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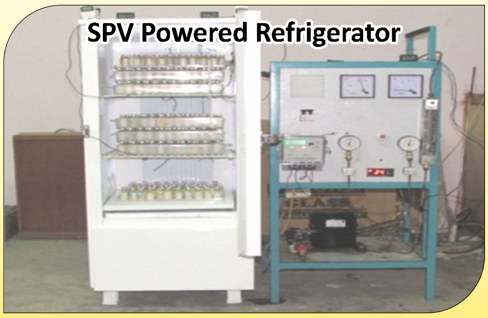

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SHORTS NOTES

Organic Farming in Greengram-Sesame Crop Rotation under North Gujarat Condition

C. K. Patel[1], N. I. Patel[2], R. N. Singh[3] and Foram Patel[4]

ABSTRACT

A field experiment was conducted at the All India Co ordinate Research Project for Dry land Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, District Banaskantha (North Gujarat) during *Kharif*seasons from 2007 to 2015 to study feasibility of organic farming in Greengram –Sesame crop rotation under rainfed condition of North Gujarat. The soil of experimental plot was loamy sand in texture, low in organic carbon and available nitrogen, medium in available phosphorous and high in available potash.The experiment was conducted with four treatments comprising of different sources of organic manures and chemical fertilizers. *i. e.* T_1: Control, T_2: 100 per cent RDF through chemical fertilizer T_3: RDN through Farm YardManure and T_4 :RDN through vermicompost and tested in Randomized Block Design with six replications. The same treatments were allotted to both the rotational crops. andtested in Randomized Block Design with six replications.The results revealed that application of 20 kg N ha^{-1} to green gram and 50 kg N ha^{-1} to seasamum either through vermicompost or FYM recorded the highest yield and net profit in green gram-seasamum crop rotation as well as improve the soil fertility.

Soil is an important natural resource that provides nutrition and quenches thirst of the plants/vegetation as per its physical, chemical and biological properties.

At present enough food grains (276 million tons) are produced for ensuring food security. Agro-chemicals were extensively used as soil nutrition, growth promoters and for controlling biotic and abiotic stresses. However, wrong crop husbandry and mentality of considering soil as dust bin to pour agro-chemicals indiscriminately for targeting higher yield has resulted in visible impact on the health of soil, environment and human. Bottomed up response of inputs, climate change, infirm soil health etc are the evident repercussions that have become global concern.

Organic crop production is expected to expand in response to increased demand for organic food. Organic crop production system can bring back the cultivation on sustainable basis without affecting environment. Organic crop production system involves organic manures, oilcakes, green manures, liquid manures, bio-fertilizers etc. agronomic practices, crop rotation, bio-pesticides etc., apart from encouraging natural parasites, predators and parasitoids in the ecosystem. The management of soil organic matter and the rational use of organic inputs such as animal manures, crop residues, green manures, sewage, sludge and food industry waste would be major constraint in sustainable agriculture in forthcoming decades.

Farm yard manure seems to act directly for increasing the crop yields either by acceleration of respiratory process with increasing cell permeability and hormonal growth action or by combination of all these processes. It supplies nitrogen, phosphorus, potassium and micronutrients like Fe, S, Mo, Zn, etc. in available form to the plants through biological decomposition and improves the physico-chemical properties of soil such as aggregation, aeration, permeability, water holding capacity, slow release of nutrients, increase in cation exchange capacity, stimulation of soil flora and fauna etc. On an average, it contains 0.50, 0.17 and 0.55 per cent of N, P and K, respectively (Gaur, 1991).

Vermicompost is an aerobically degraded organic matter which has undergone chemical disintegration by the enzymatic activity in the guts of worms and also enzymes of the associated microbial population. It contains 0.80 to 1.10 per cent N, 0.40 to 0.80 per cent P_2O_5 and 0.80 to 0.98 per cent K_2O, 10 to 52 ppm Cu, 186.60 ppm Zn, 930.00 ppm Fe and plant growth promoting substances such as NAA, cytokinins, gibberellins, etc. (Giraddi, 2001

All India Co-ordinated Research Project for Dryland Agriculture S. D. Agricultural University, Sardarkrushinagar -385506

and Giraddi *et al.*, 2006). It improves physico-chemical properties of the soil and enhances the microbial activity, crop growth and yield (Vasanthi and Kumaraswamy, 1999). The green gram-seasame crop rotation is predominant under dry farming areas of North Gujarat. Nutrient management plays vital role in improving soil fertility and yield potential of crops under organic farming .

MATERIAL AND METHODS

A field experiment was conducted at the All India Co-ordinated Research Project for Dryland Agriculture, SardarkrushinagarDantiwada Agricultural University, Sardarkrushinagar, District Banaskantha (North Gujarat) during kharif seasons from 2007 to 2015 to study feasibility of organic farming greengram –sesame crop rotation under rainfed condition of North Gujarat. The soil of experimental plot was loamy sand in texture, low in organic carbon and available nitrogen, medium in available phosphorous and high in available potash. The experiment was conducted with four treatments comprising of different sources of organic manures and chemical fertilizers. i. e. T_1: Control, T_2: 100 per cent RDF through chemical fertilizer T_3: RDN through Farm YardManure and T_4 : RDN through vermicompost. Sesamum and greengram were taken in crop rotation in same experimental plot site.The same treatments were allotted to both the rotational crops. The recommended dose of fertilizers were 20-40-0 and 50-25-0 kg N- P_2O_5-K_2O ha^{-1} for green gram and sesame crop, respectively. The experiment was conducted on fixed site

RDN was given through FYM and vermicompost on the basis of percentage of N content. Two sets of experiment were conducted simultaneously to get the results of both the crops every year. Rain water use efficiency (RWUE) of different treatment was worked out on the basis of pooled seed yield of respective treatments divided by mean rainfall. Economics of different treatment was worked out on the basis of selling price of seed and straw at the time of harvest. Selling price of organic produced seed was valued 25 per cent more than inorganic product. The sesamum variety GT 2 and green gram variety GM 4 were sown in rows at 45 cm apart using 20 and 2.50 kg seeds ha^{-1}, respectively. Other cultural operations and plant protection measures were applied as per recommendation of the region.

RESULTS AND DISCUSSION

Greengram

Seed yield

Seed yield of green gram was influenced significantly due to different treatments in individual year as well as in pooled (Table 1).

In the first year (2007) of the experimentation, application of RDF as chemical fertilizer recorded significantly the highest seed yield(703 kg ha^{-1}), but in subsequent years the application of recommended dose of nitrogen through vermicompost gave significantly higher seed yield over other treatments, but it was found at par with treatments T_3 (RDN through FYM) and T_2 (RDN through chemical fertilizer) in all the years except 2013, 2014 and 2015 where, it was found at par with treatment T_3 (RDN through FYM) only.

The result of pooled data was also found significant. Among the different treatments, application of RDN through vermicompost (T_4) recorded significantly higher seed yield (582 kg ha^{-1}) as compared to other treatments. However, it remained at par with treatment T_3 (RDN through FYM). The seed yield increased under treatments T_3 and T_4 was to the tune of 39.8 and 46.6 per cent higher overcontrol(T_1), respectively.

Stover yield

Stover yield of green gram was influenced significantly due to different treatments in individual years as well as in pooled (Table 1).

In the first year (2007) of the experimentation, application of RDF recorded significantly higher stover yield than other treatments but it was found at par with treatments T_4 and T_1, while in subsequent years application of recommended dose of nitrogen applied through vermicompost gave significantly higher yield as compared to other treatments, but it was found at par with treatments T_3 (RDN through FYM) and T_2 (RDN through chemical fertilizer) in all the years except 2013, 2014 and 2015, during these years, it was found at par with treatment T_3 (RDN through FYM).

The results of pooled data presented in Table 1 indicated that different treatments had significant effect

Table: 1. Effect of different treatments on yield of greengram crop

Treatments	Yield (kg/ha)																				RWUE
	2007		2008		2009		2010		2011		2012		2013		2014		2015		Pooled		(kg/ha.
	Seed	Straw	Seed	Straw	Seed	Straw	Seed	Straw	Seed	Straw	Seed	Straw	Seed	Straw	Seed	Straw	Seed	Straw	Seed	Straw	mm)
T_1: Control (No fertilizer)	547	1340	456	1094	333	510	354	679	329	650	348	844	368	905	688	954	148	301	397	687	0.51
T_2 : RDF through chemical fertilizer	703	1547	600	1370	439	689	483	897	403	782	508	1222	507	1224	839	1142	195	402	520	878	0.67
T_3 : RDF through F.Y.M.	610	1214	583	1379	460	667	506	876	430	829	525	1261	580	1405	1072	1381	230	492	555	903	0.71
T_4 : RDF through Vermi compost	621	1366	613	1533	479	735	527	949	449	862	552	1282	604	1458	1151	1413	245	521	582	954	0.75
SE(m)±	26	53	23	57	18	33	20	44	22	53	20	58	29	55	42	75	10	18	20.0	38.0	
CD at 5%	79	238	68	172	55	100	60	134	65	159	61	175	89	164	126	227	31	55	58.2	114.8	
Y x T SE(m)±																		24.7	47.2		
CD AT 5%																		69.1	142.5		
CV 5 %	10.4	12.1	9.88	10.4	10.5	12.5	10.4	12.81	13.2	16.6	10.2	12.31	13.9	10.7	10.9	15.1	12.3	10.5	11.8	13.7	
AV.RAIN FALL(mm) &Rain day	670 (41)		580 (25)		391.6 (17)		1191.2 (38)		915.3 (34)		628.2 (22)		1084 (37)		622.9 (24)		931.2 (12)		779.4 (27.8)		

on stover yield . Among the different treatments, application of RDN through vermicompost (T_4) recorded significantly higher stover yield (954 kg ha^{-1}) as compared to other treatments. However, it remained at par with treatments T_3 (RDN through FYM) and T_2 (RDN through chemical fertilizer kg ha^{-1}). The stover yield increased under treatment T_4, T_3 and T_2 were to the tune of 38.9, 31.4 and 27.8 per cent over control(T_1), respectively.

