-1} (M_2) treatment over others except FYM @ 51 ha^{-1} (Mi) which was at par with it in respect of nitrogen uptake only. The similar trend was also found in respect of residual nutrient in soil. Potash residual nutrient in FYM at the rate of 5 t ha^{-1} (Mi) was at par with it. Though the GMR was maximum in vermicompost @ 21 ha^{-1} (M_2) treatment, the NMR and B:C ratio was maximum with sannhemp green manuring (M_3) which might be due to low cost of organic sources.

Response of inorganic fertilizers levels:

However the mean number of functional leaves per plant at harvest, mean leaf area at harvest, mean number of monopodial and sympodial branches at harvest, dry matter accumulation at harvest, LAI at harvest (Table 1) was significantly influenced by inorganic fertilizer levels. Full RDF (50:25:25 NPK kg ha^{-1}) i.e. I_2 recorded significantly highest values for these observation. over rest of inorganic fertilizer treatments.

Values of all the growth parameters increased significantly due to full recommended doses of inorganic fertilizer. Role of major nutrients particularly nitrogen and phosphorus is well known in cell division, cell enlargement, cell development, and various metabolic activities of plant. Due to optimum nitrogen and phosphorus supply the vegetative growth might be significantly more with full RDF level of inorganic fertilizer. Sharma *et. al.*, (2001) and Katkar *et. al.* (2002) recorded a favourable influence of fertilizer on plant height, increase in number of leaves and maximum leaf number $plant^{-1}$ due to inorganic fertilizer level. Sastri *et.al.* (2001) and Yadav *et. al.* (1991) also obtained similar results in case of number of branches with increase in fertilizer levels. Ravankar and Deshmukh (1994) and Wankhede *et. al.* (2001) reported similar result in case of dry matter accumulation.

The average number of bolls $plant^{-1}$, seed cotton yield $boll^{-1}$ and seed cotton yield (gram $plant^{-1}$ and q ha^{-1}) as well as stalk yield (q ha^{-1}) was maximum and significantly higher in full RDF through inorganic source (Table 1). This might be due to the cumulative effect of supply of N and P which ultimately resulted in significant increase in various growth parameters and this might have contributed in significant increase in number of bolls $plant^{-1}$, seed cotton weight boll and seed cotton yield $plant^{-1}$. Thus the significant increase in yield (20.6 % more over control and 8.5 % more over half RDF) might be due to increase in their yield parameters. These results are similar to those reported by Sastri *et. al.*, (2001). The stalk yield was increased significantly (35.2 %) over control due to full RDF which may be attributed to significant increase in various growth parameters.

The nutrient uptake by plant as well as residual nutrient in soil in respect of nitrogen, phosphate and potash was significantly influenced by inorganic fertilizer levels and was maximum and significantly higher in Full RDF (50:25:25 NPK kg ha^{-1}) i.e. I_2 level (Table 2). Similar results were also reported by the Katkar *et. al.*, (2002). The same treatment also recorded higher GMR, NMR and B:C ratio. All the quality parameters studied were not

influenced significantly by the inorganic fertilizer levels (Table 2).

Interaction effect:

Interaction effect was not significant in respect of all growth parameters studied. The seed cotton weight per boll and stalk yield was not influenced significantly by interaction of inorganic fertilizer level and organic sources. However, number of bolls per plant, seed cotton yield plant^{-1} and seed cotton yield (q ha^{-1}) was significantly influenced by the interaction. The treatment I_2M_2 (Full RDF +Vermicompost at the rate of 2 t ha^{-1}) recorded maximum and significantly higher yield except I_2M_1 (Full RDF +FYM @ 5 t ha^{-1}) which was at par with it (Table 3).

Thus from the present study it was concluded that among the organic sources vermicompost at the rate of 2 t ha^{-1} application or FYM at the rate of 5 t ha^{-1}, among inorganic sources full RDF i.e. 50:25:25 and in combination full RDF +Vermicompost at the rate of 2 t ha^{-1} was the best to give maximum yield and the quality parameters studied remain unaffected.

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Adoption of Recommended Technology in Paddy Production

Shubhangi Alexander[1], G. B. Malthane[2], N.N. Kukade[3], and S.W.Jahagirdar[4]

ABSTRACT

The principle component analysis (PCA) approach was used for developing complete index. The net adoption of recommended technologies expressed in terms of composite scores of 120 farmers was estimated, tabulated and classified as low level adoption (40-60 %), adoption and high level adoption (above 80 %). The average recommended technology adopted by selected farmers was highest i.e. 102.24 per cent in case of nitrogen application, followed by seed rate (92.61%) while it was lowest i.e. 19.41 per cent in case of seed treatment. This indicates that the majority of the selected farmers did not use the recommendation for most of the technologies. Overall 25.83 per cent of the farmers adopted below 60 per cent technologies, 67.50 per cent farmers adopted in the range of 60-80 per cent technologies, while only 6.67 per cent farmers adopted more than 80 per cent technologies.

Rice is the most important food commodity in Asia, particularly in South and South-East Asia, where more than 90 per cent of rice is produced and also consumed. It is also a major source of livelihood for more than 250 million households. The bulk of Asia population, the urban, rural population and the marginal farmers spend more than half of their income in rice, being a dominant food staple.

The impact of green revolution in paddy began in the early sixties which was attributed to the yield increase unit[-1] area in India; indeed, a review of the development during the last 15 years shows that so far we have been able to take advantage of only those components of the improved production technology which presented a few problems in creating the management and organizational infrastructure in support of a more modern agriculture.

As far as India is concerned, the process of development of modern production technology with emphasis on very high levels of yield is still in it's stage. We must now plan for major thrust in many new areas to diversify the technology and extend its coverage.

Production technology of rice is relevant largely to the irrigated land, where water management does not present a serious problem; these lands, however, constitute only about 30 per cent of the total rice acreage. The large part of the rice crop, in India, is grown on unirrigated lands while there is serious problem of moisture stress, especially during the grain filling stage in case of upland rice. The next ten years must see a major efforts to evolve a more effective production technology for these situation, both of which have a predominance of small and marginal farmers in the eastern states of the country. The magnitude of the problem in terms of area involved is so great that the country must establish one or more additional research centres to provide technical support for rice cultivation in these land.

The major constraints for yielding increase is still lack of high yield technology for our high rainfall area. Technology without a favourable policy environment, large scale adoption will be of no use. Indian scientists have been successful since the beginning with progressively improved varietal and crop management technology which include, among the recent ones, multiple disease pest resistance varieties, hybrid rice technology, export quality, high yield *Basmati* and non *Basmati* varieties a wide choice of high yielding varieties for varied rainfall ecologies and integrated pest and nutrient management packages. Achievement of production targeted for the coming decade would depend on how effectively we translate all such opportunities into production.

Per hectare yield of paddy in Maharashtra is quite low as compared to the yield potential due

1. Assistant. Prof., Anand Niketan Agriculture Collage, Warora , 2 . Assistant. Prof. and 3 & 4. Associate Prof., Collage of Agriculture, Nagpur.

to inadequate knowledge about the cultivation practices and non adoption of recommended practices of paddy crop.

This study would be helpful to understand the adoption behaviour of paddy growers in respect of knowledge about recommended cultivation practices of paddy crop. The present study was undertaken with the specific objectives, as under:

1. To assess the extent of adoption of recommended technologies of paddy.
2. To develop a index of technology adopted by farmers by the method of principal component analysis.

MATERIAL AND METHODS

A sample of 120 farmers was selected from 6 villages of Saoli tahsil. The data pertained to agricultural year 2003-2004.

Recommended technology

The term recommended technologies refers to the cultivation practices recommended by Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola and other Agriculture Universities and State Department of Agriculture.

Adoption of technology

Adoption of technology refers to actual practices adopted by the farmers for cultivation of paddy crop. The information on practices adopted by the selected farmers was collected.

Development of composite index of technology

The components of technology recommended by the University for paddy expressed in terms of adoption score (X_1 .... X_2) were utilized for developing composite index of technology. A composite index is a single numerical value representing the net adoption of all components of technologies values lies in between 0 and 1.

The principle component analysis (PCA) approach was used for developing composite index. The principle components based on 12 x 12 correlation matrix of 12 components of technology were computed. A set of 12 principle component explaining 100 per cent of total variation of all components of recommended technology was considered.

Consider 12 Eigen vector in the farm of 12 x 12 matrix where rows represent variable and columns represent Eigen vector from which weight or coefficient of a component of technology (W_j) is determined.

$$W_i = \frac{X_i}{\sqrt{X_1^2 + X_2^2 + \ldots\ldots\ldots\ldots + X_n^2}}$$

Where, X_i = Maximum Eigen value for i^{th} vector

$i = 1,2,3,4\ldots\ldots\ldots\ldots n$

n = Total number of variable

The required function for deriving composite index (Score) is;

$$Si = \frac{W_1X_1 + W_2X_2 + \ldots\ldots\ldots\ldots + W_{12}X_{12}}{\sum W_i}$$

Which provides adoption index (of all component of technologies) for each cultivator. The composite index obtained in the process lies in between 0 and 1.

The net adoption of recommended technologies expressed in terms of composite scores of 120 farmers was estimated, tabulated and classified as low level adoption (40-60 %), medium level (60-80 %) adoption and high level adoption (above 80 %).

In order to assess the degree of association between technology adopted and productivity, an attempt was made to explore a possible linear and non linear statistical functions and a function of which the value of R^2 was highest and whose coefficient were statistically significant was finally selected for assessing the contribution of each component technology. (Desai, 1984)

RESULTS AND DISCUSSION

Table 1. Technology developed by Dr. PDKV, Akola and other Agriculture Universities for paddy

S. N.	Technology	Recommendation
1	Land preparation	Ploughing -2
2	Selection of variety	Sonasali, HMT Sona
3	Seed treatment	3 g thiram per kg of seed
4	Seed rate	35 to 0 kg (70 kg seed, without germination test and home produced seed)
5	Time of transplanting	21 to 25 days after sowing (nursery)
6	Fertilizer application	100 N, 50 P and 50 K kg/ha
7	FYM application	25 to 30 cartloads
8	Plant protection	Monocrotophos and other insecticides as per requirement for controlling insects / pest and diseases
9	Weeding	Two
10	Irrigation	The water level 2.5 cm for root settling and 5.00 cm level for grain maturing stage. In case of dry spell for more than 10 days there is recommended to provide protective irrigation to paddy crop to maintain the desired water level.

Extent of adoption of technology

Actual level of adoption of each item of technology on farmers' field was identified. Using the recommended technologies developed by Dr. PDKV, Akola and other Agricultural Universities in Maharashtra, efficiency of each technology was calculated.

Table 2. The average recommended technologies adopted by selected farmers

S. N.	Particulars	% of technology adopted by selected farmers
1	Ploughing	89.17
2	Selection of variety	91.67
3	Seed treatment	19.41
4	Seed rate	92.61
5	Time of transplanting	68.50
6	Fertilizer application	
	N	104.24
	P	88.03
	K	45.55
7	FYM application	32.07
8	Plant protection measures	37.99
9	Weeding	71.67
10	Irrigation	74.17

It is observed from Table 2 that the average recommended technology adopted by selected farmers was highest i.e. 104.24 per cent in case of nitrogen application, followed by seed rate (92.61%), while it was lowest i.e. 19.41 per cent in seed treatment.(Singh and Singh 1995)

Development of composite of technology

The components of technologies recommended by the University for paddy were identified and then the level of adoption of each component of recommended technology by the farmers was expressed in terms of adoption sources and the same was utilized for developing composite score of technology adoption. In this process, weights were properly scaled so that the composite scores lie in between 0 and 1. Composite scores were computed for all selected farmers using the following function.

Development of composite index (Scores) of technology

The estimated composite adoption score (Si) is;

$$Si = \frac{(W_1X_1 + W_2X_2 + \ldots\ldots\ldots\ldots + W_{12}X_{12})}{\sum W_i}$$

$$S_i = \frac{(0.2387X_2 + 0.2643 X_2 + 0.2920 X_3 + 0.2681 X_4 + 0.3769 X_5 + 0.2252 X_6 + 0.2442 X_7 + 0.2714 X_8 \; 0.3589 X_9 + 0.2306 X_{10} + 0.2893 X_{11} + 0.03524 \; X_{12}) \times 100}{3.4122}$$

Where,

Si's = For adoption scores for individual component of technologies
X_1 = For ploughing
X_2 = For selection of variety
X_3 = For seed treatment
X_4 = For seed rate
X_5 = For time of transplanting
X_6 = For nitrogen
X_7 = For phosphorus
X_8 = For potassium
X_9 = For FYM
X_{10} = For plant protection
X_{11} = For weeding
X_{12} = For irrigation

$$\sum W_i = W_1 + W_2 + W_3 + \ldots\ldots\ldots\ldots + W_{12}$$

Distribution of farmers according to composite adoption index

On the basis of technology adopted, the farmers were categorized under low, medium and high groups and same is presented in Table 3.

Table 3. Distribution of farmers according to composite adoption index

Range of composite adoption index	Level of adoption	No. of farmers	% of total No. of farmers	Average yield (qtls)
40-60	Low	31	25.83	29.58
60-80	Medium	81	67.50	36.93
Above 80	High	08	6.67	42.30
Total		120	100.00	36.27

It is observed from Table 3 that the composite adoption index was not below 40 per cent. The farmers whose adoption index was in the range of 40-60 were considered as low group. The farmers whose adoption index was in the range of 60-80 were considered as medium group. Whereas the farmers who adopted more than 80 per cent technology were among the high group. It was observed that 6.67 per cent of the farmers had under high level of adoption with composite adoption index was more than 80 per cent. Eightyone farmers were in medium group, whereas 31 farmers were in low technology adoption group i.e. in the range of 40-60 composite adoption index.

The ha^{-1} average yield was highest i.e. 42.30 quintals in high level of adoption group, followed by medium group (36.93 quintals) while it was lowest (29.58 quintals) in case of low level of adoption group. The overall ha^{-1} yield of the selected cultivators was 36.27 quintals.

Table 4. Relationship between technologies adopted and productivity

Sr. No.	Function	Intercept	Regression	Coefficient	R^2
1	Logistic model	Intercept			
	$Y = \frac{a}{1 \; bxe^{-cx}}$	a 48.0968	b 22.3098	c 0.0606	0.9874

(Indicates significance of R^2 at 5 per cent level)

Contribution of technologies in productivity

To find out the contribution of different technologies linear and non linear production functions were fitted to the technology adoption score and production of selected farmers. In analysis composite adoption index was considered as independent variable (X) with yield (Y) of the respective farmers as dependent variable.

Among several competing linear and non-linear models logistic model was found to be the most appropriate to the data under consideration yielding the highest R^2 to the extent of 0.9874. (Talathi & Virkar 1992). This function was used for estimate share of different components of technologies in total production.

CONCLUSION

The average recommended technology adopted by selected farmers was highest i.e. 102.24 per cent in case of nitrogen application, followed by seed rate (92.61%) while it was lowest i.e. 19.41 per cent in case of seed treatment. This indicates that the majority of the selected farmers did not use the recommendation for most of the technology.

Overall 25.83 per cent of the farmers adopted below 60 per cent technologies, 67.50 per cent cultivators adopted in the range of 60-80 per cent technologies while only 6.67 per cent cultivators adopted more than 80 per cent technologies.

Logistic model was found to be the most appropriate to the data under considering yield. The highest R^2 to the extent of 98.74 per cent.

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Contribution of Recommended Technologies on Productivity of Cotton in Vidarbha

Suvarna L. Mahalle[1], E. R. Patil[2] and Devyanee Nemade[3]

ABSTRACT

Agricultural production has increased manifold due to the introduction of high yielding varieties coupled with improved production practices. Along with the varieties of hybrid cotton many technologies were also evolved by the Dr. P.D.K.V.,Akola for hybrid cotton crop. The paper made an attempt to quantify the contribution of Recommended Package of Practices or Production Technologies based on sample survey data collected from 100 cultivators of Murtizapur Tahasil of Akola District in Maharashtra. An attempt was made to assess the extent of recommended technologies and developed a composite score to represent various components of technologies such as application of fertilizers, weeding, etc. in the form of single numerical value with the help of principle Component analysis. The study indicated that only 13 per cent farmers adopted the above 80 per cent technologies means it has to scope to increase the adoption level of the technology up to recommendation. The adoption of technologies increases the productivities and net economic returns also increases.

Cotton is one of the most important cash crops playing a vital role in Indian economy. Maharashtra is the largest cotton growing state in the country with an area of 27.66 lakh ha, out of this nearly 50 percent area is in Vidarbha. The productivity, in Maharashtra is very low i.e.191 kg ha^{-1} as compared to the productivity of cotton in India which is 399 kg ha^{-1} in 2003-04 (CCI website). Low productivity is attributed to its rainfed cultivation, erratic behavior of rainfall, less adoption of improved practices and host of many other factors.

The university has undertaken various research programs especially for cotton crops and developed a complete package of practices for the profitable cultivation of cotton in Vidarbha region. Koranee *et.al*, 1996 state that the impact of technologies evolved and recommended by Dr. P.D.K.V., Akola for cotton crop, some of the important components considered for the present investigation.

There is a need to study the contribution of recommended technologies at farm level in terms of improvement in productivities or net return. This would help further refinement of technology and for greater up take. This type of information will be useful even for fixing the priorities of competing projects in a crop research unit.

The main objectives of this study are:

(1) To assess the contribution of each component of technology towards productivity

(2) To compare the economics of cotton production adopting different levels of technology.

MATERIAL AND METHODS

A two stage random sampling technique was adopted for selecting villages and farmers. Murtizapur Tahasil in Akola district was selected purposively for the present investigation as more than 75 per cent of farmers grows cotton in this Tahasil. Five villages namely Kanadi, Kavada, Shenda, Virahit and Hirpur were selected randomly for the study. A random sample of 100 farmers 20 from each selected villages were considered for the present study. Data were collected during the year 2004-2005 on various aspect of cotton cultivation, like gap filling, thinning, fertilizer application, weeding, farm yard manure and plant protection.

Extent of adoption of technology:

Actual level of adoption of each component of recommended package of practices on farmer's field was identified. Using the recommended technologies developed by Dr. P.D.K.V., Akola, efficiency of each technology were calculated. All

1. Senior Res.Fellow, 2. Associate Dean and 3. Senior Res. Asstt., Department of Agricultural Economics, Dr. PDKV, Akola

efficiency scores scaled down to 0 to 1 and all the groups of farmers were classified as zero level adoption, 0 - 0.4, 0.4 - 0.8 and 0.8 - 1.

Development of composite index of technology:

The component of technology recommended by the University for hybrid cotton expressed in terms of adoption scores (X_1.....X_{13}) were utilized for developing composite index of technology adopted. The principle components Analysis was used to develop a Composite technology adoption score (Raheja *et. al*, 1985) state that the different procedure for developing such indices has been investigated.. A set of 13 - Principle components explaining 100 per cent of total variation of all components of recommended technology was considered. Where rows represent variable and columns represent eigen vectors from which weight or coefficient of a components of technology (Wi) say i is determined as:

$$Wi = \frac{Mi}{\Sigma Mi}$$

Where,

Mi = Maximum element in i^{th} row

The required linear function for deriving composite index (score) is:

$$Si = W_1X_1 + W_2X_2 + \ldots\ldots\ldots\ldots\ldots + W_nX_n$$

Which provides adoption index (of all component of technologies) for each cultivator. The composite index obtained in the process lies in between 0 and 1.

In order to assess the degree of association between technology adopted and productivity an attempt was made to explore all possible linear statistical functions and a function which yields highest R^2 and whose coefficient is statistically significant was finally selected for assessing the contribution of each component of technology.

Contribution of different technologies:

The contributions of different technologies are obtained through estimated Harris function as explained below.

Step (I) : Adoption index (I_1) under 100 percent adoption of recommended technology was computed and it's expected yield (Y_1) was estimated from identified relation. In this case adoption score becomes sum of weights i.e. 1

Step (II) : Adoption index (I_{2k}) under 100 percent adoption of all recommended technologies excluding adoption of k^{th} component of technology was computed. Let, corresponding estimated yield say (Y_2).

Step (III) : Contribution of k^{th} component technology is, therefore estimated as;

$$\frac{Y_2 - Y_1}{Y_1} \times 100$$

RESULTS AND DISCUSSION

Cotton is an important cash crop grown in the Vidarbha region of Maharashtra state. It occupies an important position in cropping pattern than other crops. The present study was undertaken to assess the contribution of recommended technology in cotton production, extent of their adoption input utilization levels, cost incurred and profitability of cotton.

Here efforts have been made to study the adoption levels of farmers from their region for recommended technologies and result of the same have been discussed below.

Extent of adoption of technology:

It is observed from Table 1, that 98 per cent farmers were adopted above 80 per cent technologies in respect of nitrogen application (Top dressing) followed by first and second weeding operation 96 per cent. About fertilizer application potassium, maximum farmers (70 %) were not adopted technology, only 6 per cent farmers adopted 80-100 per cent technology. In case of first and second spraying 79 and 81 per cent farmers respectively had not used any pesticides. About third spraying only 5 per cent farmers adopted above 80 per cent technology. Alshi *et. al* (1988) found that the extent of adoption of plant protection is less.

Distribution of farmers according to composite adoption index:

The net adoption of recommended technologies expressed in terms of composite score of the 100 farmers were computed and classified as composite score in low level (40-60 %), medium level

Table 1: Extent of adoption of different component of recommended technologies by different groups of farmers.

S.N.	Variable	Component	Level of adoption			
			Zero level	0-0.4	0.4-0.8	0.8-1.0
1	X_1	Gap filling	2	12	27	59
2	X_2	Thinning	0	0	14	86
		Fertilizer application				
3	X_3	Nitrogen (Basal Application)	12	0	14	74
4	X_4	Phosphor (Basal Application)	12	0	8	80
5	X_5	Potash (Basal Application)	70	10	14	6
6	X_6	Nitrogen (Top Dressing)	2	0	0	98
7	X_7	1st Weeding	0	0	4	96
8	X_8	2nd Weeding	0	0	17	83
9	X_9	3rd Weeding	4	0	0	96
10	X_{10}	Farm Yard Manure (FYM)	4	19	56	21
		Plant protection				
11	X_{11}	1st Spraying	79	0	11	10
12	X_{12}	2nd Spraying	81	0	9	10
13	X_{13}	3rd Spraying	94	0	1	5

Table 2. Distribution of farmers according to composite adoption index.

Level of adoption	composite adoption index	No. of cultivators
Low	40-60	16
Medium	60-80	71
High	Above 80	13
	Total	100

Table 3. Relationship between technologies adopted and productivity.

S. N.	Function	Intercept	Regression Coefficient		R^2
1	Harris model :				
	$Y = \frac{1}{a + bx^c}$	a	B	C	
		6.1108	-4.7459	0.0521	0.9120*
			(0.4630)		

(* Indicates significance of R^2 at 5 percent level) (Figure in parenthesis indicates standard error.)

(60-80 %) and high level(Above 80 %), it is presented in Table 2.

It was observed that only 13 per cent of the farmers had high level of adoption with composite adoption index above 80 per cent. Sixteen farmers were from low technology adoption group, where as 71 farmers were from medium technology adoption group.

Relationship between technologies adopted and productivity:

From Table 3 seen that the technology score is supposed to be strongly and positively associated

Table 4 : Contribution of different technologies as losses in yield on account of their non-adoption.

S. N.	Technologies	Loss in yield(qtl))	Percentage
1	Gap filling	3.830	28.868
2	Thinning	3.788	28.544
	Fertilizer application		
3	Nitrogen (Basal Application)	4.188	31.573
4	Phosphor (Basal Application)	2.497	18.822
5	Potash (Basal Application)	2.405	18.127
6	Nitrogen (Top Dressing)	3.580	26.989
7	1st Weeding	3.541	25.182
8	2nd Weeding	3.880	29.245
9	3rd Weeding	2.986	22.287
10	Farm Yard Manure (FYM)	2.73	20.587
	Plant protection		
11	1st Spraying	4.136	31.179
12	2nd Spraying	3.019	22.758
13	3rd Spraying	2.362	17.807
	Estimated yield at 100% adoption of recommended technologies		13.26

Table 5: Economics of Production of Hybrid Cotton.

S.N.	Particulars	Low	Medium	high	Overall
1	Yield (q/ha)	6.80	8.10	9.92	8.12
2	Value of yield (Rs.)	14280.00	17010.00	20832.00	17070.06
3	Cost (Rs.)				
	Cost A	8832.65	10094.9	11440.81	10067.90
	Cost B	11707.94	14128.08	16010.37	13985.55
	Cost C	12607.82	14128.08	16010.37	13985.55
4	Profit at				
	Cost A	5447.35	15050.61	16937.46	14905.05
	Cost B	2572.06	2881.92	4821.63	3058.50
	Cost C	1672.18	1959.39	3894.54	2165.00
5	Input output ratio at				
	Cost A	1:1.61	1:1.68	1:1.82	1:1.69
	Cost B	1:1.13	1:1.13	1:1.22	1:1.14

with the productivity of the crop. In order to find out the relation (linear or non linear) between technology score and productivity realized by the farmer, linear and all possible non linear function have been attempted. Harris Non Linear model has turned to be the best one yielding the highest correlation to the extent of 0.912. This function was used to estimate share of different components of technologies in the total production.

Contribution of Recommended Technologies on Productivities of Cotton:

The contribution of different technologies obtained through estimated Harris function as explained in methodology are given in Table 4.

If the farmers adopt all the technologies at their recommended level, a production of 13.26 quintals hybrid cotton ha^{-1} is expected. The above table indicates that nitrogen as a basal application

constitute the highest in yield i.e. 31.57 percent followed by first spraying of pesticide (31.17 %) and second weeding (29.24 %) which confirms the importance of split application of nitrogen. It can be confirmed from the above table that nitrogen as basal application, second first spraying of pesticides are the most important technologies in hybrid cotton production.

Economics of cotton production at different levels of technology:

It is observed from Table 4 the highest ha^{-1} hybrid cotton production of 9.92 quintals was obtained by high level of adoption group followed by medium level and low level adoption group 8.10 and 6.80 quintals respectively. At overall level per hectare profit at cost C was Rs.2165.00 ha^{-1} profit at cost C was highest under high level of adoption group i.e. Rs.3894.54 and it was followed by medium level of adoption group and low level of adoption group i.e. Rs.1959.39 and Rs.1672.18, respectively.

It can be concluded that per hectare produce increases with the more adoption of recommended technologies along with net returns, and input- output ratios. It thus becomes evident that the technologies evolved by the University not only help in increasing the productivities, but also provides higher economics return to the farming community.

CONCLUSION

On the basis of a sample survey conducted in Murtizapur Tahasil of Akola district for assessing the contribution of recommended technologies on productivies of cotton, it can be concluded that the majority of the farmers adopt recommended technologies which definitely increases the per hector productivity. The components like Basal application of Nitrogenous fertilizers, timely inter culture operations such as weeding, and plant protect measures play important role for attaining the higher productivities. Non adoption of these recommendations may lead to the loss in yields to the extent of 30 per cent.

The study further indicated that the more adoption of technologies lead to higher yields and there by higher economics returns.

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Technological Gap in Adoption of Recommended Soybean Production Technology and its Determinants

S.M. Jadhav[1], M.K. Bhugal[2], U.G. Thakare[3] and N.M. Kale[4]

ABSTRACT

Majority of respondents had medium level of technological gap in soybean cultivation; complete gap was observed in rate of Trichoderma, intercropping proportion, weedicides, fungicide, plant protection, FYM application. Maximum percentage of respondents had partial technological gap about fertilizer application, spacing and FYM application. No technological gap was observed about sowing method, harrowing before sowing, period of sowing and soil type. Education, land holding, area under soybean, annual income, socio-economic status, source of information, economic motivation and knowledge were found to be significant correlates of technological gap. The characteristics, namely source of information and economic motivation were the significant contributor in technological gap. All selected characteristics explained 46.4 per cent variation in technological gap.

Soybean is important oilseed crop of Maharashtra state, grown under diverse conditions. Area under soybean during 1990-91 was 20 lakh hectares which was increased to 58 lakh hectares during 1998-99. Gradually area under soybean is increasing but the yield level is very low in Vidarbha region.

Therefore, it was felt that there may exist a wide gap between the production potential and actual production. Yield level of farmers may be increased by finding technological gap in adoption of technologies recommended for soybean cultivation. With this view in mind, the present study titled "Technological gap in soybean cultivation" was conducted in Telhara, Akot and Patur *Panchayat Samiti* of Akola district. It is also helpful to identify the constraints faced by the farmers in adoption of recommended soybean cultivation practices in their farming system. Keeping this view in mind, the present study was planned and carried out with the following specific objectives:

1. To study Technological gap in adoption of recommended soybean cultivation practices
2. To study relationship between selected personal, socio-economic situational, communication and psychological characteristics of soybean growers with the technological gap in adoption of recommended soybean cultivation practices

MATERIAL AND METHODS

The use of descriptive and diagnostic design of social research was made in the present investigation. The present study was carried out in Akola district of Maharashtra state as this is one of the major soybean growing districts.

For the present study, a multistage sampling plan was used. After selection of Akola district as a major soybean growing district, Telhara, Akot and Patur *Panchayat samiti* were purposively selected because of having low, medium and high area under soybean crop in these *Panchayat samiti*, respectively. Five villages from each *Panchayat samiti* were selected based on major area under soybean cultivation. Thus, total 15 villages were selected from three *Panchayat samiti* of Akola district The list of the farmers growing soybean crop (*Kharif*) in the selected villages was prepared in consultation with *Talathi* and *Sarpanch*. From the list, 10 farmers were selected from each village by adopting random sampling method. Thus, total 150 farmers were selected as respondents for the study.

Measurement of Technological gap

The technological gap was operationally defined as the gap between technology

1. M.Sc. Student, 2 & 4 Associate Prof. and 3. Research Associate, Department of Extension Education, Dr. PDKV, Akola

recommended for cultivation of soybean by Dr. PDKV, Akola and actual adoption of these technologies by the soybean growers.

In view to calculate technological gap, practicewise technology recommended for soybean cultivation was ascertained with the help of *Krishi Sanvandini* (Krishi Diary) Dr. PDKV, Akola. Finally, 11 important package of practice of soybean cultivation and recommendations related to these practices were finalized. These selected package of practices were 1) Land preparation, 2) Sowing method, 3) Period of sowing, 4) Seed rate and variety, 5) Seed treatment, 6) Spacing, 7) Inter cultivation, 8) Intercropping, 9) Fertilizer application 10) Plant protection, 11) Harvesting and threshing. In this way, 30 technologies were grouped in 11 practices.

Responses of the respondents were collected on three point continuum *viz.*, complete adoption, partial adoption and non adoption with assigning a score of 2, 1 and 0, respectively. Then on the basis of score obtained for technologies adopted, the technological gap index for each practice was worked out by using following formula.

$$\text{Technological gap index} = \frac{R - A}{R} \times 100$$

Where,

R = Added score for technological adoption of all components in respect of particular recommended technology.

A = Score obtained out of total sub component

The composite gap index (CGI) for individual respondent was calculated by summing technological gap indices of all selected technologies and dividing the same by total number of technologies. Finally the respondents were categorized on the basis of theoretical index range in to low, medium and high technological gap, as under.

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

RESULTS AND DISCUSSION

Technological gap level of respondents

The efforts have been made to find out distribution of the respondents based on their level of existing technological gap about recommended soybean cultivation technology and same is presented in Table 1.

It is evident from data in Table 1 that majority of respondents (64.00%) were observed under medium category of technological gap of recommended soybean cultivation technology, followed by 23.33 per cent of the respondents who were observed in high level of technological gap. Only 12.67 per cent of respondents belonged to low level of technological gap.

Thus, it leads to conclude that majority of soybean growers were in medium category of technological gap about recommended soybean cultivation technology. Similar results were reported by Patil (1995) and Kalsariya *et. al.* (1998).

The practicewise distribution of the respondents according to extent of technological gap about recommended soybean cultivation technology was ascertained and findings with respect to them are presented in Table 2.

In case of recommended practices of soybean, it was observed that considerable higher percentage of respondents (100.00%, 90.67% and 89.33%) were belonged to no technological gap category about sowing method, harrowing before sowing and major land preparation operations, respectively, followed by 73.33 per cent of respondents who also found in no technological gap category with regards to recommended soil and period of sowing (70.67%).

As much as 59.33, 49.33 and 44.67 per cent of respondents had no technological gap about recommended seed rate, harvesting period and recommended depth for soybean seed, respectively, followed by FYM application (44.00%), inter-cultivation practices (37.33%), recommended varieties (32.00%), hoeing time (23.33%), spacing (22.00%), optimum plant population (20.67%), recommended fertilizer application (17.33%), recommended insecticide for pests (13.33%), chemical used for control of disease (13.33%).

Table 1: Distribution of the respondents according to their extent of technological gap

S. N.	Technological gap level	Respondents (n=150)	
		Number	Percentage
1)	Low (Upto 33.33)	19	12.67
2)	Medium (33.34 to 66.66)	96	64.00
3)	High (Above 66.66)	35	23.33

A few of the respondents also had no technological gap about both the practices like recommended fungicide for seed treatment and biofertilizers for seed treatment (12.67 % each), followed by control measure for pests (12.00%) and crop recommended as intercrop (8.67%).

The percentage of respondents having no technological gap in row proportion of intercrop, followed by recommended weedicides and three recommended practices namely, recommended dose of fungicide, quantity of chemical used for control of pests and quality of chemical used for control of disease was negligible (2.67, 2.00 and 1.33 each, respectively)

Maximum percentage of respondents were observed under partial technological gap in recommended fertilizer application (82.67%), followed by threshing period (80.00%), optimum plant population (79.33%), recommended spacing (78.00%), time of 1st and 2nd sowing (76.67%), intercultivation practices (62.67%), recommended depth for soybean seed (55.33%), recommended harvesting period (50.67%) and recommended FYM (40.67%).

A sizeable proportion of respondents was observed under partial technological gap in both the practices namely control measure for pests and quantity of chemical for control of pests (30.00 % each), followed by recommended period of sowing (29.33%), quantity of chemical used for control of disease (29.33%), recommended soil (22.00%), dose of fungicide (20.67%) and chemical used for control of pests (18.00%). A few respondents observed under partial technological gap in control measure for disease and quantity of chemical used for control of disease (17.33 % each), followed by crop recommended as intercrop (16.00%), recommended fungicide (11.33%), recommended biofertilizers (11.33%), major land preparation operation (10.67%), recommended quantity of weedicides (10.00%). A meager proportion of respondents expressed partial technological gap about both the practices, namely harrowing before sowing and recommended weedicides (9.33 %), followed by recommended rate of trichoderma (4.00%) and row proportion of intercrop (3.33%).

None of the respondents expressed partial technological gap about practices namely sowing method and recommended varieties.

Above 90.00 per cent of respondents were observed in complete technological gap in recommended practices of soybean such as recommended rate of trichoderma (96.00%), row proportion of intercrop (94.00%) and recommended quantity of weedicides ha^{-1} (90.00%). Majority of respondents had complete technological gap in adoption of recommended weedicide (80.67%) and dose of fungicide (78.00%). Around three-fourth of respondents had complete technological gap about both the practices, namely recommended fungicide and recommended biofertilizer (76.00 % each, respectively), followed by recommended crop as intercrop (75.33%). Over half of the respondents were found in complete technological gap about three practices, namely recommended control measure, chemical used for control of disease on soybean and quantity of chemical used for control of disease (69.33 % each, respectively), followed by pesticides used for control of pests (68.67%), quantity of chemical used for pests (68.67%), recommended variety (68.00%) and control measure for pests (58.00%). A meager proportion of respondents had complete technological gap in adoption of FYM application (15.33%) and negligible proportion of respondents had complete technological gap in

Table 2: Distribution of respondents according to their practicewise extent of technological gap

S. N.	Recommended practices of soybean	Technological gap		
		No	Partial	Complete
A.	**Land preparation**			
i)	Soil recommended for cultivation of soybean	73.33	22.00	4.67
ii)	Major land preparation operations	89.33	10.67	00.00
iii)	Harrowing after harvesting of previous crop	90.67	9.33	00.00
iv)	Recommended dose of FYM/ha	44.00	40.67	15.33
B.	**Sowing method**			
i)	Sowing method is recommended	100.00	00.00	00.00
ii)	sowing depth for soybean seed	44.67	55.33	00.00
C.	**Period of sowing**			
i)	Recommended time of sowing for soybean crop	70.67	29.33	00.00
D.	**Seed rate and variety**			
i)	Hybrid varieties	32.00	00.00	68.00
ii)	Recommended seed rate per/ha for soybean	59.33	40.67	00.00
E.	**Seed treatment**			
i)	Fungicide recommended for seed treatment	12.67	11.33	76.00
ii)	Biofertilizer recommended for seed (inoculate) treatment	12.67	11.33	76.00
iii)	Fungicide quantity for seed treatment	1.33	20.67	78.00
iv)	Rate of *Trichoderma* per/kg for seed treatment in soybean	00.00	4.00	96.00
F.	**Spacing**			
i)	Recommended spacing for soybean	22.00	78.00	00.00
ii)	Optimum plant population of soybean per hectare	20.67	79.33	00.00
G	**Intercultivation**			
i)	Intercultivation practices	37.33	62.67	00.00
ii)	Hoeing time	23.33	76.67	00.00
iii)	Weedicide recommended for control of weeds in soybean crop	2.00	9.33	88.67
iv)	Recommended dose of weedicide for soybean	00.00	10.00	90.00
H.	**Inter cropping**			
i)	The crop recommended as intercrop in soybean	8.67	16.00	75.33
ii)	Row proportion of intercrop in soybean	2.67	3.33	94.00
I.	**Fertilizer application**			
i)	Recommended dose of fertilizer per hectare	17.33	82.67	00.00
J.	**Plant protection**			
i)	Control measure for pests	12.00	30.00	58.00
ii)	Chemical used for control of pests	13.33	18.00	68.67
iii)	Quantity of chemical used for control of pests on soybean	1.33	30.00	68.67
iv)	Control measure for disease	13.33	17.33	69.33
v)	Chemical used for control of disease on soybean	13.33	17.33	69.33
vi)	Quantity of chemical used for control of disease	1.33	29.33	69.33
K.	**Harvesting and threshing**			
i)	Appropriate stage of harvesting of soybean	49.33	50.67	00.00
ii)	Appropriate stage of threshing of soybean	20.00	80.00	00.00

Table 3: Correlation coefficients of selected characteristics of the respondents with their technological gap

S. N.	Characteristics	Coefficient of correlation 'r' value
1	Age	0.140^{NS}
2	Education	0.390**
3	Land holding	0.398**
4	Area under soybean	0.354**
5	Annual income	0.395**
6	Socio-economic status	0.541**
7	Source of information	0.624**
8	Economic motivation	0.495**
9	Knowledge	0.833**

NS - Non-significant ** Significant at 0.01 level of probability
* - Significant at 0.05 level of probability

Table 4: Regression coefficient of different characteristics of the respondents with their technological gap about soybean cultivation technology

S. N.	Characteristics	Coefficient of regression 'b'	SE of 'b'
1	Age	0.0439	0.931
2	Education	0.231	0.303
3	Land holding	0.214	0.630
4	Area under soybean	1.005	1.260
5	Annual income	0.0000195	0.0000422
6	Socio-economic status	1.515	1.158
7	Source of information	0.730**	0.173
8	Economic motivation	1.168*	0.447

R^2 : 0.464** 'F' : 15.31
** : Significant at 0.01 level of probability * : Significant at 0.05 level of probability

adoption of recommended soil (4.67%). None of the respondents had complete technological gap about optimum plant population, intercultivation practices, time of hoeing, recommended seed rate, period of sowing, harrowing before sowing, major land preparation operation, recommended dose of fertilizer and harvesting period.

Correlates of technological gap

The correlation coefficient of personal, socio-economic, psychological, situational and communication characteristics of respondent with their technological gap have been depicted in Table 3.

It could be seen from Table 3 that the selected variables education, land holding, area under soybean, annual income, socio-economic status, source of information, economic motivation and knowledge were positively and significantly correlated with technological gap at 0.01 level of probability. The variable age showed non-significant relation with technological gap.

The above results indicated that some of the characteristics of the respondent had an influence on technological gap levels. It is quite logical that the respondents with higher level of education, possessing more land and area under soybean, having good annual income, high socio-economic status, high source of information and economic motivation and more knowledge adopt more technologies recommended for soybean crop keeping low technological gap.

Multiple regression analysis of technological gap

In order to find out the contribution of selected predictors (independent variables) with technological gap about recommended soybean cultivation technology, multiple regression analysis was carried out and have been presented in Table 4.