The application of RDN in the form of FYM or Vermicompost might be resulted in the formation of more nodules, vigorous root development, better nitrogen fixation and better development of plant growth leading to higher photosynthetic activity and translocation of photosynthates to the sink which in turn resulted in better development of yield attributes and finally higher seed yield. These results are in confirmation with Patil *et al,* (2012) in chickpea and Shwetha, 2008 in soybean

Sesame

Seed yield

Data of seed yield of sesame presented in Table 2 indicated that different treatments had significant effect on seed yield of sesame in all the individual years as well as in pooled results. During first year (2007) amongst the treatments, treatment T_2 (RDN through chemical fertilizer) recorded significantly higher seed yield than rest of the treatments, however it remained at par with treatment T_4 (RDN through vermicompost). While in subsequent years during 2008, 2011, 2012 and 2014, treatment T_4 recorded significantly higher seed yield as compare to other treatments, but it remained at par with treatment T_2 in 2008 and, treatment T3 (RDN through FYM) in 2011 and 2014, while in 2009 and 2010 treatment T_3 (RDN through FYM) noted significantly higher yield than rest of the treatments however, it remained at par with treatments T_2 and T_4.

Pooled results were found significant with respect to seed yield of sesame, application of RDN through vermicompost (T_4) recorded significantly higher seed yield (329 kg ha^{-1}) than rest of the treatments but it remained at par with treatments T_3(305 kg ha^{-1}) and T_4 (318 kg ha^{-1}) which were found equally effective and found significantly superior over treatment T_1 (Control). Increased in seed yield under treatment T_4, T_3 and T_2 was to the tune of 43, 32.6 and 38.3 per cent more over control, respectively.

Increased seed yield of sesame by application of organic manures might be due to higher availability of nutrients to plants, besides increased water holding capacity and other physical properties which might have caused increased rate of infiltration. Similar results were also reported by Yadav and Vijayakumari (2003) in chilli and Patil *et al.* (2012) in chickpea.

Table: 2. Effect of different treatments on seed yield of sesame crop

Treatments	Seed Yield (kg ha^{-1})								RWUE
	2007 Sesame	2008 Sesame	2009 Sesame	2010 Sesame	2011 Sesame	2012 Sesame	2014 Sesame	Pooled Sesame	(kg ha^{-1} mm)
T_1: Control (No fertilizer)	396	281	231	139	118	149	296	230	0.34
T_2: RDF through chemical fertilizer	581	456	312	187	144	198	349	318	0.47
T_3: RDF through F.Y.M.	485	387	328	200	156	208	374	305	0.45
T_4: RDF through Vermi compost	521	459	323	194	167	218	419	329	0.49
SE(m)± 20	09	15	09	05	11	17.68	11.8		
CD at 5%	61	28	45	27	16	34	53.3	34.9	
Y x T SE(m)±								13.4	
CD at 5%								37.6	
CV 5%	9.99	5.69	12.35	12.39	8.80	14.34	12.04	11.12	
Av. Rainfall(mm)&Rain day	670	580	391.6	1191.2	915.3	628.2	622.9	675.9	
	(41)	(25)	(17)	(38)	(34)	(22)	(24)	(26.4)	

The experiment was vitiated in 2013 and 2015 as crop was sub merged for 3 to four day due to continuous rainfall in 2013,In year 2015, long dry spell for 30daya after sowing the crop was failed..

Table 3 :Effect of different treatments on soil fertility after harvest of the crops (after completion of the experiments)

TREATMENTS	Soil nutrients availability(kg ha^{-1})					
	Greengram			Sesame		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O
T1:Control	158	35.2	177	150	36.5	157
T2:RDN through chemical ferti.	167	44.2	199	157	43.8	169
T3:RDF-FYM	180	48.5	217	175	52.9	185
T4:RDF-Vermocompost	187	47.3	223	172	51.0	183
SE (m)±	4.2	1.2	6.4	6.6	2.0	5.0
CD @ 5%	12.7	3.5	9.1	19.7	6.0	15.1
C.V.%	6.0	6.5	7.6	9.8	10.7	7.1
Initial values	165.8	45.8	212	167	46.8	209

Table 4 :Effect of different treatments on soil fertility after harvest of the crops (Pooled results from 2007 to 2015)

Treatments	Soil nutrients availability(kg ha^{-1})					
	Greengram			Sesame		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O
T1:Control	147	40.4	177	150	40.5	173
T2:RDN through chemical ferti.	164	46.5	194	157	43.5	180
T3:RDF-FYM	170	51.0	213	175	49.1	202
T4:RDF-Vermocompost	175	51.7	209	172	46.5	198
SE (m)±	2.2	0.8	2.2	6.6	0.8	2.5
CD @ 5%	6.3	2.4	6.4	19.7	2.3	7.4
YXT						
SEM ±	6.5	1.1	6.4	5.6	1.4	5.8
CD at 5%	18.9	3.1	NS	15.5	4.0	16.3
C.V.%	6.1	5.8	7.9	8.5	7.7	7.6
Initial values	165.8	45.8	212	167	46.8	209

Table 5 : Effect of different treatments on organic carbon per cent

Treatments	Organic Carbon (%)			
	Greengram		Sesame	
	Initial	After completion of crop rotation	Initial	After completion of
Crop rotation				
T_1 : Control	0.30	0.32	0.29	0.30
T_2 : RDN through chemical ferti.		0.33		0.32
T_3 : RDF-FYM		0.55		0.52
T_4 : RDF-Vermocompost		0.51		0.48

Table 6. Effect of different treatments on yield and economics of greengram-sesame crop rotation (Pooled data)

Treatments	Yield (kg ha^{-1})			Cost of cultivation	Gross income	Net Income	B : C ratio	RWUE (kg ha^{-1}mm)	
	Greengram		Sesame						
	Seed	Straw	Seed	(Rs ha^{-1})	(Rs ha^{-1})	(Rs ha^{-1})		Greengram	Sesame
T_1: Control (No fertilizer)	397	687	230	14145	54001	39856	3.82	0.51	0.34
T_2 : RDF through chemical fertilizer	520	878	318	19131	72425	53294	3.79	0.67	0.47
T_3 : RDF through F.Y.M.	555	903	305	35895	92723	56828	2.58	0.71	0.45
T_4 : RDF through Vermi compost	582	954	329	41145	98493	57348	2.39	0.75	0.49
Price, Rs kg^{-1}	Greengram seed :70 , Stover:3.0, Sesame seed 105,135, FYM:1.5, V.C.:3.0, Urea:6.0,DAP:24.5,N %: FYM: 0.50, Vemi compoct:0.80 N %: FYM: 0.50, Vemicompoct: 0.80								

Rain water use efficiency

The results indicated that recommended dose of nitrogen applied through vermicompost recorded the highest rain water use efficiency (0.75 kg ha^{-1}mm) of green gram and sesamum (0.49 kg ha^{-1} mm) which were comparatively higher than control treatment.

Soil fertility

The soil fertility status was recorded initial and after completion of experiments and presented in Table 3 and pooled results are presented in Table 4.

Green gram

The results revealed that , treatment T_4 (100% RDN through vermicompost) recorded significantly higher value of soil available N and K_2O, however it remained at par with treatment T_3 (100% RDN through FYM), in case of soil available P_2O_5 , treatment T_3 recorded significantly higher value of available P_2O_5 and were found at par with $T_4$and found significantly superior over rest of the treatments.

Sesame

Similarly in second set of experiment, treatmentT_3(RDN through FYM) recorded significantly higher value of soil available N,P_2O_5 and K_2O however, it was found at par with treatment T_4 (RDN through vermicompost).

After completion of experiment, nitrogen applied through FYM recorded maximum value of O.C. per cent followed by vermicompost. The lowest values of O.C. per cent were recorded under control and RDF-chemical fertilizers. (Table 5)

Economics

The results indicated that recommended dose of nitrogen applied through vermicompost to green gram-sesame crop rotation recorded the highest gross and net income of Rs.98493.0 and 57348 ha^{-1}, respectively followed by treatment T_3(RDN through FYM) with gross and net return of Rs.92723 and 56828 ha^{-1}, respectively. Treatments T_4 and T_3 increased 43.9 and 6.6 per cent net income respectively than treatments T_1(control) and T_2(RDN - chemical). However, the maximum B:C ratio(3.82) was recorded under control treatment (Table 6).

From the results of long term experiment it is concluded that application of 20 kg N ha^{-1} to green gram and 50 kg N ha^{-1} to sesame either through vermicompost or FYM recorded the highest yield and net profit in as well as improve the soil fertility in green gram-sesame crop rotation on loamy sand soils under dry farming condition in organic farming

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Genetic Diversity Analysis in Chickpea (*Cicer arietinum* L.)

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ABSTRACT

Genetic diversity study was conducted among 56 promising chickpea (*Cicer arietinum* L.) genotypes using Mahalanobis's D^2 statistics for days to 50 per cent flowering, days to maturity, plant height (cm), number of primary branches per plant, number of secondary branches per plant, number of pods per plant, number of seeds per pod, 100 seed weight (g), and seed yield per plant (g). By using Tocher's method, all 56 genotypes were grouped into twelve clusters. The cluster II comprised of highest number of genotypes (14) followed by cluster I, III (12), clusters x (10), clusters IV, V, VI, VII, VIII, IX, XI, XII had single genotype each. The range of inter cluster distance (D) was observed from 45.70 to 2026.67.On the basis of cluster means cluster VI exhibited higher seed yield/plant (19.39 g). Maximum genetic distance (D= 2026.67) was found between the clusters VIII (AKG-1301)and XI (AKG-1404) followed by cluster V (BDN-9-3) and XI (AKG-1404) (D = 1584.07), cluster III (C-154, C-156, C-157, C-151, C-155, AKG1303, C-160, C-319, C-318, C-333, C-313, C-315) and cluster VIII (AKG-1301) (D=1503.98).The genotypes which are included in these clusters may be further used as parents for hybridization programme to get the desirable recombinants in the segregating generations.