It is observed from Table 4, that regression coefficient of source of information (b=0.730) was found significant at 0.01 level of probability whereas, regression coefficient of economic motivation (b=1.168) was found to be significant at 0.05 level of probability. It could be said that source of information and economic motivation had influence on technological gap in soybean cultivation. All remaining variables under study did not influence technological gap in soybean. It is also evident from the data in Table 4 that coefficient of determination (R^2) was 0.464, meaning that all selected independent variables jointly explained significant amount of variation to the extent of 46.4 per cent in technological gap of soybean cultivation. The calculated 'F' value (15.31) was found to be significant at 0.01 level of probability.

CONCLUSION

As per results related to existence of technological gap, the higher proportion of respondents had complete technological gap in recommendation related to use of recommended rate of Trichoderma, row proportion of intercrop, quantity of weedicide ha^{-1}, recommended fungicides, bio-fertilizer, plant protection measure, recommended variety, recommended crop as intercrop. As these are the important cultivation practices contributing towards more yields, extension workers should take note of this high gap while planning and implementing extension activities/programme in the study area. It is suggested to conduct different short duration trainings on the theme in which high technological gap exist which improves skill and produce confidence and aptitude among the farmers for adoption of same.

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Scale for Measurement of Content Effectiveness

Harsha Kolte[1] and M. D. Yenpreddiwar[2]

ABSTRACT

The content effectiveness of farm periodical refers to the physical, technical make up and illustrations in bringing desirable changes on the part of readers. As this function involves many components, it was felt necessary to develop scale for measuring content effectiveness. The reliability coefficients obtained was 0.897 which showed highly significance at 0.01 level of probability. The content and construct validity were also judged. The final format of the scale consisted major components i.e. Heading, Illustration and Messages and sub components, which contributed to the content effectiveness of farm periodical.

Content effectiveness as the response of readers towards presentation and format of content including layout, designs, colour combination, etc., that are believed to be the matters of personal likes and dislikes of the reader. Looking into the present investigation there is a growing demand for improving the content effectiveness of farm periodicals in order to make them more popular understandable, informative and educational. The farm periodical having effective physical and technical content will serve as best medium for catering to the regular agricultural information needs of the farmers. Before the steps to make improvement in farm periodical, it is necessary to know content effectiveness of farm periodical.

MATERIAL AND METHODS

Content effectiveness of farm periodical refers to the physical, technical make up and illustration in bringing desirable changes on the part of readers. In this study, the term content effectiveness of farm periodical is operationalized as the degree to which the farm message presented by farm periodical through coverpage, text matter, illustrations are read easily, understood, perceived as useful and indicate positive action tendencies of its readers. Keeping all the dimensions in view, it was felt necessary to conduct the study on content effectiveness of Shri Sugi farm periodical published by Mahatma Phule Krishi Vidyapeeth, Rahuri.

Steps in evolving content effectiveness measurement scale

The procedure was divided in three parts.

i. Collection of components and sub-components, which contribute to content effectiveness of farm periodical
ii. Assigning weightages to components and sub-components
iii. Standardizing the weights

i Collection of components and sub components which contribute to content effectiveness of farm periodical

Referred all the available literature on similar lines of the present project under study. The senior professor of all the agricultural universities from Maharashtra state were consulted for suggestions. The editors of some farm periodical were also contacted and their practical views were considered. After all these efforts three major components i.e. Heading Illustrations and Messages and in these some sub components were finalized, which contribute to the content effectiveness of the farm periodical.

ii Assigning weightages to components and sub components

The selected components were given to 120 judges, for ascertaining relevancy of component i.e. whether the selected component really adds to the content effectiveness of farm periodical. The judges were asked to assign marks to the selected major components out of 100 marks on the basis of relative importance of that component in terms of communicability and effectiveness. Judges were asked to make the total weights of all three major components. These weights had to be given out of total weight given by judge to that particular major component.

iii. Standardizing the weights

Out of 120 judges, 55 judges had responded and sent the schedule of judgement

1 & 2 Junior Res. Asstt., College of Agriculture, Nagpur

giving the weights to content effectiveness components. In order to have similar weights the arithmetic mean of the weights given by the judge to each major component were calculated to make the total of all weightages as 100. These means were accepted as the final weights of those major components. Similarly, the arithmetic means of sub-components were calculated.

a) Validity of the scale

A scale is said to be valid when it measures what it is presumed to measure. The components used for construction of present content effectiveness measurement scale were selected from the findings of past researches. The judges identified for ascertaining relevancy of components and giving weightages to selected components were well qualified.

b) Reliability of scale

A scale is said to be reliable when it gives constantly same results when applied to same sample (Goode and Hatt, 1952). It is accuracy of precision of the measuring instrument (Kerllinger, 1966)

The measuring instrument should have maximum possible dependability of trustworthiness. The test retest methods were used for testing the reliability of the scale. A sample of 25 subscriber farmers of Shri Sugi farm periodical from Rahuri tahasil of Ahmednagar district was interviewed two times at an interval of 15 days. Coefficient of correlation between the first test and second retest scores of content effectiveness of Shri Sugi farm periodical was worked out. The 'r' value so obtained was 0.897 which showed highly significant correlation. Thus, the reliability of the scale was of high order.

RESULTS AND DISCUSSION

Content effectiveness of Shri Sugi farm periodical

The specially designed scale for measuring content effectiveness of farm periodical was applied to measure content effectiveness of farm periodical Shri Sugi by reader subscribers. The subscribers were grouped in three categories according to their perception of content effectiveness as low, medium and high. The data are given in Table 1.

Table 1 : Content effectiveness

S.N.	Content effectiveness	Number	Percentage
1	Low (Score upto 67)	39	19.5
2	Medium (Score 68 to 89)	122	61.0
3	High (Score 90 and above)	39	19.5

Near about two third of the Shri Sugi subscriber (61.0 %) perceived Shri Sugi as medium effectiveness, whereas low and high effectiveness of Shri Sugi farm periodical was perceived by equal per cent (19.5%) of them. The maximum score of ideal farm periodical was low. But Shri Sugi farm periodical could secure 84.05 total content effectiveness score. It shows that 'Shri Sugi' failed to obtain 15.95 score which is the scope of its improvement. Table 2 shows the overall average score of components and subcomponents of content effectiveness of Shri Sugi farm periodical.

The specially developed scale to measure content effectiveness of farm periodical constitutes major components and each major components has its subcomponents. The subscribers had assigned weightages to these sub components by intuition method. The average score for each content effectiveness components were calculated considering subscribers together for Shri Sugi farm periodical. The overall average score of components and subcomponents of content effectiveness are presented in Table 2. The content effectiveness score for each major component is calculated by adding content effectiveness scores of all sub components of respective major component. The total content effectiveness score of farm periodical is calculated by adding content effectiveness scores of all three major components.

CONCLUSION

Majority of the reader subscribers perceived as medium content effectiveness farm periodical. The extent of contribution of major component of Shri Sugi farm periodical like heading, illustration and message were 16.61, 17.97 and 49.77, respectively leaving scope for improvement. It was found that each major component viz, heading, illustration and message of Shri Sugi farm periodical has enough scope for content effectiveness improvement.

Table 2 : The overall average score of components and sub components of content effectiveness.

S.N.	Effectiveness Component	Over all average score obtained	
		Maximum Score	Shri Sugi
I.	**Heading**		
1.	Length of heading	4	3.68
2.	Type of heading	2	1.66
3.	Boldness of heading	3	2.50
4.	Attractiveness of heading	3	2.75
5.	Appropriateness of headings	4	3.10
6.	Existence of Subheadings	2	1.72
7.	Colour of heading	2	1.20
	Total scores	20	16.61
II.	**Illustration**		
1.	Number of illustration	2	1.45
2.	Placement of illustration	3	2.88
3.	Captions of illustration	3	2.52
4.	Clarity of illustration	3	2.86
5.	Relevancy of illustration	3	2.69
6.	Colour of illustration	2	1.81
7.	Sufficiency of table and chart	2	1.78
8.	Legitrility	1	0.82
9.	Help of illustration in simplifying complex	1	0.86
	Total Scores	20	17.67
III	**Messages**		
1.	Length of message	2	1.68
2.	format used for creating message	3	2.69
3.	Length of sentence	2	1.52
4.	Spacing between two lines	3	2.66
5.	Use of words in message	3	2.68
6.	Easyness in reading messages	3	2.52
7.	Applicability to reader subscribers situation	3	2.68
8.	Persuasiveness of message	2	1.72
9.	Action promotiveness of message	2	1.98
10.	Utility of message	3	2.62
11.	Understandability of message	2	1.12
12.	Timeliness of message	3	2.64
13.	Need orientation of message	3	2.68
14.	Practicability of message	2	1.68
15.	Relevancy of message	2	1.68
16.	Novelty of message	2	1.72
17.	Adequacy of message	2	1.82
18.	Clarity of message	3	2.79
19.	Interest creation by messages	2	1.82
20.	Problem orientation of messages	3	2.85
21.	Thought provokingness of messages	2	1.52
22.	Enjoyment in reading	2	1.67
23.	Depth of Information	2	1.15
24.	Help of information in solving problems	2	0.98
25.	Reference for further details	2	0.84
	Total scores	60	49.77

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Livelihood Pattern of Suicidal Farmers of Vidarbha Region

N. M. Kale

ABSTRACT

The agriculture with wages earning is the major livelihood source of overall deceased farmers and contributed total 91.31 per cent share in their total annual income. Majority of the victims were in severe distress due to the income that they got from all sources was not even enough to meet the essential family expenditure. For managing this gap between income and expenditure, deceased farmers might be possibly taking loans from various credit sources to meet the family expenditure. Hence, this research study clears that almost in all victims livelihood was not found sustainable and that might be the one of the causes of farmers' suicides in Vidarbha.

In recent years, a larger agrarian crisis, particularly in low rainfall and low irrigation tracts of Vidarbha region of Maharashtra has precipitated a spate of suicide death among farmers. This is now public policy concern and has been scholarly attention. As per Government record total 2616 farmers, committed suicide during 2001 to 2006 in suicide hit six districts of Vidarbha, where PM's Package is going to implement. These districts are Yavatmal, Buldana, Amravati, Akola, Washim from Amravati revenue division and Wardha from Nagpur revenue division.

"To be, or not to be." (Shakespeare, Hamlet) has been an important question among thinkers (Rauscher, 2000). As suicide is a complex social and psychological phenomenon, which factors are mostly responsible for suicides in Vidarbha region of Maharashtra and which factors should have to be taken for study is big question among researchers. However, Madan (1980) and Singh (2005) pointed that the causes of suicide are complex as are the causes of any social phenomenon. Many factors combine to cause one particular individual (and not another) to divert his aggression upon himself in the form of suicide. Durkheim (2002) also pointed that the neurobiological and socio-economic dimensions of risk factors are responsible for committing suicide but the intersection of these two sets where the relative risk of committing suicide is higher.

In recent review of the neurobiological literature, Mann (2002) cleared that the neurobiological risk factors are predisposing in nature and they are internally exist with the individual for example reducing serotonin input to the brain and disorder of the central nervous system, particularly those affecting the pathology of the brain carry a higher relative risk of suicides in an individual. The neurobiological risks factors are internally exist with an individual, hence it becomes difficult to study and identify. However, the socio-economic dimensions of risk factors that are external to the individual become important and they are precipitating in nature, can be identified. Hence, for the current research study of farmers' suicides researcher has formulated research methodology for assessing the livelihood pattern of an individual deceased farmer and his family members with the following objective.

1. To find out the annual income sources of the victims with their share in total income
2. To study the expenditure pattern of the farmers' those who committed suicide in Vidarbha Region.

MATERIAL AND METHODS

The present study was based on Descriptive Design of Social Research and carried out in six districts of Vidarbha region of Maharashtra where percentage of farmers' suicide was found relatively more than other districts.These districts were Yavatmal, Washim, Buldana, Akola, Amravati from Amravati revenue division and Wardha from Nagpur revenue division..

In this study respondents were the households of selected victim those who committed suicide during 1st January 2006 to 31st December 2006 and had declared as a legal victims by district level

1. Associate Prof., Department of Extension Education, PGI, Dr. PDKV, Akola

committee headed by Collector of the respective district, for allotting compensation of Rs. 1 lakh and had got Rs. 1 lakh compensation. The time period 1st January to 31st December 2006 was selected purposively as in this period maximum number of suicides were occurred in selected districts of Vidarbha.

Before sampling, researcher had contacted personally the collector offices of these selected districts, and obtained the complete list of farmers those who committed suicide during 1st January to 31st December 2006. In all, there were 1448 total suicide cases in selected six districts, out of which 874 cases were declared as illegal and 574 cases were declared as legal victims. From the list of 574 legal suicide cases, researcher had selected 200 victims by proportionate method of random sampling. It covered 178 villages and 34 *tahsils / talukas* of six districts.

Suicide being a sensitive social issue, the investigation had to be carried out with very guarded and careful manner, without hurting the sentiments of the family. Data were collected by personal interview method with the help of structured interview schedule. Interview was conducted at residence of respondent to review over all situation of the family by researcher. Thus, the total 200 victims' household were interviewed by the researcher for collecting the primary data for the year 2005-06.

RESULTS AND DISCUSSION

Livelihood pattern

Livelihood refers to the means of living or sustenance of an individual. In Vidarbha, farmers have been committing suicide over the last five years. In the present study, it was assumed that those who committed suicide, their livelihood might not be sustainable. Hence this was an important aspect of the present study, it would show the livelihood status of an individual deceased farmer.

In present study, livelihood pattern of the victim and his household refers to the engagement of the victim and his household in different livelihood sources or occupations or employment and income generated through it, with their annual expenditure on various items has been considered and analysed. The data with regards to the livelihood pattern have been furnished in detail through various angles in subsequent Tables 1 and Table 2.

Livelihood sources of the victims and their share in income (2005-06)

As livelihood sources of the peasant community mostly depend on size of land that he holds. Hence, distribution of the selected victims and their households according to their livelihood sources and their income from respective sources has been analysed according to their land size groups and presented in Table 1.

It is apparent from the Table 1 that overall, agriculture is the main livelihood source of all the selected victims and contributing two third 66.29 per cent share in their total annual income, followed by 70.50 per cent deceased farmers and his households were depended on wages earning in addition to cultivation of his own farms and having more than one fourth (25.02%) contribution in total income.

While non-professional business (either caste related or others) were the one of the additional sources of livelihood present with 6.50 per cent victims, contributing to about 4.76 per cent share. This was followed by only 2.00 per cent victims service/ pension were noted as an additional livelihood endeavor and added 2.64 per cent share in total income, out of these three were holding class IV service and one has a pension of his father.

Allied occupation through buffalo rearing in addition to farming was found only in 1.00 per cent deceased farmers as the additional livelihood source contributed to only 1.29 per cent share in overall income of all deceased farmers. After critical examination of the data presented in table 1 show that as land holding increases relative share of agriculture in total income also increases and relative share of wages earning in total income decreases and vice versa.

In marginal farmers group (Having land upto 1.00 ha) very pathetic condition was noticed, that was 91.49 per cent of them had to depend compulsorily on wage earning. The wage earning remains as their main livelihood source contributing over half (52.06 %) per cent share in total income, followed by agriculture (37.65%). The average annual income of the selected victims' household from all livelihood sources was estimated to Rs. 27,924.

Table 1: Distribution of selected victim's households according to their Livelihood sources and their Income from respective livelihood source (Year 2005-06)

(N = 200)

S.N.	Land size	No. of victim	Livelihood sources and annual income of respective source in Thousand and their relative share															Total income
			Agriculture			Allied occupations			Wages earning			Non professional business			Service/Pension			
			No	Income	Share	No	Income	Share	No	Income	Share	No	Income	Share	No	Income	Share	
1.	Upto-1 Ha.	47	47	301.20	37.65	0	0	0	43	416.50	52.06	3	43.00	5.37	1	39.40	4.92	800.10
			(100)						(91.49)			(6.38)			(2.13)			(100.00)
2.	1.01-2 Ha.	87	87	1235.10	57.46	2	72.00	3.35	64	701.30	32.63	7	117.00	5.44	1	24.00	1.12	2149.40
			(100)			(2.30)			(73.56)			(8.05)			(1.15)			(100.00)
3.	2.01-4.00 Ha.	41	41	910.10	75.46	0	0	0	26	225.90	18.73	2	46.00	3.81	1	24.00	1.99	1206.00
			(100)						(63.41)			(4.88)			(2.44)			(100.00)
4.	4.01-10.00 Ha.	25	25	1255.70	87.86	0	0	0	8	53.50	3.74	1	60.00	4.20	1	60.00	4.20	1429.20
			(100)						(32.00)			(4.00)			(4.00)			(100.00)
	Total.	200	200	3702.10	**66.29**	2	72.00	**1.29**	141	1397.20	**25.02**	13	266.00	**4.76**	4	147.40	**2.64**	5584.70
			(100)			(1.00)			(70.50)			(6.50)			(2.00)			(100.00)

No: - Number of households., Share:- Relative share in total income of respective size class.(Percentage)

Table 2: Annual Expenditure pattern of the victims households on different Items (Years 2005-06)

(Amount in Thousand)

S.N	Items	Up-to 1 Ha.(Marginal)		1.01-2 Ha(Small)		2.01- 4 Ha. (Semi-medium)		4.01- 10 Ha. (Medium)		Total	
		Amount	Percentage	Amount	Percentage	Amount	Percentage	Amount	Percentage	Amount	Percentage
1	**Food**	848.20	71.25	1862.40	60.41	985.60	64.72	714.20	43.89	4410.40	**59.41**
2	**Clothing**	75.000	6.30	181.30	5.88	108.20	7.10	95.80	5.89	460.30	**6.20**
3	Housing	0.700	0.06	27.00	0.88	0.00	0.00	28.10	1.73	55.80	0.75
4	**Education**	47.35	3.98	75.00	2.43	62.40	4.10	121.80	7.48	306.55	**4.13**
5	**Health**	105.40	8.85	364.70	11.83	137.80	9.05	149.00	9.16	756.90	**10.20**
6	Traveling	43.30	3.63	94.95	3.08	62.50	4.10	71.20	4.38	271.95	3.66
7	Lighting	28.86	2.42	84.14	2.73	55.46	3.64	48.92	3.01	217.38	2.93
8	**Religious functions**	37.10	3.12	339.40	11.01	46.80	3.07	103.40	6.35	526.70	**7.09**
9	**Agriculture**	0.43	0.04	29.85	0.97	57.30	3.76	246.45	15.14	334.03	**4.50**
10	Taxes	4.17	0.35	12.42	0.40	6.89	0.46	7.24	0.44	30.72	0.41
11	Others	0.00	0.00	12.00	0.38	0.00	0.00	41.30	2.53	53.30	0.72
12	Total	1190.51	100.00	3083.16	100.00	1522.95	100.00	1627.41	100.00	7424.04	100.00

Table 3: Distribution of selected victims according to their identified Gap between Annual Livelihood Income and Expenditure

S. N.	Gap Range in Rs.	Number of Victims	Percentage
1	No Gap	24	12.00
2	Upto 3000	29	14.50
3	3001 to 6000	32	16.00
4	6001 to 9000	42	21.00
5	Above 9000	73	36.50
	Total	200	100.00

Average Gap = Rs. 9196

Thus, it could be concluded that among the present livelihood sources it was found that agriculture (66.29%) with wage earning (25.02%) was the major livelihood source of overall deceased farmers and contributed total 91.31 per cent share in their total annual income. There were quite a few cases where the victim's families earned their livelihood by engaging in subsidiary occupation to supplement their income. The findings of the present study also corroborate the findings reported by Dandekar *et al.* (2005) that majority (63.88%) deceased farmers were cultivators and agricultural labourers and only one victim was dependent on agriculture and livestock for their livelihood security.

Expenditure pattern of the households (2005-2006)

Expenditure pattern is the indicative of the standard of living and ability of the respective group to invest under different items. In present research study it was assumed that those who committed suicide in Vidarbha region their essential family expenditure must exceed than their annual income and they might became in financial tension for fulfilling the growing urgent family needs. In present study, actual expenditure made by the households on different livelihood items like expenditure on food, clothing, housing, education, health, traveling, lighting, religious functions, agriculture, taxes, etc., have been studied and data have been presented in detail in Table 2.

It could be observed from Table 2 that out of total expenditure of overall deceased farmers, the expenditure on food had largest share contributing nearly 60.00 per cent (59.41%), followed by expenditure on health, religious functions and clothing having 10.20, 7.09 and 6.20 per cent share, respectively.

The expenditure on agriculture, education, traveling and lighting was 4.50, 4.13, 3.66 and 2.93 per cent, respectively. While share of expenditure on housing (repairs / construction), taxes and others were noted very negligible.