Chickpea (*Cicer arietinum* L.) commonly known as chana, gram or bengal gram. It belongs to the sub-family *Papilionaceae* of family *Leguminoceae*, is an important and unique food legume. It is an important rabi pulse crop of the world occupying third position amongst pulses. India is largest producer (25%), importer (20%) and consumer (27%) of pulses in the world. The chickpea is a good source of protein (24.6 %), carbohydrate (64.6 %) and vitamins (Abu-Salem and Abou, 2011). It also provides calcium, magnesium, potassium, phosphorus, iron, zink and manganese (Ibrikci *et al.,* 2003). This food legume has diversified uses, and presently as many as 140 countries are importing chickpea (Gaur *et al.,* 2012). India is the largest chickpea producer accounting a share of about 71% in global chickpea production with about 13.2 million ha area, 11.6 million tons production and 841 kg/ha productivity. Distribution of chickpea in six states *viz.,*Madhya Pradesh, Rajasthan, Maharashtra, Uttar Pradesh, Karnataka and Andhra Pradesh together contribute 91per cent of the production and 90 per cent of the area of the country. Maharashtra covers 1.8 million ha area with the production 1.5 million tons and productivity of 850 kg ha^{-1} (www.mahaagri.gov.in, 2018).

Genetic diversity is the base for survival of plants in nature and for crop improvement. Genetic divergence among the parents plays a vital role in cultivar improvement due to more variability in segregating generations, which can be exploited for improvement (Nimbalkar *et al.,* 2017). Inclusion of diverse parents in hybridization helps in isolation of superior recombinants. Mahalanobis's D^2 statistics is a powerful tool in quantifying the degree of variability at the genotype level. The utility of multivariate analysis has greatly been emphasized (Murty and Arunachalam, 1966). Several workers studied the genetic diversity, clustering pattern, relative contribution of different characters towards divergence and effectiveness of selection (Venkateswarlu, 2001; Manivannan *et al.,* 2002; Bisht *et al.,* 2005). The present study aims to find out the genetic diversity among 56 promising chickpea genotypes.

MATERIAL AND METHODS

The experimental material comprising 56 genotypes were raised in randomized block design in two replications during r*abi* 2016-17. A spacing of 45 x 15 cm was kept to raise the research trial. All the 56 genotypes used for the study were collected from different government institutions which include Dr. PDKV, Akola, MPKV, Rahuri, VNMKV, Parbhani & IIPR, Kanpur. The experimental material was raised at Pulses Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. Observations on nine quantitative characters were recorded on five randomly selected plants from each plot

1,3 & 4. Assistant Professor, 2. Associate Professor, Department of Agricultural Botany, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (MS)

in each replication. These plants were tagged before flowering. Data were recorded on five randomly tagged plants for days to 50 per cent flowering, days to maturity, height of the plant (cm), number of primary branches, number of secondary branches, number of pods/plant, number of seeds/pod, 100 seed weight (g), seed yield/ plant (g) .

The analysis for divergence was done by following Mahalanobis's (1936) D^2 statistic. Tocher´s method as described by Rao (1952) was followed for cluster formation. Contribution of individual characters towards divergence was estimated according to the method described by Singh and Choudhary (1979). Grouping of variety into various clusters was done and average intra and inter cluster distance were estimated.

RESULTS AND DISCUSSION

Based on the D^2 values the 56 genotypes were grouped into twelve clusters (Table 1 and Fig. 1) which revealed that the genotypes varied significantly for all the characters studied indicating considerable variable in the germplasm. The cluster II consists of maximum 14 genotypes followed by cluster I, III (12), clusters X (10). Remaining all clusters possessed one genotype in each cluster.

Cluster II consisted maximum 14 genotypes indicating that the genotypes had narrow genetic divergent among them. The similarity in the base population, from which they had been evolved, might be the cause of genetic uniformity. However, the unidirectional selection potential for one particular trait or a group of linked traits in several places may produce similar phenotypes which can be aggregated into one cluster irrespective of their geographic origin (Joshi *et al.,* 2006 and Parashi *et al.,* 2013).

The intra cluster distance ranged from 0.00 to 245.66 (Table 2). The maximum intra cluster distance was found in cluster X (245.66) followed by cluster III (200.78), II (139.82) and cluster I (134.74) indicating that the 10 genotypes including checks, JAKI-9218 and Digvijay in the cluster X were most divergent. However, maximum inter cluster distance was noticed between cluster VIII and cluster XI (2026.67), followed by cluster V and cluster XI (1584.07) and cluster III and cluster VIII (1503.98)

Table 1. Grouping of fifty six chickpea genotypes into 12 clusters by Tocher's method.

Cluster No.	No. of genotypes	Genotypes
I	12	AKG-1501, C-114, AKG-1401, Phule Vikram , C-345, C-326, BDNG-2015-2, PhuleG-13107, AKG-1201, AKG-1123, AKG-1402, C-320.
II	14	AKG-1503, BDNG-801, BDNG-797, BDNG-2010-1, AKG -1109, AKG-1405, BDNG-804, AKG-1505, PhuleG-0819-43, AKG-1504, SAKI-9516, Vijay, AKG-1146, AKG-1502.
III	12	C-154, C-156, C-157, C-151, C-155, AKG-1303, C-160, C-319, C-318, C-333, C-313, C-315.
IV	1	AKG-1216.
V	1	BDN-9-3.
VI	1	AKG-1403.
VII	1	C-159.
VIII	1	AKG-1301.
IX	1	C-111.
X	10	AKG-1506, Phule G-0805-17-5, AKG-1121, BDNG-2015-19, JAKI-9218, BDNG-2013-1, BDNG-2003-1, C-323, C-152, Digvijay.
XI	1	AKG-1404.
XII	1	C-312.

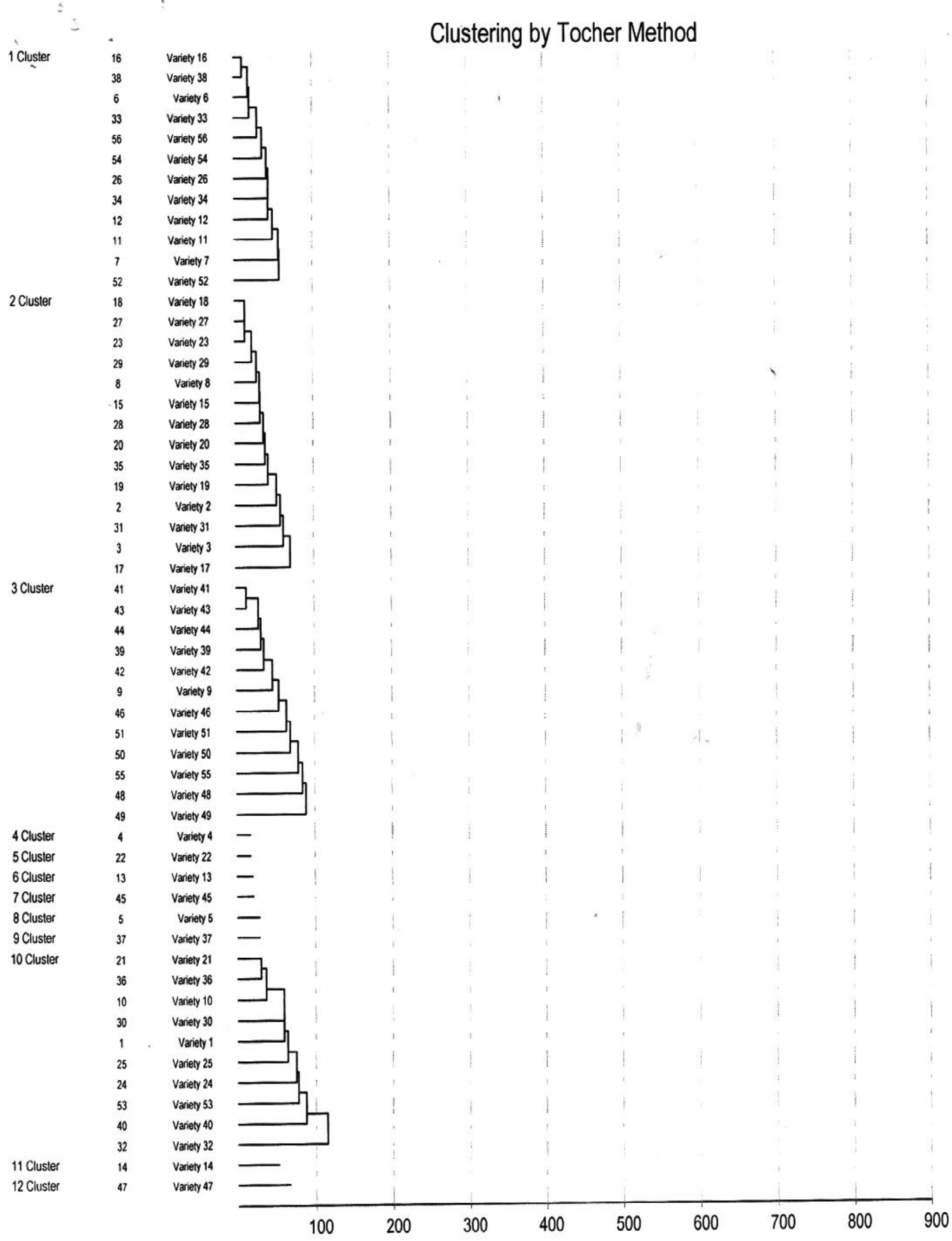

Fig. 1. Grouping of 56 genotypes into 12 clusters by Tocher's method

Table 2. Average intra and inter cluster distance (D^2) values of 12 clusters from 56 chickpea genotypes

Clusters	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
I	134.74	388.28	254.22	824.20	849.71	427.88	189.96	1110.68	613.84	481.37	458.89	405.68
II		139.82	591.66	247.61	297.54	300.50	482.41	496.08	301.15	454.06	675.08	684.80
III			200.78	1159.78	1268.03	792.00	300.73	1503.98	1041.34	791.60	340.74	299.15
IV				0.00	45.70	370.24	815.18	100.09	149.41	470.98	1398.29	1127.12
V					0.00	328.36	867.90	75.28	76.18	438.60	1584.07	1235.29
VI						0.00	360.19	536.41	261.69	233.78	1040.25	927.35
VII							0.00	988.43	585.41	340.75	720.24	477.85
VIII								0.00	148.95	512.27	2026.67	1365.83
IX									0.00	291.04	1479.33	1077.94
X										245.66	1301.20	763.16
XI											0.00	640.65
XII												0.00

indicating that these clusters are quite divergent from each other and the genotypes belonging to them can be used for hybridization programme as crosses between genotypes belonging to the clusters with maximum inter cluster distance, may give high heterotic response resulting in better recombinants. Similar findings have been reported by Lal *et al.,* (2001) and Dwevedi and Lal (2001).