A critical examination of the data shows that marginal farmers (Land upto 1.00 ha) did spend more than 70.00 per cent (71.25%) on foods only. While in small farmers group it is evident that along with food (60.41%) their maximum expenditure was noted on health (11.83%) and religious functions (11.01%). This might be due to holding maximum health care and religious responsibilities than other groups. The average annual expenditure of the selected victims was estimated to Rs. 37,120.

Gap between Income and Expenditure of the deceased farmers:

For demonstrating, the income and expenditure status of the deceased farmers researcher tried to show the gap between income and expenditure of the deceased farmers, because in majority of deceased farmers expenditure was found more than their annual income. The income gap was calculated when expenditure made by the victim was more than his annual income, the excess expenditure made by the victim than his annual income was treated as his income gap, otherwise income gap was treated as nil. As per the amount of gap, the victims were distributed and presented in Table 3.

It is evident from Table 3 that out of 200 victims, among only 24 (12.00%) victims there was no gap between annual livelihood income and expenditure that meant their livelihood income was enough to fulfill the essential family expenditure. While among rest of the 88.00 per cent victims gap was observed, that meant their annual income was short for fulfilling the essential livelihood expenditure of the family. The gap was noted, upto Rs. 3000 among 14.50 per cent victims, Rs. 3001 to Rs. 6000 among 16.00 per cent victims, Rs. 6001 to Rs. 9000 among 21.00 per cent cases, while among more than one third (36.50%) victims, gap was found above Rs. 9000. The average gap was observed Rs. 9196. From the data it is cleared that as the income gap increased the suicide rate also increased. Hence, it is cleared that present spate of suicide in Vidarbha was due to economic crisis.

CONCLUSION

It could be concluded that agriculture (66.29%) with wage earning (25.02%) was the major livelihood source of overall deceased farmers and contributed total 91.31 per cent share in their total annual income. There were quite a few cases where the victim's families earned their livelihood by engaging in subsidiary occupation to supplement their income. The average annual income of all the selected households came to be Rs. 27,924. Out of total expenditure of overall deceased farmers, the expenditure on food occupies largest share, (59.41%), followed by expenditure on health, religious functions and clothing having 10.20, 7.09 and 6.20 per cent share, respectively. The average annual expenditure of the selected victims was estimated to Rs. 37,120. Here shockingly to note that the average annual expenditure of the deceased farmers was found higher, than the annual income by Rs. 9196. This was due to low income of the 88.00 per cent victims to fulfill the essential family expenditure, hence there existed an income gap. From the data it is also clear that as the income gap increased the suicide rate was also increased. Hence, it is clear that present spate of suicide in Vidarbha was due to economic crisis.

This study suggests that this situation can be improved, if economic empowerment is ensured by creating subsidiary occupations in study area. It is observed that 99 per cent respondent suicide victims had no subsidiary occupations to support their livelihood and majority of them had medium to large family size. This implies that efforts are needed by respective line departments to involve such farmers in goat farming, dairy, small dairy unit with one or two milch animals and small poultry unit. This is very effective way to bring the distressed poor farmers families to uplift economically strong position. In addition to this, it is also suggested to motivate the few farmers households from big families to migrate willingly for search of better employment opportunities. This will help to ease the pressure on their own land. Secondly, the policy makers should declare the remunerative prices to the farm produce of the farmers and think about how irrigation potential increases in study area for remunerative farming.

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Reading Behaviour of Farmer

Harsha Kolte[1], M. D. Yenpreddiwar[2] and S. B. Shinde[3]

ABSTRACT

Published material was very useful to the farmers as they can refer it at any time they need. Farm periodical in the field of agriculture serve the reader in three ways : they inform, they guide and they entertain. It was observed that majority of them read to acquire general information and get latest information on agriculture, while large majority of readers read silently for one hour in single sitting. It was noticed that above seventy five percent reader subscribers gained knowledge after reading. Majority of subscribers did not store printed material.

Reading literature is an important part of self study. People generally vary in their reading behaviour. Some are good readers while some are poor readers. Among the mass media, farm magazine/ news paper, etc., are commonly used media for dissemination of news and current events. They also serve as educational and entertainment media, apart from dessiminating agricultural information to the farmers. The printed word can be read whenever necessary, it can refresh the memory. Regarding the importance of using print media for transfer of farm technology, Bhatt (1989) in his review paper stated that publications remain to be the most permanent and trusted source of information for transferring farm technology. Rajendran (1982) found that articles in the farm magazines helped in adoption of plant protection and package of practices. The written word has power when written well it convinces and motivates people. Its power can be made use in leading them to action (Kamath, 1969).

Therefore to understand the reading behaviour of farmers, the study was taken with the following objectives:

1. To study the reading behaviour in terms of mode, time and frequency
2. To analyse the reason for reading
3. To find out the factors affecting reading behaviour and also the effects of reading

MATERIAL AND METHODS

Farmer is a central point of any mass medium while communicating farm information. The communication centre of Mahatma Phule Krishi Vidyapeeth, Rahuri publishes Shri Sugi. This is seasonal farm periodical. Three issues namely summer, *Kharif* and *Rabi* are published in a year. These study subscriber of Shri Sugi Farm periodical were considered as one type of respondents.

The list of subscribers of Shri Sugi. farm periodical during the year 2004 was obtained from the P.R.O. Office of the university. There were 252 reader subscribers in Ahmednagar district on record during the year of study. The reader subscribers of Shri Sugi farm periodical having less than five subscribers in the villages from the selected tahsils were not considered for the study. Hence, 200 reader subscribers of Shri Sugi farm periodical were considered for analysis and further study.

RESULTS AND DISCUSSION

Background Information of the Respondents

The reader subscribers of Shri Sugi were of young to middle age group, had higher secondary level education, had no social participation, had medium socio-economic status, had medium cosmopoliteness, had agriculture as their main occupation, had semi-medium size of land holding were from lower to middle income group, had medium level of extension contact, local contact, group and mass contact.

Reading behaviour of the reader subscribers

Reading behaviour of reader subscribers of farm periodical was studied to know as to what other literature or material they read or prefer to read. It is generally said that, if an individual has a good reading habit, he will have better perception for written material.

1. & 2. Junior Res. Asstt., Dr. P.D.K.V., Akola and 3. Professor, M.P.K.V., Rahuri

Table 1 indicates that almost of subscribers, 96.00 per cent of them read silently, while only 4.00 per cent read loudly. Most (86.00 %) of reader subscriber read by sitting. No subscribers preferred to read only by lying. It can also be seen that a little more than half (50.50 %) of the reader subscribers devoted one hour for reading in single sitting. It is interesting to note that writers should limit their articles which reader subscribers can read within an hour of sitting. The content should be presented in that style so that readers can finish or read the complete article within an hour.

Reasons for reading :

Reason for reading the printed matter is the most important factor in reading behaviour. The distribution of reader subscribers according to reasons for reading is presented is Table 2.

Among all the reasons of reading, majority of the reader subscribers (93.50 %) read to get general information. Next priority reasons were to get the current information or new information related to various crops and other. Next purpose was to get latest information on agriculture (80%). It may be due to the fact that the subscribers were engaged in farming and they might want to know recent developments in farming so that they were interested in farming and adopting new practices in their farms. It showed that respondents read with a definite purpose in their mind.

Effect of reading on the reader subscribers :

The reading of literature is an important gesture of individual. Reading literature affects every individual in different ways. Therefore, an attempt was made to know the effect which was occurred after reading. The reader subscribers were distributed according to their effect of reading as shown below.

The data presented in Table 3 show that more than three fourth of reader subscribers (76.00%)

Table 1 : Distribution of the reader subscribers according to their different aspects of reading behaviour.

S.N.	Different aspects of reading behaviour	Category	Number (N=200)	Percentage
1	Mode of reading	Silently	192	96.00
		Loudly	8	4.00
2	Posture of body	Sitting	172	86.00
		lying	-	-
		Both sitting and lying	28	14.00
3	Time devoted for reading	Half hour	70	35.00
		one hour	101	50.50
		More than one hour	29	14.50
4	Storage of reading material	Yes	78	39.00
		No	122	61.00

Table 2 : Distribution of the readers subscribers according to their reasons for reading

N = 200

S. N.	Reasons for reading	Number	Percentage
1.	Acquire general information	187	93.50
2.	obtain latest information on agriculture	160	80.00
3.	As a habit	95	47.50
4.	New literature is found	79	39.50
5.	As literature is available	72	36.00
6.	solve the problems in business/daily life	69	34.50
7.	other suggested to read	55	27.50

Table 3 : Distribution of the reader subscribers according to their effect of reading.

S.N.	Effect of reading	Number (n = 200)	Percentage
1.	Gained knowledge after reading	152	76.00
2.	Got motivated to read more	136	68.00
3.	Shared gained knowledge with others	93	46.50
4.	Reading increase the ability to solve various problems.	78	39.00
5.	Used the information gained in agriculture	64	32.00
6.	Motivated others to read	52	26.00
7.	Got motivated to experiment the new ideas.	32	16.00
8.	Send queries to the expert	14	7.00

gained knowledge after reading, while above two third of the reader subscribers (68.00 %) got motivated to read more. Slightly less than half (46.50%) of the readers shared gained knowledge with others. About 39.00 per cent of readers expressed that reading helped to increase the ability to solve various problems. It was interesting to know that about two third (32.00 %) of readers used the information gained in agriculture, while 26.00 per cent of them motivated others to read the printed material. About 16.00 per cent of reader subscribers got motivated to experiment the new ideas. A few readers (7.00 %) sent queries to the experts to clarify their doubts aroused due to reading of lesson.

Thus, it can be concluded that reading has created a positive and good impact on readers. Gain in knowledge, understand lesson, motivated to experiment the new idea, get motivated to read more on the subject. These were the effects reported by Punjabi farmer readers.

CONCLUSION

Reading behaviour makes an individual knowledgeable, more innovative and more adaptive. It is interesting to note that extent of farm information utilization behaviour was notable influence by the readers reading habit. Reader subscribers having better reading habits utilized more adapt farm information and vice-versa.

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Knowledge of Recommended Soybean Production Technology and its Determinants

S.M. Jadhav[1], M.K. Bhugul[2], U.G. Thakre[3] and N.M. Kale[4]

ABSTRACT

Maximum percentage of respondents possessed medium level of knowledge about recommended soybean cultivation technology. Higher percentage of respondents had complete knowledge about sowing method, land preparation operation, harrowing before sowing, threshing, harvesting, intercultivation practices and hoeing time, recommended soil and time of sowing. Maximum percentage of soybean growers had partial knowledge about dose of fertilizer, spacing, plant population and plant protection measure. Majority of respondents had no knowledge about rate of Trichoderma, weedicide, seed treatment and recommended varieties. The results of relational analysis revealed that the variable namely age, education, land holding, area under soybean, annual income, socio-economic status, source of information, economic motivation were found to be significant correlates of knowledge. The socio-economic status and economic motivation were determinant of knowledge as emerged after regression analysis. All independent variable under study explained 53.33 per cent variation in knowledge.

Maharashtra had about 26.51 lakh hectares area under soybean in the year 2007. The total production of Maharashtra estimated 32.374 lakh tonnes with productivity of 1221 kg per hectare. However, yield level is low in Akola (1040 kg ha^{-1}), Yavatmal (1060 kg ha^{-1}) and Washim (1080 kg ha^{-1}) districts of Vidarbha. This is mainly due to inadequate knowledge and importance about improved (recommended) cultivation practices of soybean. However, it has been observed that the farmers are adopting only few recommended practices of soybean cultivation technology.

In this context, the study was conducted with the following specific objectives:

1. To study knowledge of soybean growers about recommended cultivation practices
2. To study relationship between selected personal, socio-economic situational, communication and psychological characteristics of soybean growers and their knowledge about recommended soybean cultivation practices

MATERIAL AND METHODS

The use of descriptive and diagnostic design of social research was made in the present investigation. The present study was carried out in Akola district of Maharashtra state as this is one of the major soybean growing districts.

For the present study, a multistage sampling plan was followed. After selection of Akola district as a major soybean growing district, Telhara, Akot and Patur *Panchayat Samiti* were purposively selected because of having low, medium and high area under soybean crop in these *Panchayat Samiti* respectively. Five villages from each selected *Panchayat Samiti* were selected based on major area under soybean cultivation. Thus, total 15 villages were selected from three *Panchayat Samiti* of Akola district. The list of the farmers growing soybean crop (*Kharif*) in the selected villages was prepared in consultation with *Talathi* and *Sarpanch*. From the list, 10 farmers were selected from each village by adopting random sampling method. Thus, total 150 farmers were selected as respondents for the study.

Measurement of Knowledge:

Knowledge in the present case is operationally defined as amount of understood information possessed by the respondents about various recommended practices for cultivation of soybean.

A teacher made knowledge test was developed and used for measuring the knowledge about recommended practices of soybean cultivation. Land preparation, sowing method, period of sowing, seed rate and variety, seed treatment, spacing, intercultivation, intercropping, fertilizer application, plant protection and harvesting and threshing were

1. M.Sc. Student, 2. Associate Prof., 3. Research Associate and 4. Associate Prof., Department of Extension Education, Dr. PDKV, Akola

included in knowledge test and under each practice there were some sub questions; so total 28 practices were included. Score of 2, 1 and 0 was assigned to complete knowledge, partial and no knowledge, respectively. Finally, score for all items of knowledge scale for individual respondent was summed up to obtain total score. Knowledge total score for each idividual was converted into knowledge index by using following formula.

$$\text{Knowledge index} = \frac{\text{Knowledge score actually obtained}}{\text{Maximum obtainable knowledge score}} \times 100$$

Finally, the respondents on the basis of their knowledge index arbitrary 3 classes have been formed as follows.

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

RESULTS AND DISCUSSION

Knowledge level of respondents

The knowledge of the respondents about soybean cultivation practices recommended by the Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola was ascertained and on the basis of knowledge index, the respondents were classified into three level i.e. low, medium and high and their distribution is shown in Table 1.

The distribution of respondents according to level of knowledge in Table 1 revealed that majority of the soybean growers (61.33%) were found in medium category of knowledge, followed by 33.34 per cent in high category of knowledge. Only 5.33 per cent of soybean growers found in low category of knowledge. Thus, it could be inferred that majority of soybean growers had medium level of knowledge about improved cultivation practices recommended for soybean. These finding are in line with the findings of Wane (2000), Gawande (2005) and Zade (1998) who reported that majority of the soybean growers had medium level of knowledge. The extent of knowledge possessed by an individual may have an influence on its adoption and also useful for narrowing gap. Hence, practice wise knowledge of respondents about soybean cultivation technology recommended by Dr. PDKV, Akola was ascertained. The findings pertaining to these are depicted in Table 2.

It is observed from Table 2 that cent per cent respondents had complete knowledge about recommended sowing method of soybean, followed by major land preparation operation (92.67%), harrowing after harvesting of previous crop (92.67%), appropriate stage of threshing (90.67%), recommended period of harvesting of soybean (90.00%), intercultivation practices (86.67%), recommended hoeing time (84.67%). Nearly three fourth of the respondents (74.67%) possessed complete knowledge about both the recommended cultivation practices, namely recommended soil and recommended time of sowing. It is further observed that majority of respondents possessed complete knowledge about various recommended cultivation practices of soybean namely, recommended seed rate per ha (72.00%), recommended sowing depth (54.00%), recommended dose of FYM (48.67%), hybrid varieties (44.00%), recommended spacing (38.67%), plant population (35.33%).

Only 24.00 per cent of respondents had complete knowledge about recommended dose of fertilizer, followed by crop recommended as intercrop (22.00%), recommended fungicide (19.33%), bio-fertilizer recommended for seed (18.67%), row proportion of intercrop in soybean (18.67%), only

Table 1: Distribution of the respondents according to their overall knowledge about recommended soybean cultivation technologies

S. N.	Knowledge level	Respondents (n=150)	
		Number	Percentage
1)	Low (Upto 33.33)	08	5.33
2)	Medium (33.34 to 66.66)	92	61.33
3)	High (Above 66.66)	50	33.34
	Total	**150**	**100.00**

Table 2 : Distribution of the respondents according to their practice-wise knowledge about package of practices recommended for soybean cultivation

S.N.	Recommended practices of soybean	Knowledge		
		Complete	Partial	No
A.	**Land preparation**			
i)	Soil recommended for cultivation of soybean	74.67	25.33	00.00
ii)	Major land preparation operations	92.67	7.33	00.00
iii)	Harrowing after harvesting of previous crop	92.67	7.33	00.00
iv)	Recommended dose of FYM/ha	48.67	47.33	4.00
B.	**Sowing method**			
i)	Recommended Sowing method	100.00	00.00	00.00
ii)	Sowing depth for soybean seed	54.00	46.00	00.00
C.	**Period of sowing**			
i)	Recommended time of sowing for soybean crop	74.67	25.33	00.00
D.	**Seed rate and variety**			
i)	Hybrid varieties	44.00	4.00	52.00
ii)	Recommended seed rate per/ha for soybean	72.00	27.33	0.67
E.	**Seed treatment**			
i)	Fungicide recommended for seed treatment	19.33	37.33	43.33
ii)	Biofertilizer recommended for seed (inoculate) treatment	18.67	36.00	45.33
iii)	Fungicide quantity for seed treatment	10.67	40.67	48.66
iv)	Rate of *Trichoderma* per/kg for seed treatment in soybean	1.33	13.33	85.33
F.	**Spacing**			
i)	Recommended spacing for soybean	38.67	66.67	0.66
ii)	Optimum plant population of soybean per hectare	35.33	59.33	5.34
G	**Intercultivation**			
i)	Intercultivation practices	86.67	13.33	0.00
ii)	Hoeing time	84.67	15.33	0.00
iii)	Weedicide recommended for control of weeds in soybean crop	16.67	29.33	54.00
iv)	Recommended dose of weedicide for soybean	1.33	28.00	70.67
H.	**Inter cropping**			
i)	The crop recommended as intercrop in soybean	22.00	46.67	31.33
ii)	Row proportion of intercrop in soybean	18.67	54.00	27.33
I.	**Fertilizer application**			
i)	Recommended dose of fertilizer per hectare	24.00	76.00	00.00
J.	**Plant protection**			
i)	Major pests of soybean	13.33	53.33	33.34
ii)	Insecticide recommended for control of pests	14.67	52.00	33.33
iii)	Major diseases of soybean crop	16.00	53.33	30.67
iv)	Chemical recommended for control of above disease	6.67	50.00	43.33
K.	**Harvesting and threshing**			
i)	Appropriate stage of harvesting of soybean	90.00	10.00	0.00
ii)	Appropriate stage of threshing of soybean	90.67	9.33	0.00

16.00 per cent respondents had complete knowledge about major diseases of soybean crop, followed by recommended in insecticides (14.67%) and pest of soybean (13.33%), fungicide quantity for seed treatment (10.67%), 1.33 per cent respondents have complete knowledge about both the recommended varieties and recommended dose of weedicides for soybean and rate of Trichoderma per Kg of soybean seeds.

It is observed that majority of respondents had partial knowledge about various recommended cultivation practices namely, recommended dose of fertilizer (76.00%), recommended spacing (66.675), plant population (59.33%), recommended row proportion of intercrop in soybean (54.00%).

Over half of the respondents (53.33 %) had partial knowledge about both the recommended practices like major pests of soybean and major diseases followed by recommended insecticides for control of pests (52.00%), recommended dose of FYM (47.33 %) and recommended crop as intercrop (46.67%).

It is further observed that 46.00 per cent of respondents had partial knowledge about recommended sowing depth, followed by fungicide quantity for seed treatment (40.67), recommended fungicide (37.33%), recommended biofertilizer for seed treatment (36.00%), recommended weedicides (29.33%), dose of weedicide for soybean (28.00%), seed rate (27.33%), recommended soil and time of sowing (25.33 % each). A few respondents had partial knowledge about hoeing time (15.33%), inter-cultivation practices (13.33%), recommended rate of Trichoderma (13.33%), harvesting stage (10.00%), threshing stage (9.33%), major land preparation (7.33%) and harrowing (7.33%).

Majority of respondents had no knowledge about the practices like recommended rate of Trichoderma (85.33%), recommended dose of weedicide for soybean (70.67%), recommended weedicide (54.00%), hybrid varieties (52.00%), fungicide quantity for seed treatment (48.66%), recommended biofertilizer (45.33%), recommended fungicide for seed treatment (43.33%), major pests of soybean (33.34%), insecticide application (33.33%), crop recommended as intercrop (31.33%), major diseases of crop (30.67%), row proportion of intercrop (27.33%), plant population (5.34%), recommended dose of FYM (4.00%), recommended seed rate (0.675) and recommended spacing (0.66%).

Correlates of knowledge

The correlation coefficient of knowledge with personal, socio-economic, situational, psychological and communication characteristics of the respondents has been depicted in Table 3.

Results depicted in Table 3 reveal that all selected characteristics of respondents *viz.*, education, land holding, area under soybean, annual income, socio-economic status, source of information and economic motivation found to have positive and highly significant correlation with their knowledge at 0.01 level of probability. Whereas the age showed significant association with knowledge at 0.05 level of probability.

Thus, it may be said that with increase in age, education, land holding, area under soybean, annual income, socio-economic status, source of information and economic motivation of the soybean growers, their knowledge about soybean cultivation practices also increased. The findings of present study in respect of age conformed the findings of Gawande (2005), whereas the findings in respect of

Table 3: Relationship of selected characteristics of the respondents with their knowledge

S. N.	Characteristics	Coefficient of correlation 'r' value
1	Age	0.179*
2	Education	0.466**
3	Land holding	0.402**
4	Area under soybean	0.345**
5	Annual income	0.426**
6	Socio-economic status	0.597**
7	Source of information	0.679**
8	Economic motivation	0.418**

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

Table 4 : Regression coefficient of different characteristics of the respondents with knowledge of respondent about soybean cultivation practices

S. N.	Characteristics	Coefficient of regression 'b'	SE of 'b'
1	Age	0.0772	0.101
2	Education	0.557	0.331
3	Land holding	0.351	0.687
4	Area under soybean	0.0719	1.375
5	Annual income	0.000004	0.00005
6	Socio-economic status	2.0708*	1.264
7	Source of information	1.0432**	0.189
8	Economic motivation	0.2029	0.488

R^2 = 0.5333 'F' = 20.13**

** = Significant at 0.01 level of probability

* = Significant at 0.05 level of probability

education, land holding annual income are in line with the observation of Asane (2003) and area under soybean are in line of the findings of Kubde *et al.* (1999). The socio-economic status, source of information and economic motivation were in line with the observation of Shinde (2000).

Multiple regression analysis of knowledge

The multiple regression coefficient of personal, socio-economic, situational, psychological and communication characteristics with their knowledge have been depicted in Table 4.

Results depicted in Table 4, reveal that regression coefficient of source of information (b=1.0432) had significantly contributed in explaining the knowledge at 0.01 level of probability. The regression coefficient of socio-economic status (b=2.708) found to have significantly contributed in explaining knowledge at 0.05 level of probability. Remaining all variables had not any influence on knowledge level of farmers. This leads to conclude that the variables namely, source of information and socio-economic, status were the determinant of knowledge of farmers about soybean cultivation technology. All independent variables jointly explained 53.33 per cent of the variation in knowledge as coefficient of determination (R^2) was found to be significant at 0.01 level of probability.

CONCLUSION

In case of knowledge, majority of the farmers possessed medium level of knowledge about recommended soybean cultivation technology. The knowledge prosperity of the respondents needs to be increased. In this connection, it is implicated that the extension agencies and government functionary engaged in development of agriculture in the area should try hard by using appropriate strategies like organization of trainings and filed days, exhibitions and result demonstrations to improve the knowledge.

The extension, thus, should be in line with the providing importance and the significance of the neglected practices in increment of the yield and economic return through soybean farming.

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Evaluation and Utilization of Improved Animal Husbandry Practices by Dairy Farmers of Raipur District

R.S.Chaudhary[1], S.D.Sarnaik[2], R.N.Surve[3] and D.K.Suryawanshi[4]

ABSTRACT

The present study was conducted in Raipur district of Chhattisgarh state with a sample size of 140 farmers each having more than five milch animals. The results indicated that 90 per cent of the respondents were having improved breeds, 56.43 per cent of respondents fed their livestock with improved feeds while 80.71 per cent of the respondents reported that they are following vaccination practices regularly to keep their livestock healthy. The majority (68.57%) of the respondents represented medium level of utilization of improved animal husbandry practices. Age, education and annual income had positive and significant relationship with utilization of improved animal husbandry practices, while family size, sources of information, credit acquisition and income from diary did not show any relationship with dependent variable.

Indian farmers are slowly accepting the truth that it is hard to survive and improve their socio-economic status by depending only on agriculture. Agriculture along with subsidiary business like poultry, piggery, dairy farming etc., helps the farmers to attain the economic goals. Among these subsidiary business diary farming and agriculture forms a symbiotic relationship. Green fodder helps to increase milk production of dairy animals, while application of FYM results in higher crop production. Besides, dairy provides indirect insurance against risk failures of crops.

Livestock management involves the integrated use of the principles of animal breeding, feeding, housing and disease control. The objective behind any livestock enterprise is to achieve maximum productivity and profitability. Lot of livestock research was undertaken and generated sufficient improved practices of animal husbandry for improvement in diary farming.

Keeping this in view, the present investigation was carried out with the following objective:

1. To find out the level of utilization of improved animal husbandry practices.
2. To find out the relationship between personal profile of respondents with improved animal husbandry practices.

MATERIAL AND METHODS

The present investigation was carried out in Raipur district of Chhattisgarh State. The district is having adequate diary population. The district is quite advanced and farmers are more conscious about the livestock management practices, milk production etc., in comparison to other districts of state. Therefore, 140 farmers who are having more than five milch animals were randomly selected from the list collected from Directorate, Veterinary Sciences, Raipur district.

RESULTS AND DISCUSSION

(A) Improved Breed:

Proper breeding, feeding, healthcare and management are the indicators of successful diary farming. The data in Table 1 show that 90 per cent of the respondents possessed improved breed in the range of 67 to 100 per cent. A marginal percentage (2.14%) of respondents do not have any improved breed and maintained local breeds.

(B) Improved Feeding:

With regard to the improved feeding, 56.43 per cent of the respondents were providing improved feed upto medium level (up to 66.66%) to their milch animals. While negligible percentage of the respondents were in low category of utilization of improved feeding practices.

1 M.Sc. student, 2. Junior Res. Asstt., STRU, Dr. PDKV, Akola, 3 Assistant Prof. College of Home Science, Akluj and 4. Assistant Prof., Department of Extension Education, IGKVV, Raipur (CG)

Table 1: Distribution of the respondents according to use of improved animal husbandry Practices.

S.N.	Improved animal husbandry practices	Frequency(n=140)	Percentage
1	**Improved Breed**		
a	None	3	2.14
b	Up to 33.33 per cent	2	1.43
c	33.34 to 66.66 per cent	9	6.43
d	66.67 to 100 per cent	126	90.00
2	**Improved Feeding**		
a	Low (Up to 33.33%)	2	1.43
b	Medium (33.34 to 66.66 %)	79	56.43
c	High (66.67 to 100%)	59	42.14
3	**Health care**		
a	Vaccinated the animals	113	80.71
b	Never vaccinated the animals	27	19.29

Table 2 : Distribution of the respondents according to the level of utilization of improved animal husbandry practices.

S.N.	Level of utilization	Frequency(n=140)	Percentage
1	Low (upto 33.33%)	0	0
2	Medium (33.34 to 66.66%)	44	31.43
3	High (above 66.67%)	96	68.57

Table 3: Relationship of independent variables with extent of utilization of improved animal husbandry practices.

S.N.	Independent variables	Coefficient of correlation('r' value)
1	Age	0.2934**
2	Education	0.4315**
3	Family size	0.1262
4	Annual income	0.4750**
5	Credit acquisition	0.1597
6	Sources of information	0.0824
7	Herd size	0.1890*
8	Income from diary	0.1020

* significant at 0.05 level of probability ** significant at 0.01 level of probability

(C) Health Care:

It is quite clear from Table 1 that majority of the respondents i.e. 80.71 percent were aware about animal care and following vaccination practices regularly. While 19.29 per cent of the respondents were not following vaccination practices for animals.

Thus, it could be inferred that diary farmers of Raipur district were keeping improved breed to a large extent and feeding their livestock with improved feed. Majority of the respondents were conscious about proper vaccination and treatment to diseased animals. These findings corroborate with the findings of Shinde *et al.*,(1999) stating that majority of the respondents were in medium level of adoption of improved animal husbandry practices.

Level of utilization of improved animal husbandry practices

The data about level of utilization of improved animal husbandry practices have been furnished in Table 2. The data revealed that 68.57 per cent of the respondents were utilizing improved animal husbandry practices. It was followed by 31.43 per cent of respondents who represented medium level of utilization of improved animal husbandry practices. The analysis indicated that diary farmers were much conscious and also taking all possible measures for fetching maximum return from their enterprise. The present findings however differed from Singh *et al*., (2003) who concluded that majority of the respondents (46.09%) had medium level of adoption and 26.08 per cent high level of adoption of recommended dairy management practices.

Relationship between profile of farmers and their utilization of improved animal husbandry practices.

The data in Table 3 revealed that the variables namely age, education and annual income had positive and significant association with utilization of improved animal husbandry practices at 0.01 level of probability, where as herd size shows positive and significant association with utilization of improved animal husbandry practices at 0.05 level of probability. However, the remainder variable namely family size, sources of information, credit acquisition and income from diary did not show any relationship with dependent variable.

The plausible reason behind significant correlation of age, education, annual income and herd size might be that education opens mental faculty of individuals and leads to seek enough knowledge, which is prerequisite for utilization of improved practices. The plausible reason behind non-significant association of credit acquisition and sources of information with utilization of improved animal husbandry practices might be that respondents were well versed in fetching higher milk productivity by using improved animal husbandry practices.

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Abnormal Behaviour of Crossbred Calves Under Different Housing Systems

S. N. Rokde[1], R.M Zinjarde[2], A.S Ingole[3], M.V Atkari[4] and R.V Pawar[5]

ABSTRACT

Crossbred calves (48) of Karan Swiss and Karan Fries breed of either sex aging five days were obtained from calf section of NDRI as and when born within a short span of time. They were randomly divided into 3 different housing systems viz. loose housing in group (H_1); Individual housing in cages (H_2) and Individual tying with string (H_3) and maintained on NDRI feeding schedule until they attained the age of 6 months in 3×2 factorial randomized block design. Their abnormal behaviour was studied for entire period of six months. The housing systems were found to have highly significant effect ($P < 0.01$) on various abnormal behavioural traits of crossbred calves viz . inter-licking , inter- sucking, licking of inanimate objects ,urine drinking behaviour and coat mouthing. Sex was found to have highly significant effect($P < 0.01$) on inter-licking and non-significant effect($P > 0.01$) on inter- sucking, licking of inanimate objects ,urine drinking behaviour and coat mouthing. Period was found to have highly significant effect($P < 0.01$) on inter-licking ,inter- sucking and coat mouthing and significant effect($P < 0.05$) on leaning. Whereas period had non-significant effect ($P > 0.01$) on licking of inanimate objects and urine drinking behaviour.

Behaviour is the unconcealed expression of the reactions of any animal in response to the environment in which it is kept. It is the dynamic means whereby an animal communicates with its environment. The behaviour which is a variant of normal activity is abnormal or anomalous behaviour (Fraser,1980) the animal can communicate with its environment, both animate and inanimate. The abnormal behaviours are related to noxious stimuli or environmental stress. Inferior environments may lead to deviation of normal behaviour and result in abnormal behaviour such as tail biting, wood chewing etc. Most housed animals spend a major portion of their life in intimate contact with the floor. The uncomfortable housing conditions may result in expression of abnormal behaviour in calves (Prasad, 1983). Hence to re-verify these facts and to study the pattern of abnormal behaviour under three different systems of housing under a set of Indian conditions ,the present investigation was undertaken.

MATERIAL AND METHODS

A study was conducted at N.D.R.I., Karnal , Haryana in order to study the pattern of abnormal behaviour exhibited by crossbred calves of Karan Swiss and Karan Fries calves under three different systems of housing .For this study, 48 crossbred calves of Karan Swiss and Karan Fries breed of either sex aging five days were taken from calf section of N.D.R.I., Karnal , Haryana. Groups were maintained under three different housing systems viz. loose housing in group (H_1); Individual housing in cages (H_2) and Individual tying with string (H_3) .Thus there were 16 calves under each housing system. The details of housing is given below.

1. Loose housing in group (H_1): The crossbred calves under this housing system were let loose day and night in a closed shed having *Pucca* floor having 29'x14' dimension, adjoining an open paddock having same dimension. Each calf availed an open area 72.75 ft^2 and covered area of 52.93 ft^2

2. Individual housing in cages (H_2): This system comprised housing the calves in individual cages installed on a slatted floor. A raised flooring 1.5' above the ground level was installed using wooden slats having 5'x3"x1' dimension. The gap between the slats was 1" and individual cages having 5'x3' dimensions made up of wire mesh partitions having 5'x3' dimensions were built on that slatted floor. The calves were housed in those individual cages all day and night except for one hour each in the morning and noon when they were let loose for milk feeding and exercise and to enable the workers to clean the cages.

1. Senior Scientist (LP&M),KVK, CICR (ICAR), Nagpur ; 2. Assistant Prof., 3.Professor, 4. Dairy Manager and 5. Junior Res. Asstt., Section of AH & Dairying ,College of Agriculture, Nagpur

3. Individual tying with string (H_3): In this system the calves were tied individually with a string on partially *Kutcha* floor during day time and on *Pucca* floor at night during summer and *Vice versa* during winter. They were let loose for milk feeding and exercise and to enable the workers to clean the cages.

All the experimental calves were maintained under N.D.R.I feeding schedule (Anonymous,1979). During the entire experimental period various management practices viz. feeding , washing and grooming etc., were followed as per standard practices followed at calf section of N.D.R.I., Karnal. The maximum and minimum temperatures recorded during the experimental period were 38 °C and 15.55 °C, respectively. During the entire period of experiment all the experimental crossbred calves were carefully watched monthly for a period of 24 hours till they attained six months age and observations on abnormal behaviour viz. inter-licking . inter-sucking, licking of inanimate objects ,urine drinking behaviour and coat mouthing, their duration , frequency and total time spent on a particular behaviour were recorded diurnally. A specially developed sheet to record observations for 24 hours was used for recording. The data were analyzed as per Snedecor and Cochran (1964)

RESULTS AND DISCUSSION

It was observed that 100 per cent of the crossbred Karan Swiss and Karan Fries calves expressed one or more type of abnormal behaviour. Maity (1989) reported somewhat less percentage (64.05 %) of crossbred calves which exhibited one or more type of abnormal behaviour . Similarly Legha (1994) also reported that, 64.05 per cent of crossbred Karan Swiss and Karan Fries calves exhibited one or more type of abnormal behaviour. However Wipkema *et. al.*, (1983) observed that the incidence of abnormal behaviour in a herd was observed in more than 5 per cent of the animals.

Inter-licking

The duration of inter-licking during day and night hours was observed to be highest in H_1 (5.12 and 4.36 min.), followed by H_3 (3.76 and 3.55 min) and least in H_2 (2.78 and 2.33 min), respectively. But the percentage of calves exhibiting inter-licking behaviour was highest (51.68 and 47.93 %) in H_2 followed by H_1 (25.71 and 31.04 %) and least (22.60 and 20.74 %) in H_3 during day and night hours, respectively (Table 1). The reason for this might be that the calves in H_2 and H_3 were confined in cages and with string, respectively for most of the time whereas the calves in H_1 were free to do this activity. The duration of inter-licking during day hours was observed to be more than night hours (Table-2). This might be due to the fact that both the milk feedings were done during day time only and in an attempt to lick milk stuck on each other's mouth there was higher incidence of inter-licking behaviour after milk feeding.

The analysis of variance revealed that housing systems had highly significant ($P < 0.01$) effect on inter-licking behaviour (Table 3).Similar

Table- 1: Percentage of crossbred calves engaged in abnormal behaviour

Abnormal behaviour	Period	H_1			H_2			H_3		
		P_0	P_1	Overall	P_0	P_1	Overall	P_0	P_1	Overall
Interlicking	7AM -7PM	49.95	50.55	25.71	47.54	46.99	51.69	57.50	42.50	22.60
	7PM-7AM	52.94	47.06	31.04	23.08	76.92	47.93	71.11	28.89	20.74
Intersucking	7AM -7PM	49.45	50.55	26.69	50.58	49.42	50.44	58.97	41.03	22.87
	7PM-7AM	51.43	48.57	32.41	24.00	76.00	46.30	73.91	26.09	21.30
Licking of inanimate	7AM -7PM	62.00	38.00	22.83	35.00	65.00	45.66	31.88	68.12	31.51
objects	7PM-7AM	68.42	31.58	20.00	40.00	60.00	63.16	15.15	24.24	16.84
Urine drinking	7AM -7PM	55.36	44.64	26.32	39.25	60.75	51.44	46.69	53.33	21.63
behaviour	7PM-7AM	61.90	38.10	21.88	28.57	71.43	51.04	53.85	46.15	27.08
Leaning behaviour	7AM -7PM	43.40	56.60	17.97	39.55	38.06	62.71	47.37	52.63	19.32
	7PM-7AM	46.67	53.33	16.30	13.06	86.92	70.65	58.33	41.67	13.04
Coat mouthing	7AM -7PM	42.31	57.69	16.67	73.22	26.78	58.65	38.96	61.04	24.68
behaviour	7PM-7AM	54.16	54.84	13.72	77.40	22.60	64.60	16.33	83.67	21.68

Table- 2: Diurnal variations in abnormal behaviour manifested by crossbred calves

Abnormal behaviour	Period	H_1			H_2			H_3		
		P_0	P_1	Overall	P_0	P_1	Overall	P_0	P_1	Overall
Interlicking	7AM-7PM	5.80±0.69(45)	4.43±0.46(46)	5.12±0.58(91)	3.44±0.40(87)	2.12±0.38(85)	2.78±0.39(172)	4.19±0.12(46)	3.32±0.53(33)	3.76±0.33(78)
	7PM-7AM	3.69±0.56(36)	5.03±0.61(34)	4.36±0.59(70)	1.75±0.25(24)	2.70±0.21(76)	2.23±0.23(100)	4.79±0.09(34)	2.30±0.01(34)	3.55±0.05(46)
Intersucking	7AM-7PM	10.20±1.00(45)	6.98±1.08(46)	8.59±1.04(91)	5.63±0.83(87)	6.22±0.68(86)	5.93±0.76(183)	6.90±1.28(46)	4.53±1.31(34)	5.72±1.30980)
	7PM-7AM	5.64±0.76(36)	5.34±0.47(32)	5.49±0.62(68)	2.25±0.25(24)	2.10±0.22(80)	2.18±0.24(104)	2.01±0.23(32)	1.87±0.22(13)	1.94±0.23(45)
Licking of	7AM-7PM	3.48±0.469(31)	3.68±0.67(19)	3.58±1.13(50)	3.93±0.73(35)	4.80±0.62(65)	4.37±0.68(100)	6.22±1.38(22)	5.93±0.24(47)	6.08±0.81(69)
inanimate objects	7PM-7AM	3.00±0.52(13)	3.50±2.50(6)	3.25±1.51(19)	1.00±7.29(25)	2.12±3.35(36)	1.56±5.30(60)	2.10±1.12(6)	2.08±0.19(10)	2.09±0.66(16)
Urine drinking	7AM-7PM	9.71±1.33(31)	8.10±0.52(25)	8.98±0.33(56)	7.47±1.31(42)	5.31±1.21(65)	6.39±1.26(107)	9.43±2.99(21)	6.54±1.36(24)	7.99±2.18(45)
behaviour	7PM-7AM	6.40±1.31(13)	1.00±0.00(8)	3.70±0.66(21)	12.00±8.50(14)	4.13±2.10(35)	8.07±5.30(49)	13.36±2.99(14)	5.33±1.04(12)	9.35±2.02(26)
Leaning behaviour	7AM-7PM	3.38±0.67(23)	6.43±1.10(30)	4.91±0.89953)	3.89±0.19(51)	8.28±0.99(134)	6.09±0.59(185)	3.14±0.89(27)	6.37±1.49(30)	4.76±1.19(57)
	7PM-7AM	1.83±0.51(14)	1.60±0.24(16)	1.72±0.38(30)	1.49±0.14917)	13.71±2.89(113)	7.60±1.54914)	1.67±0.14914)	1.57(0.89)±	1.62±0.52(24)
Coat mouthing	7AM-7PM	6.30±1.07(22)	11.47±1.92(30)	8.89±1.50(52)	16.85±2.17(134)	7.63±1.01(49)	12.24±1.59(183)	13.45±1.21930)	20.89±7.41(47)	17.17±4.30(77)
behaviour	7PM-7AM	4.08±1.29(14)	2.50±0.43(17)	3.29±0.86(31)	22.51±2.08(113)	6.11±1.21(33)	14.31±1.65(146)	3.56±0.89(8)	27.14±4.23(41)	15.35±2.51(49)

Note: Figures given in the parentheses indicate number of observations

to the findings of present study, Todkar (1984) also reported that the percentage of crossbred calves exhibiting inter-licking behaviour was highest (22.81 %) in calves kept in cages, followed by the calves kept on the floor without bedding (18.95) and least in calves kept on bedding (17.49).He also observed that during the period of 24 hours, the calves in cages licked for more time than the calves of the other two groups at all ages except at 60 days where the frequency was higher in bedding groups. He further observed that, the licking behaviour was more prominent during day time at all ages and treatments. He opined that with an increase in age, there was decreasing trend in the total frequency of licking but as per the results of present study are contradictory upto attainment of six months by the crossbred calves .