A considerable inter-cluster variation was observed among the cluster means The average cluster mean of nine characters revealed that none of the clusters contained genotype with all the desirable characters and so recombinant breeding between genotypes of different clusters is needed (Table 3). The genotype in cluster VI recorded highest cluster mean for seed yield per plant (19.39). The cluster means for number of seeds per pod was maximum in cluster XII (1.78) and it was minimum in cluster XI (1.10). The cluster mean for number of pods per plant was highest in cluster IV (76.05) and minimum in cluster XII (36.49). The cluster mean for 100 seed weight

Table 3. Cluster mean values of twelve clusters for nine characters in chickpea

Cluster No.	Days to 50 % flowering	Days to maturity	Plant height (cm)	No. of pri. Branches $plant^{-1}$	No. of sec. branches $plant^{-1}$	Number of seeds pod^{-1}	Number of pods $plant^{-1}$	100 seed weight (g)	Seed yield $plant^{-1}$ (g)
I	52.63	96.46	42.13	2.89	8.86	1.27	43.96	20.05	10.71
II	51.96	95.00	41.46	3.47	10.18	1.39	63.15	17.53	14.36
III	53.38	101.58	44.78	2.98	7.51	1.23	39.08	16.38	8.40
IV	44.50	94.00	44.75	3.90	11.35	1.58	76.05	18.95	17.01
V	45.00	87.50	44.60	3.61	10.90	1.56	75.85	20.10	19.26
VI	57.50	101.00	40.75	3.58	10.10	1.49	56.86	22.70	19.39
VII	52.00	109.00	48.60	3.19	7.90	1.25	43.94	22.05	11.65
VIII	42.50	90.50	51.55	3.68	10.20	1.65	79.18	20.05	18.92
IX	42.00	90.50	46.60	3.13	10.75	1.43	69.83	22.40	17.60
X	49.75	96.95	49.47	3.41	9.93	1.53	53.91	22.89	16.67
XI	58.00	106.00	33.70	3.26	9.50	1.10	41.66	13.40	8.01
XII	54.00	90.50	48.90	2.90	6.55	1.78	36.49	13.60	7.98

was minimum in cluster XI (13.40 g) and it was maximum in cluster X (22.89 g).

Genetic diversity analysis within and between cluster revealed that the genotypes of the same cluster had little divergence from each other with respect to the characters studied. The hybridization between the genotypes of the same cluster thus, may not provide good segregants. Based on inter cluster distances and *Per se* performance of genotypes AKG-1301, AKG-1404, BDN-9-3 and AKG-1403 were identified for inclusion in hybridization programme for realizing desirable transgressive segregants. This finding is in accordance with that of Dwevedi and Lal (2009) and Gaikwad *et al.,* (2014).

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Effectof Different SowingTimes on Growth and Yield Attributes of Wheat

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ABSTRACT

Optimum date of sowing is an important parameter, which affect the growth and yield attributes of wheat along with other cultivation practices. To find out optimum date of sowing, promising genotypes and interaction effects among sowing dates and genotypesanexperiment was conducted at Wheat Research Unit., Dr. P.D.K.V., Akola, Maharashtra (India) during 2017-18 and 2018-19. Sowing dates and genotypes were statistically significant for grain yield /ha^{-1}.On the basis of mean of the sowing dates over years,late sowing i.e sowing from 26th November to 2ndDecember recorded higher grain yield (3816 kg ha^{-1}) as compared to timely sowing ie. sowing from 5th to 11th November (3514 kg ha^{-1}) and very late sowing i.e sowing from 17th to 23rd December (3074 kg ha^{-1}).On the basis of over the year mean of the genotypes, the genotype AKAW 4210.6 (3845 kg ha^{-1}) ranked first followed by AKAW 4627 (3659 kg ha^{-1}) and AKAW 1071 (3487 kg ha^{-1}) ranked second and third respectively for grain yield and found superior over other genotypes. Plant height (cm), number of tillers / metre and number of grains / spike were found higher during timely sowing (5th to 11th Nov) followed by late sowing (26 th November to 2 ndDecember).

Globally, wheat is a major staple crop. After rice it is second most important staple crop in India. Because of its wider adaptability it is grown from temperate irrigated to dry and high rainfall areas and from warm humid to dry cold environment. Because of its complex genome nature it has wider adaptability. Being a C-3 type crop, it thrives well in cool environment. In India it is grown on 29.8 million hectares area with total production of 99.12 million tones during the season 2018-19 (Anonymous). In case of wheat date of sowing is most important factors that governs the phenological development of crop and also efficientconversion of biomass into economic yield. It has been observed that the wheat crop sown at normal date usually have longer crop duration thus they get an opportunity to accumulate more biomass as compared to late sowing and thus it finally resulted in higher grain yield. In case of delayed sowing the wheat crop is exposed to low temperature at the time of establishment and exposed to high temperature at the reproductive phase that finally leads to forced maturity. Therefore, the optimization of sowing time is an important parameter to attain maximum yield andefficient conversion of biological yield into economic yield. Hence, an experiment was planned to have knowledge about optimum dateof sowing.

MATERIAL AND METHODS

The present study was carried out at Wheat Research Unit, Dr. P.D.K.V., Akola, Maharashtra (India) during 2017-18 and 2018-19. Geographically Wheat Research Unit is situated at 200 42'34.45"Nlatitude and 760 59'53.16" E longitudes. The elevation of this place from mean sea level is 287 to 316 meter. Generally, the monsoon sets from October to January. The mean annual rainfall is 700 mm. May is thehottest month of the year and temperature generally rises up to 48°C. However, minimum temperature can be low as 8°C. The experiment was conducted during rabi season of 2017- 18 and 2018-19. The experiment was laid in Split Plot Design with three replcations. Size of each plot was 2 × 6 m^2. Sowing of wheat Genotypes i.e AKAW-4627, AKDW-4021, AKAW-3722, AKW-1071 , NIDW-295. AKAW-3997 and AKAW-4210-6 was done at three different dates *viz.* Timely sowing, sowing from 5th to 11th November , Late sowing, sowing from 26th November to 2 nd December and Very late sowing, sowing from 17th to 23rd December. 6, 7 and 8 Irrigations given to timely, late and very late sowingsrespectively.The crop was fertilized according to the recommendations for Timely and late sowings. Observations were recorded on the parameters viz. plant height (cm), number of tillers /m , number of grains / spike and grain yield ha^{-1}. Statistical analysis for Grain yield was carried out by the method of Split Plot Design as suggested by Steel *et al.* 1997.

RESULTS AND DISCUSSION

Effect of different Dates of sowing on plant height

Results revealed that different dates of sowing

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have significant influence on plant height. On the basis of mean of sowing dates, the height was observed maximum (88.8 cm) during timely sowing (sowing from 5th to 11th November), where as it was decreased in late sowing (26th November to 2nd December) was 75.9 cm and very late sowing (17th to 23rd December) was 75.7 cm.However Zia –ul –Hassan *et al.* reported the effect of sowing dates on the plant height was not significant at 5per cent level of significance in both 2008-2009 and 2009-2010.

Effect of different dates of sowing on number of tillers / m.

It was found that different dates of sowing have significant influence on Number of tillers m^{-1} . On the basis of mean of sowing dates, the Number of tillers m^{-1} were observed maximum (101.3 m^1) during timely sowing (5th to 11th November) was 101.3 m^1) where as tiller number was decreased in ate sowing (26th November to 2nd December) was 77.9 m^1 and very late sowing (17th to 23rd December) was 69.1 m^1). Mohammed *et al.*(2003) found that sowing dates significantly affected number of tillers per unit area as the lower temperature encouraged tiller production during the early growth period

Effect of different Dates of sowing on number of grains spike[1]

Data pertaining tonumber of grains spike[1] revealedthat different dates of sowing have significant influence on Number of grains spike[1]. On the basis of means of sowing dates, the number of grains $spike^{-1}$ were observed higher (56.9 spikes) during timely sowing (5th to 11th November),where as it was decreased (55.0) in late sowing (26th November to 2 nd December) and very late sowing (17th to 23rd December) was lowest number of grains (43.5 / spike) .Sokolo and Singh. 2013 reported highest number of grains per spike in cultivar Imam (38.91), whilethe highest number of grains per spike was counted in 1st November sowing date (39.12). The number of grains

Table 1 :Effect of Dates of sowing on Grain Yield, Yield contributing and ancillary characters of Wheat.