Inter-sucking

Inter-sucking behaviour was exhibited by all calves of all ages reared under all the three housing systems. The inter-sucking behaviour was more prominent during day time at all ages and under all the three housing systems. During day hours, the percentage of calves exhibiting inter-sucking behaviour was highest (50.44 %) in H_2 followed by H_1 (26.69 %) and least (22.87%) in H_3 (Table-1). Similar trend was observed during night hours and the percentage of calves exhibiting inter-sucking behaviour was highest (46.30 %) in H_2 followed by H_1 (32.41 %) and least (21.30%) in H_3. The analysis of variance revealed that housing systems had highly significant ($P < 0.01$) effect on inter-sucking behaviour (Table 3). Donald and Anderson (1967) , Wilt (1967) , Wood *et al.* (1967), Simonsen (1983), Sambraus (1984), Swansan (1956), Maity (1989), also reported higher incidence of inter-sucking in group penned crossbred calves. As per Simonsen (1983) the major probable reason for this might be that sucking time for each meal with milk replacer was less than 5 minutes while during natural suckling it was 6 to 12 minutes.

Thus the appetite of calves was not satisfied during artificial feeding which induced non-nutritive sucking. Secondly during natural suckling the instinct of calves was satisfied but it did not happen during artificial feeding which induced non-nutritive sucking. Thirdly in artificial rearing/weaning system the calves which were kept confined weariness and bordem was developed and when they got free at the time of milking, cleaning of sheds, etc., they got a chance to do whatever they want.

Licking of inanimate objects

The behaviour of licking of inanimate objects in growing crossbred calves included the behaviour of licking wall, floor of pen , licking and chewing of ropes , metal gate , floor of pen , licking and chewing of rope , wooden fixtures and welded iron mesh of cages. The duration of licking of inanimate objects was highest in calves kept in H_3 during day hours (7.00 am to7.00 pm) followed by calves kept in H_2 and H_1, respectively. During night hours, the duration of licking of inanimate objects was highest in calves kept in H_1, followed by calves kept in H_3 and H_2 respectively (Table 2).

During day hours, the percentage of calves exhibiting licking of inanimate objects behaviour was highest (45.66 %) in H_2, followed by H_3 (31.51 %) i.e. calves which were kept confined and least (22.83 %) in H_1 i.e. free calves. During night hours, the percentage of calves exhibiting licking of inanimate objects behaviour was highest (63.16 %) in H_2 followed by H_1 (20.00 %) and least (16.84 %) in H_3 (Table-1).

Table-3: Analysis of variance for abnormal behaviour manifested by crossbred calves

Source of variation	d.f	Mean sum of squares				Leaning	Coat mouthing
		Interlicking	Intersucking	Licking of inanimate objects	Urine drinking		
Housing	2	255.8**	1481.60**	184.0**	27.7^{NS}	985.8**	2831.6**
Sex	1	103.7**	163.11^{NS}	7.0^{NS}	6.4^{NS}	7.6	251.4
Month	5	229.6**	538.5*8	22.8^{NS}	64.5^{NS}	189.2*	630.3*
Error	383	13.2	57.7	13.3^{NS}	66.2^{NS}	68.9	108.1

* Significant **Highly significant NS = Non-significant

The analysis of variance revealed that housing systems had highly significant ($P < 0.01$) effect on licking of inanimate objects behaviour (Table 3). Similar to these results, Maity (1989) also observed that licking of inanimate objects behaviour was influenced by age and space density. He further reported that licking of inanimate objects behaviour in 48.05 per cent of young crossbred calves and it decreased with the advancement in their age. In group penned male calves it was found to be more i.e. 43.33 per cent of group penned male calves exhibited this behavior. This was followed by growing bulls (37.77) and individually penned adult bulls (33.33 %).

Urine drinking behaviour

During day hours of first and second month, the calves in H_2 spent more time on urine drinking behaviour, followed by H_1 and H_3, respectively. During night hours, the calves in H_3 spent more time on this activity, followed by H_2 and H_1, respectively (Table 2). It was more in H_3 in second, third , fourth and fifth month .In sixth month it was more in H_1 and H_2 and less in H_3.The overall picture shows that during day hours it was highest in H_1, followed by H_3 and least in H_2 During night hours, it was it was highest in H_2 followed by H_3 and least in H_1

The analysis of variance revealed that housing systems had non- significant ($P > 0.05$) effect on urine drinking behaviour (Table 3). .Maity (1989) also observed higher incidence of urine drinking behaviour and reported this behaviour in 20.63 per cent of individually penned bull calves. During day hours the percentage of calves which exhibited this behaviour was highest (51.44 %) in H_2, followed by H_1 (26.32 %) and least(21.63 %) in H_3. During night hours, the percentage of calves which exhibited this behaviour it was highest (51.04 %) in H_2, followed by H_3 (27.08 %) and least (21.88) in H_1. Incidence of urine drinking behaviour was reported by Wipkema *et. al.*,(1983). The results of present study are in close agreement with Sambraus (1989) who reported about 52.71 per cent cases of urine drinking behaviour among bull calves. Maity (1989) also observed higher incidence of urine drinking behaviour in male calves aging 6- 12 months.

Leaning

During day hours, the percentage of calves which exhibited leaning behaviour was highest(62.71 %) in H_2, followed by H_3 (19.32 %) and least (17.97) in H_1 During night hours, it was highest (70.65 %) in H_2 followed by H_3(16.30 %) and least (13.04 %) in H_3(Table 1). The analysis of variance revealed that housing systems had highly significant ($P < 0.01$) effect on leaning behaviour (Table 3).

Coat mouthing

During day hours, average time spent on coat mouthing was highest in H_3 (17.17 ± 4.31 min.) followed by H_2 (12.24 ± 1.59 min.) and least in H_1 (8.89 ± 1.50 min.). During night hours, similar trend was observed and the average time spent on coat mouthing was highest in H_3 (15.35 ± 2.51 min.) followed by H_2 (14.31 ± 1.65 min.) and least in H_1 (3.29 ± 0.86 min) .

During day hours, the percentage of calves exhibiting coat mouthing behaviour was highest in H_2 (58.65%) followed by H_2 (26.78 %) and least in H_1 (16.67 %). During night hours, similar trend was observed and the percentage of calves exhibiting coat mouthing behaviour was highest in H_2 (64.60%), followed by H_2 (21.68 %) and least in H_1 (13.72 %) (Table 1). The analysis of variance revealed that housing systems had highly significant ($P < 0.01$) effect on coat mouthing behaviour (Table 3). So, from these results it is evident that the coat mouthing behaviour was more in confined and tied calves. Similar results were obtained by Maity (1989) who observed that coat mouthing behaviour was very less in all ages except in group penned calves (6-12 months age group) where it was 20 per cent. Wiepkema *et. al.* (1983) also obtained similar results.

CONCLUSION

From the above results, it can be concluded that almost 100 per cent of the crossbred Karan Swiss and Karan Fries calves expressed one or more type of abnormal behaviour. Inter-licking behaviour was highest in calves kept confined in cages (H_2) and/ or with string (H_3) for most of the time whereas in case of the calves kept in loose housing (H_1) inter-licking behaviour was less because they were free to do this activity. The duration of inter-licking ,

intersucking , licking of inanimate objects, leaning behaviour and coat mouthing were more during day hours and less during night hours.

The incidence of abnormal behaviours such as inter-licking , intersucking , licking of inanimate objects were more pronounced one hour prior to milk feeding and one hour after milk feeding. This might be due to the fact that, the appetite of calves was not satisfied during artificial feeding which induced non-nutritive sucking. In artificial rearing/weaning system the calves which were kept confined, weariness and bordem was developed and when they got free at the time of milking, cleaning of sheds, etc., the incidence of exhibiting abnormal behaviour was more.

Hence from the results obtained during present study, it is recommended that the farmers should use loose housing system for crossbred calves or they may tie them individually with string. Further, they may put rope muzzles to the calves one hour prior to milk feeding. Further in order to discourage the calves from non-nutritive sucking and abnormal behaviour, the mouth of calves should be wiped clean with the help of a clean cloth .This should be immediately followed by feeding a pinch of salt to them and tying rope muzzles to them. This will greatly help in checking infections, incidence of diarrhea etc., maintain good health and enhance profitability of dairy farm.

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Effect of Bypass Fat on Quantity and Quality of Milk of crossbred Cows

P.D. Bothe[1], S.B. Akhare[2], R.V. Pawar[3] and Kavita Morey[4]

ABSTRACT

Significant increase in milk yield, milk fat and total solids was observed in the experimental animals fed with concentrate mixture, wheat straw and green maize in T_1 group and concentrate mixture, wheat straw, green maize and bypass fat @ 20 gl^{-1} in T_2 treatment for a period of 30 days. However, the average milk protein was non significantly decreased, whereas lactose, solids-not-fat content of milk were significantly decreased, but specific gravity, titratable acidity, ash and pH remained unchanged in both the treatments. The net profit gain from the feeding of bypass fat was Rs. 412.4/- 30 $days^{-1}$ $animal^{-1}$ as compared to T_0 treatment.

In the new millennium the global dairy industry is in search of initiatives to enlarge its market. Dairy markets in the new millennium are being increasingly shaped by twin strands of globalization and localization. The feeding of the economic and scientifically balanced ration for production in terms of economic return is the primary objective of animal nutrition. In India still the livestock are mainly reared for milk and draught purpose and not for meat. The market price of milk, in India is generally based on its fat content. All milk components are synthesized from the blood. The milk fats are synthesized from acetate, beta hydroxybutyrate, glucose and free fatty acids (Banerjee, 2005).

The rumen active fat can attach to the rumen microbes and consequently affect the enzyme system in the rumen which results in reduced fiber digestibilities.

The deleterious effect of fats on rumen activity can be overcome with bypass fat. Fats that can pass through the rumen without interfering with the rumen microorganism function is called bypass fat. These fats are also referred as rumen inert fat or ruminant's fats. Rumen bypass fats are not attached to rumen bacteria and do not interfere with fiber digestibility. There is minimal alteration where it passes through the rumen yielding better intestinal digestibility in ruminants.

The fat profile included in bypass fat is similar to milk and is efficient, energy saving and positively influencing milk solids and milk yield (Charlotte, 2002). Bypass fat include reproduction and functional feed formula that promote high levels of conjugated linoleic acid in the milk.

MATERIAL AND METHODS

Six crossbred milch cows in the mid stage of the lactation of Agriculture College Dairy Farm, Nagpur were selected for the experiment and were subjected to two different treatments in a crossover manner.

In T_0 treatment, normal cattle feed (Wheat straw, green maize, sugras) were fed and in T_1 treatment normal cattle feed (Wheat straw, green maize, sugras) with bypass fat "Improved Urja" @ 20 gl^{-1} of milk production were fed.

Each experimental feed was fed to all the cows in crossover manner for period of 30 days. At the time of crossover of treatment to the other 21 days rest period was given to nullify the carryover effect of earlier treatment.

The milk yields of all animals were recorded in kilograms both the times. Milk samples were subjected to chemical and physical analysis i.e. acidity, specific gravity, pH, fat, TS, SNF, protein, lactose and ash.

The cost structure was determined by considering the cost of bypass fat (Improved Urja) required for increase in the fat per cent and milk yield.

1. M.Sc. Student, 2. Assistant Prof. Veterinary Science 3.Junior Res.Asstt. 4. Senior Res.Asstt., Section of Animal Husbandry and Dairying, College of Agriculture, Nagpur.

RESULTS AND DISCUSSION

Milk production

The milk production obtained during the experimental period of 30 days was significantly increased in T_1 treatment. The total milk production obtained was 1015.3 and 1106.6 kg i.e. average 5.64 and 6.15 kg of T_0 and T_1 treatment respectively. It means 9.04 per cent increase in milk yield in T_1 treatment. The results are in agreement with Mishra *et al.* (2005) who reported that supplementation of bypass fat to crossbred cows increased milk yield by 12.89 per cent. Sirohi and Walli (2005) reported that supplementation of bypass fat to crossbred cows increases milk yield by 15.61 per cent.

Fat

Significant increase in fat content of milk of T_1 treatment over T_0 i.e. the fat content of milk increased by 31.51 per cent in T_1 treatment. These results are in agreement with Hotter *et al.* (1993) reported that bypass protein fat supplementation to cows increases milk fat per cent. Sirohi and Walli (2005) reported the increase in fat by supplementing bypass fat to cows.

Protein

The non significant decrease in T_1 treatment over T_0 treatment was observed i.e. 3.27 and 3.19 per cent protein in T_0 and T_1 treatment respectively. These results are in agreement with Moser (1978) who reported that additional dietary fat decreased milk protein content in cows. Also Petit *et. al.*, (2004) observed decrease in milk protein in cows on Megalac (Bypass fat) feeding.

Lactose

The significant decrease in lactose content of milk observed in T_1 treatment. Average lactose content was 4.65 and 4.53 in T_0 and T_1 treatment, respectively.

Table 1. Average values as influenced by various treatments.

	Milk Yield (Av.total production)	Milk Yield Av./Ani.	Fat	Protein	Lactose	Total Solids	Solids not-Fat
T_0	169.2	5.64	4.03	3.27	4.65	12.623	8.595
T_1	184.43	6.15	5.32	3.19	4.53	13.72	8.405
S.E (m) ±	0.8005	0.0269	0.016	0.02	0.012	0.022	0.0097
CD at 5 %	3.14	0.105	0.06	NS	0.049	0.087	0.038
CV	14.74	2.71	1.89	2.73	1.44	1.50	0.82

Table 2 Economics of feed cost and milk production.

Particulars Feed cost (Rs./Ani./Day)	Control Treatment T_0	Bypass fat Treatment T_1
Green fodder	10.20	10.20
Wheat straw	12.00	12.00
Conc. mixture	21.12	22.49
Bypass fat	-	7.38
Total feed cost day^{-1}	43.32	52.07
Feed cost Kg.$^{-1}$ milk production	7.68	8.46
Total feed cost 30 days^{-1} animal^{-1}	1299.6	1562.1
Increased feed cost over control	-	262.5
Total sale price of milk 30 days^{-1} animal^{-1}	2199.6	2874.5
Profit over control treatment	-	674.9
Net profit over control treatment animal^{-1}	-	412.4

These results are in agreement with Martinez *et al.* (1991) who reported that increasing amount of dietary fat decreases lactose concentration in milk.

Total solids

The significant increase in total solids content of milk observed. Average total solids content was 12.62 and 13.72 per cent in T_0 and T_1 treatment, respectively.

These results are in agreement with Sirohi and Walli (2005) who reported that supplementing bypass fat on lactating cows increased total solids content of milk.

Solids-not-fat

The significant decrease in SNF content of milk in T1 treatment was observed. The average values were 8.595 and 8.405 in T_0 and T_1 treatment, respectively.

These results are in agreement with Sirohi and Walli (2005) who observed non significant increase in SNF content of milk of cows fed with bypass fat for 13 weeks.

The average values of specific gravity, titratable acidity, ash and pH content of milk were same in both T_0 and T_1 treatment i.e. 1.028, 0.13, 0.678 and 6.50, respectively.

Cost structure

Feed cost was calculated on the market price of ingredients during the experimental period. The cost of green maize was Rs. 60 quintal^{-1}, wheat straw Rs 200 Kg^{-1}, Conc. Mixture Rs. 6.5 kg^{-1}, Bypass fat (Urja) Rs. 60.00 kg^{-1} and whole milk price sold in T_0 treatment @ 13.00 kg^{-1} and milk in T_1 treatment @ 15.58 kg^{-1} (Table 2).

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Mode of Feeding Practices Adopted by Crossbred Cow Cultivators

R.S. Futane[1], S.P. Nage[2], N.S. Deshmukh[3], K.U.Bidwe[4] and M.R. Thokal[5]

ABSTRACT

The survey was carried out in 9 villages of Nandura tahasil by randomly selected *15* cultivators in each village. Thus, total 135 animal owners were interviewed according to landless, marginal, small, medium and large categories. Out of these categories, majority of cultivator provide agricultural residues like *Jowar kadabi*, wheat straw and 73:33 per cent farmers allowed their cows for grazing and only 26.67 per cent practiced stall feeding, whereas 37.28 per cent crossbred cows were reared by the farmers on roughages.

All over the country, crossbreds are gaming popularity for their higher milk production as compared to indigenous cows. Although, no unusual care is needed for this category of livestock, still there are certain fundamental principles like scientific feeding, well housing, proper breeding and management. The crossbred cows can produce 3-4 07times more milk as compared to local cows (Parmar and Gill, 1988). As a thumb rule, for the sake of economy, feeding of green fodder to the crossbred at the level of 1/10 of their body weight, along with concentrate mixture is recommended. To produce a balanced ration to crossbred cattle it becomes necessary to ascertain their nutritional requirement, productive as well as reproductive purpose. Keeping these views in mind, present research paper focused on mode of feeding adopted by crossbred cattle owners of Nandura tahasil in Buldhana district, to provide valuable information about feeding practices adopted by the dairy farmer.

MATERIAL AND METHODS

To know the mode of feeding by crossbred cattle owner of Nandura tahasil in Buldhana district 15 farmers were selected randomly in each village. Total 135 crossbred cattle owners were interviewed according to landless, marginal, small, medium and large categories. Data were collected through personally contacting and presenting schedules for assessing the mode of feeding on type of ration, type of dry fodder, type of green fodder, type of feeding practices, processing of dry fodder, processing of concentrates and feeding of additives, etc. Feeding practices followed by crossbred cattle owners were compared with recommended feeding practices. The data analysed statistically as per method suggested by Panse and Sukhatme (1967).

RESULTS AND DISCUSSION

The result on mode of feeding crossbred cows by the farmer presented in table 1 indicated that maximum number of farmers formulated a ration comprising roughages and concentrates (75.56) for 62.72 per cent of crossbred cows. Whereas 37.28 per cent crossbred cows were fed on roughages by 24.44 per cent of farmers. The concentrate commonly used by farmers was cotton seed cake. Same trend was observed by Netke (1997) and Pore (1998) in Akola tahasil. Although cotton cake was the source of protein but it was found to be the unbalanced ration..

In case of type of dry fodder, *Jowar kadabi* was fed by 31.11 per cent of farmers to 24.86 per cent of cows. The other dry fodder combination was *kadabi* + *Tur* straw + wheat straw which was fed by 68.89 per cent of farmers to 75.15 per cent of cows. Type of green fodder available with farmers was indigenous grasses grown along with bunds or in field. Some of the farmers cultivated green fodder in their fields having facilities of irrigation.

As far as feeding practices are concerned, majority of farmers (73.33 %) comprising 74.28 per cent of cows were reared under this practice. Stall feeding was practiced by 26.67 per cent of farmers covering 25.72 per cent of cows. Similar trend was observed by Agrwal and Sharma (1986). Who reported that about 80 per cent of cows were sent for grazing to the fields for 7 h. or less day in villages around Karnal.