	Grain yield kg ha^{-1}		
Dates of sowing	**2017-18**	**2018-19**	**Mean**
Timely sowing (5th to 11 Nov)	3779	3249	3514
Late sowing (26th Nov to 2 Dec)	3673	3959	3816
Very late sowing (17th to 23rd Dec)	2727	3422	3074
SE (m) -	137	40	
CD 5 %	393	115	
Varieties /Genotypes			
AKAW-4627	3541	3778	3659
AKDW-4021	3328	3153	3240
AKAW-3722	3284	3545	3414
AKW-1071(AC)	3436	3539	3487
NIDW-295(DC)	2858	3679	3268
AKAW-3997	3593	3131	3362
AKAW-4210-6 (PDKV Sardar)	3713	3978	3845
SE(m)	79	211	
CD 5 %	227	429	
Interaction (SD x Genotypes)			
SE (d)	393	365	
CD 5 %	NS	NS	

Table 2 :Mean (2017-18 +2018-19) yield contributing and ancillary characters.

Sowing dates	Timely sowing	Late sowing	Very late sowing	Timely sowing	Late sowing	Very late sowing	Timely sowing	Late sowing	Very late sowing
Gentypes		**Pl ht**			**Tillers/m**			**Grain/ Spike**	
AKAW-4627	83	74.5	69.5	105	85	69.5	51.5	50	40.5
AKDW-4021	92.5	75	76.5	94	68.5	60.5	53	57.5	34.5
AKAW-3722	84	86	74	113.5	66	67	58	62.5	43
AKW-1071(AC)	95	81.5	77	101.5	86	78	57.5	59	45
NIDW-295(DC)	89	70.5	74.5	94.5	78	58.5	51.5	49.5	39
AKAW-3997	94	71	85	109.5	100	73.5	63	53	57.5
AKAW-4210-6	84	73	73.5	91	61.5	76.5	64	53.5	45
Mean	**88.8**	**75.9**	**75.7**	**101.3**	**77.9**	**69.1**	**56.9**	**55.0**	**43.5**

per spike showed a descending order with the order of planting dates in both seasons; this may be due high temperature at grain filling stage.

Effect of different dates of sowing on Grain yield.

Sowing dates and Genotypes were statistically significant for grain yield h^{-1}. During 2017-18, timely sowing (5th to 11 Nov) ranked first (3779 kg ha^{-1}) followed by late sowing (26 th November to 2 nd December) was 3673 kg/ha and found statistically superior over very late sowing (17th to 23rd December)was 2727 kg/ha. Where as in 2018-19, Sowing from 26 th November to 2 nd December (3959 kg ha^{-1}) ranked first followed by very late sowing, sowing from 17th to 23rd Dec (3422 kg ha^{-1}) and found statistically superior over timely sowing (5th to 11th Nov).

On the basis of mean, late sowing (3816 kg ha^{-1}) recorded higher yield followed by timely sowing (3414 kg ha^{-1}) and Very late sowing (3074.5 kg ha^{-1}). For grain yield, among the genotypes, during 2017-18, the genotypes viz AKAW 4210.6 (3713 kg/ha) followed by AKAW 3997 (3593 kg ha^{-1}) and AKAW 4627 (3541 kg ha^{-1}) ranked first, second and third respectively and found superior over other genotypes. During 2018-19 for grain yield, the genotypes viz AKAW 4210.6 (3978 kg ha^{-1}) followed by AKAW 4627 (3778 kg ha^{-1}) and NIDW 295 (3679 kg ha^{-1}) ranked first, second and third respectively and found superior over other genotypes. On the basis of mean of the genotypes for the years 2017-18 and 2018-19, the genotype AKAW 4210.6 (3845.5 kg ha^{-1}) ranked first followed by AKAW 4627 (3659.5 kg ha^{-1}) and AKAW 1071 (3487.5 kg ha^{-1}) ranked first, second and third, respectively for grain yield and observed superior over other genotypes.

During 2017-18 the interaction (Sowing date x Genotypes) effects were found statistically significant and the combinations viz. D2 x G7(Late sowing, during 26 Nov to 2 nd January x Genotype, AKAW 4210-6, 4583 kg ha^{-1}), .D1 x G3(Timely sowing, during 1st to 20th November x Genotype, AKAW 3722, 4561 kg ha^{-1}), and D2 x G1(Late sowing, during 26 thNov to 2 nd January x Genotype, AKAW 4627, 4436 kg ha^{-1}). Ibrahim 1995 reported that the sowing of November 1stand 15thwere more beneficialthan the late sowings as far as in arid areas the growing season for the winter crops is short, therefore, the growth period is completed by high temperature at the end of the growing season.

The study indicated that, the higher grain yields could get under late sowing (26 th November to 2 nd December) which is followed by timely sowing (5 th to 11th November). Very late sowing (17th to 23rd December) recorded lowest grain yields. Hence the sowing of wheat from 5 th November to 2 nd December is more beneficial for higher grain yields. On the basis of mean of two years, the genotypes viz. PDKV Sardars, AKAW 4627 and AKAW 1071 recorded higher grain yields over other genotypes and found promising for this region.

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Effect of Fumigation Frequencies on Seed Germination ond Groundnut Bruchid, Caryedon Serratus (Olivier) Population Under Storage

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ABSTRACT

Experiment was conducted at laboratory of Seed Technology Research Oilseed, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during 2014 -15 with an objective to study the influence of fumigants and number of fumigations on seed germination and population of groundnut bruchid in storage condition. The experiment was laid in completely randomized design with factorial concept in three replications. Seed stored in plastic tins for applying fumigants as per recommended doses and method at 30,90 and 150 days after harvest. Aluminium phosphide and Ethylene dibromide were used as fumigant. Frequency of application of fumigants changed in seven treatments. Visual observations and number of beetles were manually counted and furnished as beetle population. Percent germination was calculated by standard germination test. The seed fumigated with ethylene dibromide recorded numerically more (78.00 and 52.46) per cent germination as compared to seed fumigated with aluminium phosphide (77.17 and 51.79) during six and ten months of storage, respectively. Irrespective of fumigants, the seeds which received one fumigation either at 30, 90 and 150 days after harvest retained 70 per cent germination which was above the minimum seed certification standard up to eight months of the storage. Seed fumigated with aluminium phosphide spared minimum number of bruchids as compared to seed treated with ethylene dibromide. Irrespective of fumigants, among the number of fumigations lowest population of bruchid (0.00,0.00,0.00,0.00 and 2.00) was recorded in seeds receiving three fumigations at 30,90 and 150 days after harvest during two, four, six, eight and ten months of storage. In interaction treatment seed treated with aluminium phosphide at 30,90 and 150 days after harvest during two, four, six, eight and ten months of storage recorded minimum population of bruchids (0.00,0.00,0.00,0.00 and 1.00). Fumigation at 30 days after harvest found better as compared to higher period than this.

Groundnut (*Arachis hypogaea* L.) is one of the major oil seed crops containing 48 - 50 per cent edible oil and 25 per cent high quality protein and being a legume it occupies a unique position in the farming system. Over 60 per cent of the global production is crushed for extraction of oil for edible and industrial uses, while 40 per cent is consumed for food and other uses (seed for sowing) (Birthal *et al.*, 2010). For seed purpose the pods are to be stored for longer period during which it is prone to various insect particularly bruchids, Caryedon serratus (Olivier) which cause greater losses. Damage by Caryedon serratus (Olivier) in groundnut seeds to the extent of 45 per cent results in 65 per cent loss in dry weight of damaged seeds (Kapadia, 1994). The bruchid is characterized by habit of its boring through the shell or the dried nuts. Initially, causes damage to groundnut in low proportions in the field, but its subsequent damage in store is heavy (Faekin, 1973 and Anitha Kumari *et al.*, 2002). The success of crop depends on the use of quality seed sown in commercial production programme. Among several seed quality attributes, the storage potential of seed plays an important role in meeting the demand for commercial crop production programme. Protection of seed from insect attack is of great importance until it is sown in next season or year. The seed quality changes during storage such as decrease in germination from 84-79 per cent (Junaithal Begum *et al.*, 2013). During storage, quality of seed can be maintained for a longer period by adopting several prophylactic measures viz., disinfestation of storage room, physical and chemical treatments, fumigation, etc. Among these methods, fumigation is said to be a convenient, rapid and effective method to control infestation of store pests. Seed sanitation usually requires more than one fumigation to prevent attack from insect pests. Effect of repeated fumigation on germination of seed is an important factor to be considered in storage. In some cases increased injury to germination capacity may be observed due to two fumigations. Knowledge of these factors is very much required for successful fumigation process and its frequency. In that context, present experiment was

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conducted with an objective to study the influence of number of fumigations on seed germination and infestation of groundnut bruchids in storage condition.

MATERIAL AND METHODS

The study was conducted at Seed Technology Research Oilseed, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during 2014 -15. The experiment was laid in completely randomized design with factorial concept in three replications involving two fumigants viz., aluminium phosphide (0.9 g q^{-1}) and ethylene dibromide (3 ml q^{-1}) and its seven frequencies. Seed stored in plastic tins for applying fumigants. The calculated quantities of fumigants were placed in the plastic tins measuring 30 cm (length) 30 cm (breadth) and 44 cm (height) containing I kg pods and the boxes were closed with lids. The cover portion of lid was made air tight by plastering with celephine tape. After the required exposure period, the cover was opened and pods were removed from boxes and were stored in aerated gunny bags under ambient storage conditions. This process of fumigation was repeated as per the treatment combinations for effecting repeated fumigation of the pods. The seed germination and beetle population were recorded bimonthly. While reduction in seed germination calculated at after ten months of storage over initial germination. The germination test was conducted as per ISTA rules (Annonymous,1999). The data were statistically analysed (Panse and Sukhatme, 1978).