It was observed that 64.44 per cent of farmers fed 62.13 per cent of cows by chaffing dry fodder. Whereas chaffing dry fodder with salt sprinkling was practiced by 35.56 per cent of farmers which benefited 37.86 per cent of total cows. The

I. M.Sc. Student, 2. Senior Res. Asstt., 3. Agril. Asstt., SAO, Akola, 4. Assistant Prof. and 5. Professor, Department of AH & Dairying, Dr. PDKV, Akola

Table 1: Mode of feeding adopted by crossbred cattle owners

S.N.	Mode of Feeding	No. of Farmer (n=135)	NoofCows(n=346)
1.	Type of ration		
	Roughage + Concentrates	102(75.56)	217(62.72)
	Roughages	33 (24.44)	129 (37.28)
2.	Type of dry fodder		
	Kadbi	42(31.11)	86 (24.86)
	Kadbi + wheat, straw etc	93 (68.89)	260(75.14)
3.	Type of green fodder		
	Green grass	135(100.00)	346 (100.00)
4.	Type of feeding practices		
	Stall feeding	36 (26.67)	89 (25.72)
	Grazing + Stall feeding	99 (73.33)	257 (74.28)
5.	Processing of dry fodder		
	Chaffing	87 (64.44)	215 (62.13)
	Chaffing with salt sprinkling	48 (35.56)	131 (37.86)
6.	Processing of concentrates		
	without soaking	52 (38.52)	103 (29.77)
	Soaking	83(61.48)	243 (70.23)
7.	Feeding of additives		
	Supplement Common salt	108 (80.00)	283(81.79)
	No supplement	12 (8.89)	27(7.81)
	Supplement	15(11.11)	36(10.40)

Figures in parentheses indicating percentage to the total

practice of soaking concentrates was followed by 61.48 per cent of farmers, while 38.52 per cent of farmers fed concentrates without soaking. Handa and Gill (1986) observed majority of farmers of Buldhana district adopted a practice of soaking cone + roughage mixture before feeding to animal. The practice of common salt and supplements was practiced to the extent of 80.00 per cent and 11.11 per cent of farmers covering 81.79 per cent and 10.40 respectively. These results are in agreement with Gohain and Konwar (1994) who observed the use of common salt in the diet of livestock by 55 per cent of farmers in Kamrup district of Assam.

Majority of farmer used roughages and concentrates (75.56) for 62.72 per cent of crossbred cows, followed by dry fodder, *Jawar kadbi* was fed by 31.11 per cent of farmers to 24.86 per cent of cows. Chaffing dry fodder with salt sprinkling was practiced by 35.56 per cent of farmers which benefited 37.86 per cent of total cows.

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Efficacy of Herbal Preparation in Subclinical Mastitis with Reference to Immunological Study

S. P. Waghmare[1], S.G.R. Daimi[2] and S.G. Mode[3]

ABSTRACT

The efficacy of herbal preparation was evaluated in subclinical mastitic cows in terms of its effect on immunological parameters. Subclinical mastitic cows were treated with aqueous extract of *Azadirachta indica* (neem) bark @ 250 ml orally bid along with the local application of paste of *A. indica* (leaves powder) and *Curcuma longa* (rhizome) on udder bid daily for 15 days. The treatment with herbal drugs recorded 30 per cent recovery rate and initiated improvement in restoring TLC, neutrophil percentage, lymphocyte percentage, phagocytic activity, milk and serum immunloglobulins and SCC. However, it did not restore the altered parameters to normalcy except milk immunoglobulin within 15 days of treatment.

Subclinical mastitis is the most important disease of dairy animals as it is responsible for heavy economic losses to the farmers and dairy industry. To tackle the problem of bacterial resistance and antibiotic residues in milk, the herbal medicinal plants need to be evaluated as an alternative approach in management of mastitis. In the present investigation, therapeutic efficacy of *A. indica* (bark and leaves) and *Curcuma longa* (rhizome) was evaluated on subclinical mastitis in cows on the basis of restoration of altered immunological parameters.

MATERIAL AND METHODS

Crossbred lactating cows (12) in mid-lactation, found positive for subclinical mastitis (SCM) by Modified California Mastitis Test (MCMT), were selected and randomly divided into 2 equal groups containing 6 animals each and one group of 6 apparently healthy cows free from SCM was kept as normal healthy control (T_1) for comparison. Out of two groups positive for SCM, one was kept untreated (T_2) and 20 affected quarters of group T_3 was treated with aqueous extract of *A. indica* (neem) bark orally @ 250 ml bid daily for 15 days along with topical application of aqueous paste prepared from equal quantity of dried neem leaves powder and *Curcuma longa* rhizome powder on the udder bid daily for 15 days.

The milk and blood samples were collected on day 0, 3, 7, 10 and 15 post treatment for estimation of somatic cell count (Schalm *et al.*, 1971) in milk total leukocyte count (TLC), neutrophil percentage, lymphocyte percentage (Sastry, 1989) and phagocytic activity (Malik, 2003) in blood and immunoglobulines (Pfeiffer *et al.*, 1977) in milk and serum. The data were analyzed statistically by factorial completely randomized design (FCRD) as per Snedcor and Cochran (1989).

RESULTS AND DISCUSSION

Out of 20 affected SCM quarters only 6 (30%) quarters recovered. Study of leukocytic changes revealed leukopenia, neutropenia and lymphocytosis in the SCM. After treatment with herbal preparation, TLC and neutrophil percentage increased ($7.42 \pm 0.21 \times 10^3$/cmm and 32 ± 1.37 per cent, respectively) significantly over corresponding pretreatment values, ($6.56 \pm 0.21 \times 10^3$/cmm and 26.5 ± 1.48%, respectively) whereas, lymphocyte percentage decreased significantly from 66.67 ± 1.28% to 61.67 ± 1.17 per cent after 15 day post treatment. However, the treatment did not restore leucocytic changes to normal within 15 days of treatment. The somatic cell count (SCC) in milk of subclinical mastitic cows was found significantly elevated ($7.95 \pm 0.78 \times 10^5$ cells/ml) as compared to normal healthy ($3.04 \pm 0.06 \times 10^5$ cells/ml) cows (Shlke *et al.*, 1998). The herbal preparations restored SCC to normal within 15 days of treatment.

The phagocytic activity in all subclinical mastitic cows was found significantly decreased (35.33 ± 1.58%) as compared to normal healthy group

1 & 3 Associate Professor, 2 M.V.Sc. Student, Department of Veterinary Medicine, PGIVAS, Akola

Table 1 : Immunological parameters in normal and subclinical mastitic cows before treatment ('0' day) and 3rd, 7th, 10th and 15th day post treatment

Group	Period	TLC (....x10³/ cumm)	Neutrophil (%)	Lymphocyte (%)	Phagocytic activity (%)	Milk immunogl -obulin (mg/ml)	Serum immunogl -obulin (mg/ml)	Somatic cell count (.... x10⁵ cells/ml)
Normal	0	9.53^{a}	37.17^{a}	56.17^{a}	45.17^{a}	6.57^{a}	25.82	2.96^{a}
healthy		±0.4	±2.44	±2.36	±1.25	±0.27	±1.34	±0.15
control(T_1)	3	9.42^{a}	39.33^{a}	54.50^{a}	45.67^{a}	6.5^{a}	25.82	3.08^{a}
		±0.33	±2.16	±2.05	±0.71	±0.21	±1.29	±0.22
	7	9.59^{a}	38.83^{a}	54.50^{a}	44.5^{a}	6.39^{a}	25.57	2.95^{a}
		±0.36	±2.4	±2.59	±0.67	±0.17	±0.44	±0.17
	10	9.73^{a}	40.5^{a}	53.33^{a}	45^{a}	6.43^{a}	27.03	2.94^{a}
		±0.37	±1.8	±1.63	±1.18	±0.21	±0.98	±0.10
	15	9.74^{a}	40.17^{a}	53.33^{a}	45.83^{a}	6.53^{a}	26.03	3.25^{a}
		±0.24	±1.62	±1.69	±1.45	±0.16	±0.72	±0.15
Untreated	0	6.91^{a}	28.33^{c}	64.83^{a}	34.67^{b}	10.03^{a}	30.8	5.71^{a}
control(T_2)		±0.27	±1.05	±1.05	±1.43	±0.88	±1.03	±0.51
	3	6.78^{a}	26^{bc}	67.17^{ab}	32.83^{ab}	10.37^{a}	31.5	6.04^{a}
		±0.25	±0.93	±0.75	±1.3	±0.88	±1.22	±0.56
	7	6.54^{a}	23.83^{ab}	70^{bc}	31.17^{a}	11.64^{ab}	32.23	8.35^{b}
		±0.2	±0.83	±0.97	±0.98	±0.94	±1.31	±0.93
	10	6.28^{a}	21^{a}	73^{c}	30.17^{a}	13.69^{bc}	32.68	11.12^{c}
		±0.18	±0.52	±0.52	±1.14	±0.92	±1.33	±0.9
	15	6.3^{a}	19.67^{a}	74.33^{c}	29.83^{a}	15.11^{c}	33.6	14^{d}
		±0.17	±0.56	±0.49	±1.17	±0.98	±1.34	±0.54
Herbal	0	6.56^{a}	26.5^{a}	66.67^{b}	35.33^{a}	11.59^{b}	31.27	7.95^{c}
treatment(T_3)		±0.21	±1.48	±1.28	±1.58	±1.05	±1.11	±0.78
	3	6.88^{ab}	27.33^{a}	66^{ab}	36.5^{ab}	10.96^{b}	30.87	7^{bc}
		±0.2	±1.41	±1.48	±1.34	±1.02	±1.04	±0.69
	7	7.42^{bc}	29.0^{ab}	64.5^{ab}	37.33^{ab}	9.75^{ab}	30.23	6.34^{abc}
		±0.21	±1.48	±1.31	±0.95	±0.8	±1.08	±0.65
	10	7.8^{cd}	30.33^{ab}	62.83^{ab}	38.67^{b}	8.67^{a}	29.77	5.38^{ab}
		±0.16	±1.41	±1.14	±1.15	±0.66	±1.03	±0.62
	15	8.28^{d}	32^{b}	61.67^{a}	39.5^{b}	8.01^{a}	29.12	4.68^{a}
		±0.14	±1.37	±1.17	±1.2	±0.65	±1.06	±0.52

Similar superscript indicates non-significant difference

(45.17 ± 1.25%). After treatment with herbal preparation phagocytic activity increased significantly (38.67 ± 1.15%) on 10th day post treatment over pretreatment value (35.33 ± 1.58%), though did not restore to normalcy within 15 days of treatment (Table 1).

Milk (11.59 ± 1.05 mg/ml) and serum (31.27 ± 1.11 mg/ml) immunoglobulins in SCM were found increased significantly as compared to normal (6.48 ± 0.03 mg/ml and 26.05 ± 0.25 mg/ml) cows (Caffin *et al.*, 1983). After treatment with herbal preparation serum immunoglobulin level decreased from 31.27 ± 1.11 mg/ml to 29.12 ± 1.06 mg/ml within 15 days of treatment whereas, milk immunoglobulin level restored to normal (8.01 ± 0.65 mg/ml) on day 15 post treatment. This improvement in altered immunoglobulin might be due to reversal of increased permeability of udder parenchayma due to antiinflammatory and immunomodulatory properties of *A. indica* and *C. longa* (Ahmed *et al.*, 1995).

From above investigation, it is concluded that the treatment with herbal drugs recorded 30 per cent recovery rate by MCMT and initiated improvement in the altered values of TLC, neutrophils percent, lymphocyte per cent, phagocytic activity, milk and serum immunglobulins and SCC but did not restore them to normalcy except milk immunoglobulin within 15 days of treatment. It indicated partial efficacy of herbal drugs (*A. indica* and *C. longa*) in restoring immunological parameters in SCM in cows.

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Research Notes

Induction of Mutations for Improving Quantitative Characters in Groundnut

Mutagenic treatment results in genetic changes leading to altered character expression. The direct effects of mutagenic treatments in M_2 generation are readily observable. Induced mutation could, therefore, be used as a valuable tool in breaking the linkage of undesirable traits with useful productive traits.

The main objective behind the use of mutagenesis is to increase in the magnitude and spectrum of genetic variation and appearance of novel mutants of positive values in the population. Keeping these points in view, groundnut genotype AK-265 was treated with gamma rays and EMS alone and in combination, to asses their potentialities to induce genetic variability and also to identify the potent mutagens which could cause genetic variability in desirable direction.

The present research field trials were conducted at Oilseed Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (MS), during *Kharif* 2004 and *Rabi* 2004-05. The dry, healthy and genetically pure groundnut seeds of genotype AK-265 were obtained from the Senior Research Scientist, Oilseed Research Unit, Dr. PDKV, Akola. Hundred gram seeds of AK-265 for each treatment were used for physical and chemical mutagenic treatments. For physical treatment the seeds were irradiated by gamma rays (^{60}CO) with the doses of 30 kR, 40 kR and 50 kR at Bhabha Atomic Research Centre (BARC), Trombay, Mumbai. For chemical treatment the seeds were pre-soaked in distilled water for a period of 6 hrs. These pre-soaked seeds were kept immersed separately in 40 mM and 60 mM aqueous solutions of EMS for about 12 h. For combination treatments of EMS and gamma rays, the 20 kR gamma rays treated seeds were immersed in 20 mM aqueous solution of EMS for 12 h after pre-soaking in water for 6 h. Thorough washing of treated seeds under running tap water was followed after the mutagenic. Hundred gram seeds soaked in distilled waster for 6 hrs were used as control.

The seeds along with a control were hand dibbled immediately after treatment in rainy season of 2004 to raise M_1 generation. The spacing of 30 cm x 15 cm was maintained between and within the rows, respectively. The M_1 population was studied for recording observations from time to time, harvested single plants carried to M_2 generation. During post rainy season of 2004, all the harvested seeds from each treatment were sown to raise M_2 population. The sowing was done in non replicated trial. The plot was on the basis of plant to row progenies with spacing 30 cm x 15 cm. In M_2 generation, variability induced to treated population for five quantitative characters *viz.*, height of main axis (cm), number of primary branches plant^{-1}, number of secondary branches plant^{-1}, number of matured pods plant^{-1}, pod yield plant^{-1} (g) and shelling per cent were studied. Observations were recorded for different characters on randomly selected 30 plants from each treatment. In the present experiment, the highest mean value for height of main axis was recorded in the treatment 40 kR gamma rays (12.03 cm). The lowest (10.23 cm) mean value amongst the treated population was recorded in treatment EMS 60 mM (Table 1). The combined treatment of 20 kR gamma rays and 20 mM EMS affected the plant height more than gamma rays alone except in 40 kR. The reduction of plant height due to mutagenesis in M_2 may be mainly due to disturbances or inhibition of physiological activities of plants. The similar results were also recorded by Kumar *et al.* (1997) in groundnut. The treated population in general registered significant increase in mean number of secondary branches plant^{-1}. Amongst the treatments higher variation for number of primary branches plant^{-1} was noticed in 40 kR gamma rays. The mean values for this character were increased in 40 mM EMS, 20 kR + 20 mM, 30 kR gamma rays and 50 kR gamma rays treated populations as compared to that of control. For number of secondary branches it was found increased in 40 mM EMS and 20 kR + 20 mM combination treatment. Sah and Shrivastava (1991) and Kumar *et. al.*, (1997) also reported the similar findings in groundnut. The mean values for number of matured pods plant^{-1} were found decreased in all the treatments as compared to control (Table 1). The variation was more pronounced in lower doses of gamma rays and higher dose of EMS (60 mM). Similar

Table 1. Effect of mutagenic treatments on five quantitative characters of groundnut genotype AK-265

S. N.	Treatments	Height of main axis (cm)		Number of branches plant^{-1}				Number of matured pods plant^{-1}		Pod yield plant^{-1} (g)		Shelling per cent	
				Primary		Secondary							
		M	V	M	V	M	V	M	V	M	V	M	V
1.	Control	11.83	5.24	5.87	1.71	9.40	14.94	14.60	39.63	11.84	17.59	59.66	172.66
2.	40 mM EMS	11.37	2.66	6.07	1.72	11.20*	9.13	13.07	10.89	10.50	10.16	64.66	70.22
3.	60 mM EMS	10.23**	2.59	5.60	0.94	7.07*	11.10	8.03**	16.65	6.91**	13.82	67.94**	95.06
4.	20 kR + 20 mM	11.70	5.38	6.37	2.03	10.50	6.95	12.77	12.05	12.56	9.79	68.98**	26.73
5.	30 kR Gamma rays	10.97	4.71	6.37	1.96	8.37	15.48	9.77**	12.39	9.70*	17.54	69.82**	43.56
6.	40 kR Gamma rays	12.03	7.56	5.43	2.19	6.37**	4.31	6.97**	15.21	5.67	13.06	68.35**	97.81
7.	50 kR Gamma rays	11.07	4.75	5.93	2.00	8.77	8.25	8.30**	8.56	7.06**	12.72	61.25	210.54

M = Mean, V = Variance, EMS = Ethylmethane sulphonate, kR = Dose of radiation in kilo Roentgen, mM = Dose of chemical in mili Mole

* Significant at t(tab) 5% (∞) = 1.960 **Significant at t(tab) 1% (∞) = 2.576

trend has been reported by Patil (1972) and Sah and Shrivastava (1991) in pea. In the treated population, the character dry pod yield was found to be affected in one or the other way by mutagenesis. The mean value was lower in most of the treatments but the combination of 20 kR gamma rays + 20 mM EMS was found to be effective in increasing mean pod yield over control. The higher variability amongst the treatments for dry pod yield was recorded in gamma rays 30 kR, followed by EMS 60 mM. In groundnut, due to mutagenesis decrease in pod yield has been reported by Gregory (1968) while, increase in pod yield was reported by Pathirana *et al.* (1986) and Kumar *et al.* (1997).

The mean values for the shelling per cent was found significantly increased in treated population as compared to control. It was found highest in 30 kR gamma rays treatment (69.82%) followed by combination of 20 kR gamma rays + 20 mM EMS (68.98%). Amongst the treatments, gamma rays (50 kR) was more effective in creating higher variability in the character shelling per cent. Similar trend has been reported by Patil (1972) in groundnut.

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Department of Agril. Botany
Dr. PDKV, Akola

N.G. Sonone
S.N. Deshmukh
S.P. Patil
A.C. Khote

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Soil Moisture, Moisture Use Efficiency and Productivity of Soybean as Influenced by Land Treatments on Inceptisol

Soil and water are our most precious natural resources and maintaining the soil in state of high productivity on sustainable basis is important for meeting growing food demand of our growing population. But the situation is not encouraging due to increasing industrialization and urbanization, which has resulted into decrease in the area of fertile land for crop production. The productivity per unit area is also declining due to low inputs, poor management and unawareness amongst farmers regarding basic soil resources.

Limiting soil moisture is a prime constraint in increasing crop production and soil act as storehouse for the moisture. The conservation of moisture by contour farming in watershed area is one of the important approaches. Contour cultivation along various vegetative barriers in a watershed area is useful for increasing available soil moisture storage and moisture use efficiency.

The non replicated field experiment was carried out in the Watershed Management Research Unit, Agro-ecology and Environment Centre, Dr. PDKV, Akola with three land treatments viz., T_1- Sowing along main slope, T_2- Sowing along the graded bund at 1m VI (Vertical Interval) and T_3- Contour cultivation along the vetiver hedge at 1m VI. The soil site selected for this trial had established vetiver hedgerows and the graded bunds.

Soil samples for soil moisture study were collected using screw auger from 0-15 cm and 15-30 cm depth from lower side (LS) and upper side

(US) of field slope at three different growth stages of soybean from initial stage to harvest of crop. Soil sampling was followed from fixed site and the soil moisture percentage was determined gravimetrically as described by Piper (1966).

Soil moisture was calculated as follows.

$$\text{Soil moisture (mm) in 0-15 cm layer depth} = \frac{\text{\% moisture gravimetric} \times \text{Bulk density} \times \text{Soil depth (mm)}}{100}$$

Soil moisture to 30 cm depth at subsequent sampling during the first period was considered as initial soil moisture for second period and likewise the moisture was determined as per soil water depletion method.

Moisture use by soybean crop during a period was calculated as follows.

$$\text{Moisture use (mm) during a period} = \text{Soil moisture (mm) to 30 cm depth at initial sampling} + \text{Rainfall during a period (mm)} - \text{Soil moisture (mm) to 30 cm depth at subsequent sampling} - \text{Runoff (mm)} + \text{Soil water flux beyond root zone (mm)}$$

$$\text{Total moisture use (mm)} = \sum_{i=1}^{n} \text{Moisture use during different periods}$$

Moisture use efficiency for each treatment was calculated on the basis of economic yield of the crop and total moisture use by that crop (Michael and Ojha, 1983).

$$\text{MUE (kg ha}^{-1}\text{mm}^{-1}) = \text{Crop yield (kg ha}^{-1}) / \text{Total moisture use (mm)}$$

$$\text{Productivity rating index (PRI)} = (\text{Actual yield} / \text{Standard yield}) \times 100$$

Harvest index (HI) = (Economic yield/ Biological yield) x 100

Total moisture use and moisture use efficiency of soybean

Data pertaining to the total moisture use and moisture use efficiency during different periods of growing season of soybean are presented in Table 1.