RESULTS AND DISCUSSION

Germination percentage (%)

The significant differences in per cent germination due to fumigants were noticed at sixth and tenth month the storage period irrespective of number of fumigations (Table 1). Seeds fumigated with ethylene dibromide recorded more (78.00 and 52.46%) germination while it was less (77.17 and 51.79%) in aluminium phosphide fumigated seeds during six and ten months of storage, respectively. During second, fourth and eight month non-significant differences on germination were noticed due to fumigants. The seeds which received one fumigation at 30 days after harvest recorded significantly maximum (89.17, 88.17, 79.50, 75.17 and 58.34%) germination while, it was minimum (84.17, 78.83, 77.17, 58.67 and 46.34%) in the seeds fumigated thrice at 30, 90 and 150 days after harvest during two, four, six, eight and ten months of storage respectively. Irrespective of the fumigants, among the number of fumigations, the seeds which received one fumigation at 30 days after harvest maintained the germination per cent above the minimum seed certification standard (70%) up to eight months of storage. The once fumigated seeds either at 30, 90 and 150 DAH (N1, N2 and N3) could retain above 70 per cent germination up to eight months only. In general with increase in number of fumigations, the per cent germination was found to decline irrespective of the fumigants and also with the advancement of storage period gradual decrease in per cent germination was noticed in all the treatments. In interaction between fumigants and number of fumigations, ethylene bromide fumigation at 30 days after treatments (F2N1) recorded significantly highest (89.67, and 75.33%) germination during two and eight months of storage, respectively. While, it was least (78.33, and 58.33%) in aluminium Phosphide fumigation at 30, 60 and 90 days after harvest (F1N7) during four and eight months of storage, respectively. During other months of storage, the interaction effects were non- significant.

Irrespective of number of fumigations, between the fumigants, Eythelene dibromide recorded Minimum (44.19%) reduction in germination, while it was maximum (44.90%) in aluminium phosphide fumigated seeds at the end of tenth month of storage. Irrespective of fumigants, the seeds which received one fumigation at 30 days after harvest recorded minimum (37.94%) reduction in germination, while it was maximum (50.71%) in seeds fumigated thrice at 30, 90 and 150 days after harvest at the end of tenth month of storage. In interaction effect between fumigants and number of fumigations, the treatment combinations Ethylene dibromide Fumigation at 30 days after harvest (F2N1) and Aluminium phosphide Fumigation at 30, 90 and 150 days after harvest (F1N7) recorded minimum (37.58%) and maximum (51.06%) reduction in germination respectively at the end of tenth month of storage from initial germination value (Table 2).

.Beetle population

Irrespective of number of fumigations, between the fumigants, the seeds fumigated with aluminium phosphide spared minimum number of insects (1.58, 1.54, 2.50, 3.79 and 5.38) while, ethylene dibromide allowed more

Table 1. Influence of fumigants and number of fumigations on per cent germination of groundnut seeds

Treatments	Months after storage									
	Two		Four		Six		EightTen			
	F1	F2	F1	F2	F1	F2	F1	F2	F1	F2
N0 : No fumigation (control)	86.00	86.00	84.33	84.00	77.00	78.33	62.00	63.33	52.67	53.00
	(68.04)	(68.04)	(66.69)	(66.43)	(61.35)	(62.26)	(51.94)	(52.73)	(46.53)	(46.72)
N1 : Fumigation at 30 days after harvest	88.67	89.67	87.67	88.67	79.33	79.67	75.00	75.33	58.00	58.67
	(70.33)	(71.25)	(69.44)	(70.33)	(62.96)	(63.20)	(60.00)	(60.22)	(49.60)	(49.99)
N2 : Fumigation at 90 days after harvest	86.67	87.33	86.00	88.33	78.00	78.33	74.67	75.00	57.33	58.00
	(68.59)	(69.15)	(68.03)	(70.03)	(62.03)	(62.26)	(59.78)	(60.00)	(49.22)	(49.60)
N3 : Fumigation at 150 days after harvest	86.33	86.33	85.00	86.00	77.67	78.00	74.00	74.67	55.00	56.33
	(68.31)	(68.31)	(67.22)	(68.04)	(61.80)	(62.03)	(59.35)	(59.78)	(47.87)	(48.64)
N4 : Fumigation at 30 and 90 days after harvest	85.67	85.67	83.00	77.00	77.00	77.33	61.33	62.00	49.67	50.67
	(67.76)	(67.76)	(65.66)	(61.35)	(61.35)	(61.57)	(51.55)	(51.94)	(44.81)	(45.38)
N5 : Fumigation at 30 and 150 days after harvest	85.00	85.33	82.67	83.33	76.67	77.00	63.00	60.00	48.67	49.00
	(67.22)	(67.48)	(65.40)	(65.91)	(61.12)	(61.35)	(52.54)	(50.77)	(44.24)	(44.43)
N6 : Fumigation at 90 and 150 days after harvest	84.67	85.00	80.33	81.67	76.00	76.67	59.33	59.67	47.00	47.33
	(66.95)	(67.22)	(63.68)	(64.65)	(60.67)	(61.12)	(50.38)	(50.57)	(43.28)	(43.47)
N7 : Fumigation at 30, 90 and 150 days after harvest	84.00	84.33	78.33	79.33	75.67	78.67	58.33	59.00	46.00	46.67
	(66.43)	(66.69)	(62.26)	(62.96)	(60.44)	(62.49)	(49.80)	(50.19)	(42.71)	(43.09)
For comparing means of	SE (M)±	CD at 5%	SE (M)±	CD at 5%	SE (M)±	CD at 5%	SE (M)±	CD at 5%	SE (M)±	CD at 5%
F	0.12	NS	0.11	NS	0.11	0.31	0.10	NS	0.09	0.27
N	0.25	0.71	0.23	0.66	0.21	0.62	0.21	0.59	0.19	0.54
F × N	0.35	NS	0.32	0.93	0.30	NS	0.29	0.84	0.26	NS

* Figures in the parenthesis indicates arc sine transformed values NS : Non significant

Fumigants (F) : F1 : Aluminium phosphide F2 : Ethylene **Per cent reduction in germination** number of insects to survive (2.00, 2.04, 3.13, 5.00 and 6.38) during two, four, six, eight and ten months of storage, respectively (Table 3). Irrespective of fumigants, among the number of fumigations, unfumigated groundnut seeds recorded highest (5.00, 6.83, 9.00, 11.50 and 13.67) number of groundnut beetles while, it was lowest (0.00, 0.00, 0.00, 0.00 and 2.00) in seeds that received three fumigations at 30, 90 and 150 DAH during two, four, six, eight and ten month of storage. In interaction treatment, the seeds fumigated with ethylene dibromide once at 30 DAH recorded highest (2.67, 4.67, 7.67 and 9.33) number of groundnut beetles while during four, six, eight and ten months of storage, aluminium phosphide the least (0.00, 0.00, 0.00, 0.00 and 1.00) population of beetles was registered in the seeds exposed to three fumigations at 30, 90 and 150 DAH during two, four, six, eight and ten months of storage.

Between the fumigants, the seeds fumigated with ethylene dibromide recorded higher seed germination besides this treatment also recorded less per cent reduction in germination compared to seeds fumigated with aluminium phosphide at the end of ten month of storage. The better performance of ethylene dibromide is due to its lesser penetration into seeds and its vapours are non inflammable. So, it did not react with constituents of food stuff and reduced residual effect on seed is observed which is also supported by Agarwal *et al*. (1987) in maize.

The seeds fumigated with aluminium phosphide recorded less number of groundnut beetle populations compared to ethylene dibromide at the end of ten months of storage which clearly indicates that, aluminium phosphide has more toxicity than ethylene dibromide, which combats the pest population effectively, but drastic reduction in seed quality parameters were noticed throughout the storage. Aluminium phosphide fumigated seeds can maintain the satisfactory seed germination (70 %) up to six months with less pest population. The present findings are in agreement with those of Lindgren *et al.* (1962). The groundnut seed fumigated with ethylene dibromide at 30 and 90 days after harvest maintained germination (70 %) and seed quality parameters Kamble *et al.* (2013). In many instances, single fumigation is not sufficient for control of storage pest. The fumigant may lose its concentration with the advancement of storage period and reoccurrence of the pest in storage is found several times. It is essential to combat the storage pest during entire storage period for which repeated fumigation could be adopted at definite intervals between the fumigations. Repeated fumigation has cumulative injury to seeds, some residue of fumigants retained after first fumigation again gets accumulated in each subsequent fumigation which leads to drastic reduction in seed quality parameters like germination. But, effective control of storage pest may be achieved by adopting exact number of fumigations and groundnut seeds can tolerate with a particular fumigant and also the time gap between the repetitions of fumigation needs to be ascertained. Decrease in seed quality by repeated fumigations with ethylene

Table 2. Influence of fumigants and number of fumigations on per cent reduction germination after ten months of storage of groundnut seeds over initial germination.

Treatments	Per cent reduction in germination(%) at 10 months after storage	
	F1 : Aluminium phosphide	F2 : Ethylene dibromide
N0 : No fumigation (control)	43.96	43.61
N1 : Fumigation at 30 days after harvest	38.29	37.58
N2 : Fumigation at 90 days after harvest	39.01	38.29
N3 : Fumigation at 150 days after harvest	41.48	40.07
N4 : Fumigation at 30 and 90 days after harvest	47.15	46.09
N5 : Fumigation at 30 and 150 days after harvest	48.22	47.87
N6 : Fumigation at 90 and 150 days after harvest	50.00	49.64
N7 : Fumigation at 30, 90 and 150 days after harvest	51.06	50.35

Table 3. Influence of fumigants and number of fumigations on beetle population in groundnut seeds

Treatments	Months after storage														
	Two			Four			Six			Eight			Ten		
	F1	F2	Mean	F1	F2	Mean	F1	F2	Mean	F1	F2	Mean	F1	F2	Mean
N0	4.33	5.67	5.00	6.33	7.33	6.83	8.67	9.33	9.00	11.00	12.00	11.50	13.33	14.00	13.67
N1	0.00	0.00	0.00	1.33	2.67	2.00	3.67	4.67	4.17	6.00	7.67	6.83	7.67	9.33	8.50
N2	1.67	2.67	2.17	0.00	0.00	0.00	4.33	6.33	5.33	5.33	5.67	5.50	6.67	7.33	7.00
N3	3.00	3.33	3.17	3.67	4.67	4.17	0.00	0.00	0.00	1.33	2.00	1.67	5.33	3.67	4.50
N4	0.00	0.00	0.00	0.00	0.00	0.00	2.00	3.67	2.83	3.67	6.33	5.00	5.00	5.33	5.17
N5	0.00	0.00	0.00	1.00	1.67	1.33	1.33	1.00	1.17	2.00	3.67	2.83	3.00	4.67	3.83
N6	3.67	4.33	4.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2.67	1.83	1.00	3.67	2.33
N7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	3.00	2.00
Mean	1.58	2.00	1.79	1.54	2.04	1.79	2.50	3.13	2.81	3.79	5.00	4.40	5.38	6.38	5.88