In soybean, total moisture use varied from 292.74 to 342.44 mm in treatment T_1 and T_3 respectively. Total moisture use was found highest in treatment of sowing along the vetiver hedge (T_3) because there was more water conservation due to vetiver hedge. Similar findings were also recorded by Gabhane *et al.* (2000).

The data on moisture use efficiency varied from 4.52 to 5.23 kg/ha/mm in treatment T_1 and T_3 respectively. Highest moisture use efficiency was found in treatment of sowing along the vetiver hedge (T_3). Similar observation was also recorded by Bharad *et al.* (1992).

Effect of Contour Cultivation on Yield, PRI and HI of Soybean

The data in relation to yield, productivity rating index and harvest index of soybean as influenced by various land treatments are presented in Table 2.

Table 1. Moisture use pattern and efficiency of soybean

Treatments	Flowering	Pod development	At harvest	Total moisture use (mm)	Moisture use efficiency (kg/ha/mm)
T_1(LS)	130.73	132.4	29.61	292.74	4.94
T_1(US)	153.38	130.0	36.52	319.9	4.52
T_2(LS)	158.72	112.22	34.94	303.88	4.93
T_2(US)	131.62	126.62	48.04	306.28	4.89
T_3(LS)	156.03	116.45	33.87	306.35	5.23
T_3(US)	170.69	96.83	74.92	342.44	4.68

Table 2. Yield (q ha^{-1}) Productivity rating index and harvest index of soybean

Treatment	Yield (q ha^{-1})		Productivity rating	Harvest index
	Grain / seed	Straw /fodder	index (PRI)	(HI) (%)
T_1	14.49	14.88	57.96	49.33
T_2	14.99	15.41	59.96	49.30
T_3	16.03	16.27	64.12	49.62

Results indicate that the highest grain yield was recorded in contour cultivation along vetiver barrier (16.03 q ha^{-1}) and minimum grain yield was recorded in treatment (T_1) sowing along the slope (14.49 q ha^{-1}). Highest straw yield was recorded in contour cultivation along vetiver barrier (16.27 q ha^{-1}) and minimum straw yield was recorded in treatment (T_1) sowing along the slope (14.88 q ha^{-1}). The increase in grain and straw yield under land treatment sowing along the graded bund (T_2) was 3.45 and 3.56 per cent and in contour cultivation along Vetiver barrier (T_3) was 10.63 and 9.34 per cent respectively over sowing along the main slope (T_1).

Thus contour cultivation along with vegetative hedgerows are one of the yield contributing factors which may help in uniform distribution of rain water in the soil solum leading to uniform recharge of soil moisture in effective rooting depth of crops. Moreover, vegetative hedgerows act as barriers. The beneficial effects due to these combinations might be attributed to reduction in nutrient losses and enhancement in availability of nutrients.

The productivity rating indices of soybean ranged from 57.96 (T1) to 64.12 (T3) , indicating that the highest value of productivity rating index (64.12) was recorded under treatment of sowing along the vetiver hedge as compared to other treatments.

Data related to harvest indices (HI) of soybean presented in Table 2 indicate that the highest harvest index (49.62) was observed in treatment of contour sowing along the vetiver hedges (T_3). Hence, it can be stated that the contour cultivation along the vetiver hedges enhanced the grain yield and moisture use efficiency of soybean.

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Department of Soil Science and Agricultural Chemistry, Dr.PDKV , Akola.

V.V. Gabhane
Shraddha Wable
N.S. Chore
S.M. Taley

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Identification of Kabuli-Chickpea Lines Against *Fusarium cicieri* and *Helicoverpa armigera*

Chickpea (*Cicer arietinum* L.) is one of the most important grain legumes of the world, which being grown in 44 countries across five continents. Many serious diseases and pests that have the potential to destroy the crop have been reported.

In Maharashtra, chickpea occupied 13.08 lakh ha. area with production of 9.24 lakh tones having average productivity of 706 kg ha^{-1} (Anonymous 2007[a]).

Fusarium wilt, in chickpea caused by *Fusarium oxysporum f. sp. ciceri* Mutuo and Sato (Foc) is considered to be a major constraint to chickpea production throughout the world and particularly in Indian Subcontinent and the Mediterranean basin. Most of the existing varieties are susceptible to *Fusarium* wilt, dry root rot, *Ascochyata* blight and pod borer (*Helicoverpa armigera*), which are the major bottlenecks in increasing production potential of chickpea (Singh *et al.*, 1994).

In *kabuli* types, limited information on their broad based resistance against *Fusarium* wilt and *Helicoverpa armigera* has hampered the development of stable, resistant cultivars (Kaul *et al.*, 2007). Furthermore, because of narrow genetic base, varietal deterioration / degeneration over the years, too, contributed towards their susceptibility to *Fusarium* wilt causing losses upto 100 per cent in wilt disease (Harware *et al.*, 1986) and also *H.armigera* is a key pest of chickpea.

In Maharashtra, Puri *et al.*, (1998) reported 60-80 per cent crop losses due to pod borer from vegetative to podding stage in chickpea, Lateef (1992) also noticed the damage upto 84.40 per cent with an average of 7.00 per cent in different farming systems.

In recent times, *Kabuli* varieties have gained considerable market preference in India and elsewhere on account of their large seed size and acceptance. Hence the major objective in *Kabuli* breeding entails to screen for resistance to wilt and pod borer and identify stable sources. Thus, the use of resistant varieties is an ideal component of diseases and pests management.

Thirteen *Kabuli* advance breeding lines and two commercial varieties *viz.*, Virat and Vihar were screened in wilt sick plot with susceptible variety JG-62, as a susceptible check and were sown after every two test entries to ensure high disease pressure. Each breeding line has row length of 4 m and 30 cm apart with plant to plant spacing of 10 cm and recommended package of practices except plant protection measures. The observations on number of plants wilted in each breeding line were recorded at 30, 45, 60, 75 and 90 days after sowing and thereafter mean per cent wilt incidence was calculated as per the scale (Mayee and Datar, 1985).

The same lines were screened against gram pod borer. The chickpea varieties *viz.*, Virat and Vihar was used as resistant checks and the observations on pod damage were recorded on five random plants at maturity by counting the total number of healthy and damaged pods. Per cent pod damage was calculated and the percentages were further converted into percentage pest susceptibility rating (1-9 scale) as suggested by Lateef and Reed (1983).

Wilt:

The genotype , JG-62 was completely wilted thereby indicating high and uniform level of sickness in the field. All the 15 genotypes showed varying per cent of mortality (Table -1) ranging from 2.47 per cent on Phule G-03404 to 100.00 per cent on JG-62. From the wilt reaction, it was observed that the genotypes *viz.*, Virat, Vihar, Phule G-95333 and PG-03404 were resistant (<10%) while Phule G-9926-40-3 was moderately resistant (10-20%) to *Fusarium* wilt and remaining lines exhibited susceptible reaction to wilt pathogen.

Gaur *et al.*, (2006) reported sources of resistance in *Kabuli* chickpea for *ciceri* pathogen. Similiarly Chaudhry *et al.*, (2007) noticed the resistance source in chickpea germplams against *fusarium* wilt pathogen.

Pod damage:

The mean pod damage due to *Helicoverpa armigera* among the test genotypes was ranged from 6.38 per cent in *Phule* G-9926-40-3 to 13.55 per cent in *Phule* G-9924-83-4. From the pest susceptibility rating (PSR), it was noticed that the genotypes *viz*., *Phule* G-95333, *Phule* G- 9926-40-1, *Phule* G- 992640-40-3 and *Phule* G- 9939-9-2 were most promising against *H. armigera* had PSR value 4. While Phule G - 9925-19-3 and *Phule* G-9933-26-3 had PSR of 5 and found to be less susceptible than check Virat, while rests of the genotypes had PSR above 6 are more susceptible (Table 1).

Similar results revealed in All India Co-ordinated Research Project on Chickpea (Anonymous 2007[b]), the pod borer damage was less in L-550 (4.35 %) and highest damage was recorded in KAK-2 (8.69 %) in kabuli type chickpea screened at Junaged, while the pod damage was varied from 22.17 to 31.00 per cent in GLK-24107 and GLK-23028, respectively at Ludhiana.

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Pulses Improvement Project
MPKV, Rahuri

G. P. Deshmukh
S.K. Patil

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Efficacy of Fungicides and Bioagents Against *Colletotriclum Gloeosporioides* Causing Blight of *Piper betle*

A severe incidence of blight *(Colleto-trichum gloeosporioides)* was noticed on betel vine at Akot and Anjangaon area during August to December, 2007. Nine fungicides and three bioagents were tested *in vitro* revealed that mancozeb + carbendazim (0.2%) and propiconazole (0.1%) was most effective as they completely inhibited the growth of C. *gloeosporioides*. Among the bioagents, *Trichoderma viride* was observed most effective antagonist against *C. gloeosporioides*.

A number of diseases have been reported from betel vine growing areas of India but blight is one of the most serious diseases and under favorable weather conditions the disease may cause 25-90 per cent loss in consumable leaves (Maiti and Sen, 1982). Lacking appropriate management strategies, these

diseases continue to pose a serious threat to betel vine cultivation. Several workers have worked on the efficacy of different fungicides and bioagents against blight *(Colletotrichum gloeosporioides* Penz.). At present chemical fungicides such as mancozeb + carbendazim (0.2%) and propiconazole (0.1%) and bioagents like *Trichoderma viride* are used to combat the disease.

Efficacy of chemicals by poisoned food technique and bio-agents by dual culture technique.

Poisoned food technique was used to evaluate fungicides *in vitro* against *Colletotrichum gloeosporioides*. The inoculated plates were incubated at room temperature for five days. The colony diameter of the fungal pathogen on medium was recorded and per cent inhibition in each treatment was calculated by using Vincent following formula.

The six mm diameter discs of *Trichoderma viride* and *T. harzianum* were cut from peripheral growth of the plate using sterilized cork borer under aseptic condition and put three discs at equidistance from centre on the Petri plate of solidified medium and disc of pathogen separately were kept at the centre. Control plates, containing only pathogen were also maintained. The treatments were replicated thrice. The radial mycelial growth of pathogen was measured on fifth day and inhibition per cent was calculated.

Antagonistic properties of *Pseudomonas fluorescens* was tested against fungal pathogen on PDA using a dual culture technique. A loopful of 24 hours old culture of bacterial strain was inoculated at 2 cm just opposite to the pathogen on each plate. The plates were incubated at 27 ± 2°C for 5 days and per cent growth inhibition was calculated.

In vitro study showed that propiconazole (0.1%) and mancozeb + carbendazim (0.2%) was significantly superior over all other treatments in inhibiting the pathogen. It is found that, these two chemicals completely inhibited the growth of pathogen (Table 1). Nandoskar (2001) and Patel and Joshi (2002) also reported that propiconazole totally inhibited the mycelial growth of *C. gloeosporioides* in leaf spot of turmeric and anthracnose of *Piper betle* these finding are uniformity with this results.

In dual culture technique different bioagents viz, *T. viride, T. harzianium* and *Pseudomonas fluorescens* were tested against *Colletotrichum gloeosporioides. Trichoderma viride* could significantly reduced the mycelial growth (66.29%) of *Colletotrichum gloeosporioides* and was followed by *Trichoderma harzianum* (58.06%). The least inhibition (15.01%) was found due to *Pseudomonas fluorescens (* Table 2).

The maximum per cent inhibition of *C. gloeosporioides* was achieved due to *T. viride* (89.66) as earlier observed by Haralpatil (2005) for anthracnose *of Piper betle.*

Table 1. Efficacy of different fungicides against *Colletotrichum gloeosporioides* (poisoned food technique) *in vitro*

Tr. No.	Treatments	Cone. (%)	Radial mycelial growth (mm)*	Per cent growth inhibition
T_1	Mancozeb	0.25	57.11	35.83
T_2	Chlorothalonil	0.1	46.58	47.69
T_3	Copper oxychloride	0.3	56.44	36.58
T_4	Carbendazim	0.1	25.40	71.46
T_5	Propiconazole	0.1	0	100
T_6	Tridemorph	0.1	20.77	76.66
T_7	Mancozeb + Carbendazim	0.2	0	100
T_8	Mancozeb + Tricyclozole	0.2	12.99	85.40
T_9	Zineb + Hexaconazole	0.2	20.81	76.61
T_{10}	Control	-	89	-
	CD (P=0.01)	-	9.10	-

*Mean of three replication

Table 2. Efficacy of different bioagents against *Colletotrichum gloeosporioides* (Dual culture technique) *in vitro*

Tr.No.	Treatment	Radial mycelial growth (mm)*	Per cent growth inhibition
T_1	*Trichoderma viride*	16.84	66.29
T_2	*Trichoderma harzianum*	20.95	58.06
T_3	*Pseudomonas fluorescens*	42.47	15.01
T_4	Control	49.99	-
	CD (P=0.01)	2.10	-

*Mean of three replication

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Section of Plant Pathology
College of Agriculture, Akola

C.U. Patil
S.B. Bramhankar

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Influence of Neonicotinoids on Bollworm Incidence in Rainfed Cotton

Cotton crop suffers from heavy attack of sucking pests and bollworms and often cause heavy yield losses, if the plant protection measures are not undertaken at proper time. Sucking pests like, aphids *(Aphis gossypii* Glover), jassids *(Amrasca biguttula biguttula* Ishida) and thrips *(Scirtothrips dorsalis* Hood) are the major serious pests at initial stage of crop and limiting the cotton production in India (Mote *et al.*, 1995).

Now a days a new generation chemicals from nitroguanidine group are available in the market which proved effective against early season sucking pests of cotton (Dandale *et al.*, 2001). These chemical insecticides are more effective at lower doses than conventional insecticides *viz.,* methyl demeton 25 EC and dimethoate 30 EC (Saini and Rohilla, 2003).

Repeated use of imidacloprid (Confidor 200 SL) and methyl demeton 25 EC against early season sucking pests resulted in increase in *H. armigera* oviposition and larval damage on cotton (Vennila *et al.*, 2000). Hence, in order to have specific knowledge about their after effects on early incidence of bollworm at their varying doses, present investigation was undertaken.

A field experiment was conducted at Cotton Research Unit, Dr. PDKV, Akola during *Kharif* 2004-05 in RBD with three replications and twelve treatments. A variety LRA 5166 was dibbled on

8.7.2004 at 60 X 60 cm spacing with gross and net plot size of 6.00 X 4.80 and 4.80 X 3.60 meters, respectively. The recommended package of practices was followed to raise the crop, except plant protection measures. The first insecticidal treatment spray was started at 15 days after germination (DAG) and repeated twice at 10 days interval for control of sucking pests and to study their further effects on bollworm incidence and damage, if any.

The observations on eggs and larval count and damage in green fruiting bodies (GFB) due to *Helicoverpa armigera* and *Earias vitella* were recorded separately on whole plant by randomly selecting five plants form each net plot at fortnightly interval. The data on boll worm incidence and damage recorded from 35 to 125 DAG were consolidated and cumulative means were calculated. The yield of seed cotton was also recorded.

Effects of various insecticidal treatments on bollworm incidence, their damage and seed cotton yield were statistically non significant (Table 1).

H. armigera egg (0.68 to 1.21 plant^{-1}) and larval count (0.03 to 0.20 plant^{-1}) was higher in all the treated plots than untreated plot. Such count in

Table 1: Average eggs, larvae and damage in green fruiting bodies and seed cotton yield in various insecticidal treatments.

TrNo	Treatments	Cone (%)	*H. armigera* plant^{-1}		Damage by *H. armigera* (%)	*E. vitella* plant^{-1}		Damage by *E. vitella* (%)	Seed Cotton Yield (Kg ha^{-1})
			Eggs	Larvae		Eggs	Larvae		
T_1	Imidacloprid 17.8 SL	0.004	1.11 (1.04)	0.13 (0.79)	6.59 (2.59)	0.08 (0.76)*	0.01 (0.71)*	1.20 (1.30)*	173.29
T_2	Imidacloprid 17.8 SL	0.006	0.84 (0.91)	0.15 (0.80)	6.56 (2.61)	0.03 (0.72)	0.05 (0.74)	0.98 (1.21)	167.50
T_3	Imidacloprid 17.8SL	0.008	1.21 (1.10)	0.17 (0.81)	7.52 (2.83)	0.02 (0.72)	0.08 (0.76)	1.78 (1.50)	169.10
T_4	Imidacloprid 17.8 SL	0.01	1.17 (1.08)	0.15 (0.80)	8.27 (2.96)	0.03 (0.72)	0.01 (0-71)	1.95 (1.56)	152.71
T_5	Acetamiprid 20 SP	0.003	0.96 (0.97)	0.07 (0.75)	4.83 (2.83)	0.02 (0.72)	0.02 (0.72)	1.09 (1.26)	136.64
T_6	Acetamiprid 20 SP	0.006	1.08 (1.02)	0.12 (0.78)	4.67 (2.26)	0.03 (0.72)	0.00 (0.71)	1.44 (1.37)	213.15
T_7	Thiamethoxam 25 WG	0.005	0.93 (0.96)	0.15 (0.80)	4.98 (2.31)	0.00 (0.71)	0.00 (0.71)	1.45 (1.39)	168.14
T_8	Thiamethoxam 25 WG	0.01	0.95 (0.97)	0.20 (0.84)	6.31 (2.60)	0.00 (0.71)	0.06 (0.74)	2.12 (1.57)	171.36
T_9	Methyl demeton25 EC	0.02	0.68 (0.82)	0.08 (0.76)	5.29 (2.39)	0.02 (0.72)	0.00 (0-71)	1.38 (1.33)	141.46
T_{10}	Dimethoate 30 EC	0.03	0.64 (0.79)	0.03 (0.73)	5.39 (2.34)	0.00 (0.71)	0.02 (0.72)	1.94 (1.52)	138.24
T_{11}	Imidacloprid 70 WS Seed treatment	10 g/Kg	1.08 (1.03)	0.08 (0.76)	8.58 (2.99)	0.02 (0.72)	0.06 (0.74)	2.68 (1.77)	183.25
T_{12}	Control (untreated)	-	0.61 (0.78)	0.02 (0.72)	5.45 (2.33)	0.00 (0.71)	0.02 (0.71)	1.79 (1.48)	101.59
	F test		NS	NS	NS	NS	NS	NS	NS
	SE(m)±		0.08	0.03	0.23	0.01	0.01	0.18	21.74

* ( ) Square root of X + 0.5.

untreated plot was 0.61 and 0.02 plant^{-1}, respectively. The highest egg count (1.21 plant^{-1}) was noticed in higher dose (0.008 %) of imidacloprid and lowest (0.64 plant^{-1}) in dimethoate (0.03 %) Maximum larval count was recorded in thiamethoxam 0.01 per cent (0.20 plant^{-1}) and minimum in diamethoate 0.03 per cent (0.03 plant^{-1}).

E. vitella egg and larval count was higher in imidacloprid 0.006 and 0.008 per cent, and imidacloprid 10 g Kg^{-1} seed treatment than control. The Maximum egg and larval count was noted in imidacloprid 0.04 and 0.008 per cent, respectively. Dhaliwal *et. al.*, (2000) reported that insecticides belonging to pyrethroid and organophosphate group recorded higher number *of H. armigera* eggs as compared to control.

H. armigera and *E. vitella* damage was higher in imidacloprid 0.01 , thiomethoxam 0.01 per cent and imidacloprid 10 g Kg^{-1} seed treatment than the untreated control. Maximum *H. armigera* (8.58 %) and *E. vitella* damage (2.68 %) was recorded in imidacloprid 10 g Kg^{-1} seed treatment.

Vennilla *et al.*, (2000) found more number of *H. armigera* eggs and larval damage than control in imidacloprid 10 g Kg^{-1} seed treatment and two foliar sprays of each of imidacloprid 200 SL (@ 150 ml ha^{-1}) and oxy demeton methyl 25 EC (@ 750 ml ha^{-1}) used for control of early season sucking pests. Similarly, Domnik and Moharsunadaram (1992) also reported that repeatedly pesticide treated plant having higher total sugar and protein content resulted in increase in pest population on cotton. These findings support findings of present study.

Maximum seed cotton yield (213.15 Kg ha^{-1}) was obtained in crop sprayed with acetamiprid @ 0.006 per cent and was minimum (101.59 Kg ha^{-1}) in untreated control. These results conform the findings of the present study as Srinivasn *et.al.* (2004) reported highest seed cotton yield in acetamiprid @ 0.008 to 0.012 per cent (10 to 15 g a.i. ha^{-1}).

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Cotton Research Unit
Dr. PDKV, Akola

A.V. Kolhe
S.S. Nawod
B.R. Patil

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RESEARCH NOTES

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