Fumigants (F)
F1 : Aluminium phosphide
F2 : Ethylene dibromide

Number of fumigations (N)
N0 : No fumigation (control)
N1 : Fumigation at 30 days after harvest
N2 : Fumigation at 90 days after harvest
N3 : Fumigation at 150 days after harvest
N4 : Fumigation at 30 and 90 days after harvest
N5 : Fumigation at 30 and 150 days after harvest
N6 : Fumigation at 90 and 150 days after harvest
N7 : Fumigation at 30, 90 and 150 days after harvest

dibromide and aluminium phosphide were also reported by Yadav *et al.* (1968) in wheat, paddy and maize seeds; Raghunathan *et al.* (1969) in sorghum, Yadav and Mookherjee (1974) and Kirsur (1985) in maize and Ramazan and Chahal (1989) and Rathod (1999) in wheat. In the unfumigated seeds (control) noticed highest number of groundnut beetle while, it was lowest at the end of ten months of storage in seeds given three fumigations at 30, 90 and 150 days after harvest. The present findings were confirmed with findings of Gupta and Kashyap (1995) in pulses. In the interaction effects between the fumigants and number of fumigations, the seeds fumigated with ethylene dibromide once and at 30 days after harvest (F2N1) performed better by recording higher quality parameters like germination besides recording less per cent reduction in germination. Better seed quality in this treatment combination (F2N1) may be due to less residual effect of fumigants. The finding of present study are in conformity with the reports of Yadav *et al.* (1968) who worked in wheat, paddy and maize seeds ; Raghunathan *et al.* (1969) in sorghum, Yadav and Mookherjee (1974) and Kirsur (1985) in maize; Umapathy (1988) and Ramazan and Chahal (1989) in wheat.

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Correlation and Path Analysis forYield and Yield Contributing Traits in Chickpea (*Cicer arietinum* L.)

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ABSTRACT

The present studies were conducted to the estimation of correlation for quantitative traits using 56 promising chickpea (*Cicer arietinum* L.) genotypes. Correlation studies at both genotypic and phenotypic levels were made to resolve the direction and magnitude of association among characters. Seed yield per plant had highly significant positive correlation with number of secondary branches per plant (0.8222), number of pods per plant (0.7965), number of seeds per pod (0.6086), 100 seed weight (0.5945), number of primary branches per plant (0.5311), Plant height (0.3086) while seed yield per plant had significant negative association with days to 50 per cent flowering (-0.2764) and days to maturity (-0.3414). Path coefficient analysis help to find out the direct and indirect contribution from each of the characters towards seed yield per plant. The path coefficient analysis revealed that highest direct effect of number of pods per plant (0.4866) exerted on the seed yield followed by 100 seed weight (0.3903), number of seeds per pod (0.1905) and number of secondary branches per plant (0.1595).

The present study was conducted for estimation of correlation between quantitative traits using 56 promising chickpea (*Cicer arietinum* L.) genotypes. Chickpea (*Cicer arietinum* L.) commonly known as Chana, Gram or Bengal gram. It belongs to the sub-family *Papilionaceae* of family *Leguminoceae*, is an important and unique food legume. It is an important pulse crop of the world occupying third position amongst pulses.

It is one of the most important *Rabi* pulse crops in Asia. India is largest producer (25%), importer (20%) and consumer (27%) of pulses in the world.The chickpea is a good source of protein (24.6 %), carbohydrate (64.6 %) and vitamins (Abu-Salem and Abou, 2011). It also provides calcium, magnesium, potassium, phosphorus, iron, zink and manganese (Ibrikci *et al.,* 2003). This food legume has diversified uses, and presently as many as 140 countries are importing chickpea (Gaur *et al.,* 2012).

Path coefficient analysis has been found to be aquantify direct and indirect trait association with yield(Bakhsh *et al.* 1998; Saleem *et al.* 2002). When morecharacters are involved in correlation study it becomesdifficult to ascertain the characters which significantlycontribute to yield. The methods of partitioning the correlation into direct and indirect effects by path coefficients analysis was suggested by Wright (1921). It provides useful information on the relative merit of the traits in the selection criterion.The correlation and path analysis provides information on genetic association of yield and different yield contributing characters, which in turn are useful in developing breeding strategies. In view of the above facts, the present investigation was undertaken involving fifty six diverse and elite genotypes of chickpea

MATERIAL AND METHODS

The experimental material comprising 56 genotypes which were raised in Randomized Block Design in two replications during *Rabi* 2016-17. The experimental material was grown at Pulses Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. Observations on following 9 quantitative characters were recorded on five randomly selected plants from each plot in each replication. Correlation studies at both genotypic and phenotypic levels were made to resolve the direction and magnitude of association among characters. To find out the direct and indirect contribution from each of the characters towards seed yield plant^{-1}, path coefficient analysis was carried out as suggested by Dewey and Lu (1959) and developed by Wright (1921).

RESULTS AND DISCUSSION

The genotypic and phenotypic correlations of nine characters studied were presented in Table 1 and 2.

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Table 1. Estimates of genotypic (above diagonal) correlation coefficient among different characters in chickpea genotypes

S.N.	Characters	Days to 50 % flowering	Days to maturity	Plant height (cm)	Number of primary branches $plant^{-1}$	Number of secondary branches $plant^{-1}$	Number of seeds pod^{-1}	Number of pods $plant^{-1}$	100 seed weight (g)	Seed yield $plant^{-1}$
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1.	Days to 50% flowering	**1.000**	0.5026**	-0.0424	-0.1211	-0.2012*	-0.4274**	-0.2083*	-0.2857**	-0.2764**
2.	Days to maturity		**1.000**	0.1807	0.0057	-0.3340**	-0.3862**	-0.3247**	-0.0945**	-0.3414**
3.	Plant height (cm)			**1.000**	0.1445	0.0750	0.2116*	0.1065	0.3964**	0.3086**
4.	No. of primary branches per plant				**1.000**	0.6724**	0.2720**	0.5590**	0.1905*	0.5311**
5.	No. of secondary branches per plant				**1.000**	0.4261**	0.8218**	0.3853**	0.8222**	
6.	Number of seeds per pod						**1.000**	0.4650**	0.2892**	0.6086**
7.	Number of pods per plant							**1.000**	0.1578	0.7965**
8.	100 seed weight (g)								**1.000**	0.5945**
9	Seed yield /plant									**1.000**

* Significant at 5 % level of probability or level of significance.

** Significant at 1 % level of probability or level of significance.

Table 2. Estimates of phenotypic (above diagonal) correlation coefficient among different characters in chickpea

Characters	Days to 50 % flowering	Days to maturity	Plant height (cm)	Number of primary branches plant^{-1}	Number of secondary branches plant^{-1}	Number of seeds pod^{-1}	Number of pods plant^{-1}	100 seed weight (g)	Seed yield plant^{-1}
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Days to 50 % flowering	**1.000**	0.4678**	-0.0375	-0.1189	-0.1983*	-0.3880 **	-0.2014*	-0.2759**	-0.2686**
Days to maturity		**1.000**	0.1779	-0.0022	-0.3048**	-0.3741**	-0.3117**	-0.0942	-0.3242**
Plant height (cm)			**1.000**	0.1402	0.0768	0.2018*	0.1048	0.3886**	0.3028**
No. of primary branches per plant				**1.000**	0.6500**	0.2594**	0.5490**	0.1908*	0.5201**
No. of secondary branches per plant					**1.000**	0.3966**	0.8009**	0.3781**	0.7974**
Number of seeds per pod						**1.000**	0.4547**	0.2769**	0.5914**
Number of pods per plant							**1.000**	0.1551	0.7903**
100 seed weight (g)								**1.000**	0.5856**
Seed yield /plant									**1.000**

* Significant at 5 % level of probability or level of significance.

** Significant at 1 % level of probability or level of significance.

Table 3. Path coefficient analysis showing direct and indirect effects of eight traits on seed yield in chickpea.

S. N.	Characters	Days to 50 % flowering	Days to maturity	Plant height (cm)	Number of primary branches plant^{-1}	Number of secondary branches plant^{-1}	Number of seeds pod^{-1}	Number of pods plant^{-1}	100 seed weight (g)	Total genotypic correlation with seed yield plant^{-1}
1.	Days to 50 % flowering	0.0964	0.0484	-0.0041	-0.0117	-0.0194	-0.0412	-0.0201	-0.0275	-0.2764
2.	Days to maturity	-0.0402	-0.0799	-0.0144	-0.0005	0.0267	0.0309	0.0260	0.0076	-0.3414
3.	Plant height (cm)	-0.0027	0.0116	0.0642	0.0093	0.0048	0.0136	0.0068	0.0255	0.3086
4.	No. of primary branches plant^{-1}	-0.0035	0.0002	0.0041	0.0286	0.0192	0.0078	0.0160	0.0054	0.5311
5.	No. of secondary branches plant^{-1}	-0.0321	-0.0533	0.0120	0.1072	0.1595	0.0680	0.1311	0.0615	0.8222
6.	Number of seeds pod^{-1}	-0.0814	-0.0736	0.0403	0.0518	0.0812	0.1905	0.0886	0.0551	0.6086
7.	Number of pods plant^{-1}	-0.1013	-0.1580	0.0518	0.2720	0.3999	0.2263	0.4866	0.0768	0.7965
8.	100 seed weight (g)	-0.1115	-0.0369	0.1547	0.0743	0.1504	0.1129	0.0616	0.3903	0.5945

Residual effect = 0.312, Bold figures indicate direct effect

The only significant correlations either in positive or negative directions are described. In general, genotypic correlation coefficients were higher than their corresponding phenotypic correlation coefficients

The significant positive correlation was reported between seed yield per plant with number of pods plant^{-1}, number of seeds pod^{-1}, number of primary branches plant^{-1}, number of secondary branches plant^{-1} and 100 seed weight. These results are in agreement with the findings of Malik *et al.* (2010), Padmavathi (2013) and Johnson *et.al* (2015). The significant negative correlation was reported between seed yield per plant with days to 50 per cent flowering and days to maturity indicating that early maturing genotypes produce high yield due to escape from moisture stress. These results are in agreement with Deshmukh and Patil (1995) and Bhanu *et al.* (2017). Seed yield plant^{-1} had highly significant positive correlation with number of secondary branches plant^{-1} (0.8222), number of pods plant^{-1} (0.7965), number of seeds pod^{-1} (0.6086), 100 seed weight (0.5945), number of primary branches plant^{-1} (0.5311), Plant height (0.3086) while seed yield plant^{-1} had significant negative association with days to 50 per cent flowering (-0.2764) and days to maturity (-0.3414). Among the yield components plant height had significant positive correlation with 100 seed weight; number of primary branches also shows positive correlation with number of pods per plant, number of secondary branches showed the highly positive significant correlation with number of pods plant^{-1}. This indicates the simultaneous improvement of these characters through selection can lead to the development of high yielding chickpea varieties. The importance of this association was also reported by Sandhu *et al.* (1991)

The path coefficient analysis revealed that highest direct effect of number of pods plant^{-1} (0.4866) exerted on the seed yield followed by 100 seed weight (0.3903), number of seeds pod^{-1} (0.1905) and number of secondary branches plant^{-1} (0.1595). Both correlation and path analysis indicated that number of pods plant^{-1}, 100 seed weight, number of seeds pod^{-1} are the major contributor to seed yield.These direct effects are mainly responsible for significant positive association of these characters with seed yield plant^{-1}. These results are similar to findings of Tripathi *et al.*(1995), Jeena and Arora (2002), Noor *et al.* (2003) Bhanu *et al.* (2017) and Singh *et al.* (2016).

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Genetic Variability Studies In Land Races of Sorghum

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ABSTRACT

The experiment was conducted during kharif season of 2011 using Randomized Block Design with three replications. The experimental material consisted of 99 land races of sorghum received from Directorate of Sorghum Research (DSR), Hyderabad. Observations were recorded for each genotype on eleven different characters namely days to 50% flowering, plant height (cm), seed hardness (kg/cm2), threshed grain mold rating (%), specific gravity of seed (g/ml), germination percentage of seed, vigour index of seed, electrical conductivity (dsm-1), 1000 seed weight (g), fodder yield per plant (g), and grain yield per plant (g).The characters fodder yield per plant, grain yield per plant and threshed grain mold rating showed high GCV and PCV values indicating thereby large amount of variation in aforesaid characters. The higher magnitude of PCV as compared to GCV in respect of characters, grain yield per plant and 1000 seed weight indicated the greater effect of environment on these characters. The high heritability estimates were observed for all the characters expect 1000 seed weight and these characters would respond positively to selection. The high values of expected genetic advance over mean were recorded for the characters fodder yield per plant, threshed grain mold rating, grain yield per plant, seed hardness and plant height.

Sorghum is an important cereal crop in India. Sorghum ranks fifth, among the world cereal food crops (Rice, Wheat, Maize, and Barley). The sorghum is grown extensively in almost all the countries in Africa, America, Brazil, China, Russia and Peru. Sorghum crop is widely grown especially in tropical and sub tropical regions of India as a major cereal crop used for dual purpose i.e. feedand fodder. The fodder is used as animal feed in the form of chop, hay, silage, pasture etc. It has several industrial uses. The grains are used for making bread, pop and beer. In the present investigation the variability parameters i.e. phenotypic and genotypic co-efficient of variation (PCV and GCV), heritability, genetic advance (GA) and correlation were studied.

The challenge to sorghum improvement will be to concentrate on utilization of desirable traits from such land races that may aid in developing the improved lines aiming to surpass the present productivity plateau combined with better drought, disease and pest resistance along with improved grain quality. It is well established fact that the progress in improvement of a crop depends on the degree of variability in the desired character in the base material i.e. germplasm collection.

MATERIAL AND METHODS

The ninety nine landraces received from Directorate of Sorghum Research (DSR), Hyderabad were grown in randomized block design with three replication during kharif 2011.The recommended cultural practices were followed to raise a good and healthy crops. Observations were recorded for each genotype on eleven different characters namely days to 50% flowering, plant height (cm), seed hardness (kg/cm^2), threshed grain mold rating (%), specific gravity of seed (g/ml), germination percentage of seed, vigour index of seed, electrical conductivity (dsm^{-1}), 1000 seed weight (g), fodder yield per plant (g) and grain yield per plant (g).

RESULTS AND DISCUSSION

In any crop improvement programme existence of sufficient amount of genetic variability is a prerequisite for success of any breeding programme. It is therefore necessary to assess the extent of variability existing in the population. The land races are the rich reservoirs of genetic variability.

The characters fodder yield per plant, grain yield per plant, threshed grain mold rating, seed hardness and

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plant height showed high GCV and PCV values indicating thereby large amount of variation for the aforesaid characters. Same results were found by The characters fodder yield per plant, grain yield per plant, threshed grain mold rating, seed hardness and plant height showed high GCV and PCV values indicating thereby large amount of variation for the aforesaid characters. Similar results were found by Can et al.(1998), Kumar and Singh (1986), Rathod (2005) and Bakheit (1990) for the above characters respectively. The higher magnitude of PCV as compared to GCV in respect of characters, grain yield plant^{-1} and 1000 seed weight indicated the greater effect of environment on these characters.

With the genotypic coefficient of variation, it is difficult to determine the relative amounts of heritable and non heritable components of variation present in the population. Estimates of heritability and genetic advance would supplement this parameter. The effectiveness of selection for any character depends not only on the extent of genetic variability but also in the extent to which it will be transferred from one generation to next.

The high heritability estimates were observed for the characters threshed grain mold rating followed by electrical conductivity, days to 50 per cent flowering, fodder yield per plant, plant height, seed hardness, grain yield per plant, germination parentage of seed, vigour index of seed and specific gravity of seed. These characters would respond positively to selection because of their high broad sense heritability.

High heritability estimates for threshed grain mold rating were reported by Rathod (2005) and Deepalaxmi and Ganeshmurty (2007). For character electrical conductivity, high heritability estimates were reported by Rathod (2005) and Thorat *et al.* (2005). Similarly for days to 50% flowering high heritability estimates were reported by Naphade (1973), Eckebil *et al.* (1977), Salilkumar and Singhania (1984), Kishor and Singh (2005), Hemlata Sharma *et al.* (2006), Deepalaxmi and Ganeshmurty (2007), Godbharle *et al.* (2010), Ahmed *et al.* (2012) and Jain and Patel (2012).

For fodder yield per plant high heritability estimates were reported by Kulkarni and Shinde (1987), Satpute and Tiwari (1990), Warkhad *et al.* (2008), Jain *et al.* (2009), Godbharle *et al.* (2010).

Expected genetic advance percent over mean is important selection parameter. It is an improvement in main genotypic value of selected plant over parental population. The estimate of genetic advance helps in understanding the gene action involves in expression of various polygenic characters and also in deciding the breeding procedure for the genetic improvement of various polygenic traits. High value of genetic advance percent over mean was recorded for fodder yield per plant. These results are confirmed with findings of Salilkumar and Singhania (1984), Kumar and Singh (1986).

In general high heritability accompanied with high expected genetic advance for characters suggest that the genes governing these character may have additive effect. It can be mentioned here that characters fodder yield per plant, grain yield per plant, threshed grain mold rating, seed hardness and plant height exhibited high heritability values along with high values of expected genetic advance. The phenotypic expression of these characters may be governed by the gene acting additively and thereby indicating the importance of these characters for selection. For character fodder yield per plant, similar findings were recorded by Satpute and Tiwari (1990) and Godbharle et al.(2010). Similar findings were also recorded by Deepalaxmi and Ganeshmurty (2007) for the character grain yield per plant.

Low values of expected genetic advance percent over mean were observed for the characters electrical conductivity followed by days to 50 per cent flowering, vigour index of seed, 1000 seed weight, germination percentage of seed and specific gravity of seed. Similar results were observed for the character electrical conductivity by Thorat *et al.* (2005). Similar results were obtained by Deepalaxmi and Ganeshmurty (2007) for the character days to 50 per cent flowering. Low values of expected genetic advance percent over mean for the character 1000 seed weight were reported by Thorat *et al.* (2005), Deepalaxmi and Ganeshmurty (2007) and Chavan*et al.* (2010). For the character specific gravity of seed, similar results were reported by Rathod (2005) and Thorat *et al.* (2005).

Table 4.3 Estimation of genetic parameters – range, mean, GV, PV, GCV, PCV, h^2 and EGA for characters under study

S.N.	Character	Range	Mean	SE(d)	Genotypic variance	Phenotypic variance	Genotypic coefficient of variation	Phenotypic coefficient of variation	h^2 %	EGA as % over mean
1	Days to 50% flowering	54.33 -95.33	74.83	1.01	102.77	105.27	13.22	13.42	97.06	26.83
2	Plant height (cm)	110.00–434.00	272.00	7.00	4149.17	4296.51	19.85	20.20	96.57	40.18
3	Seed hardness (kg/cm^2)	4.03 -10.13	7.08	0.20	3.517	3.643	26.78	27.25	96.53	54.19
4	Threshed grain mold rating (%)	3.06 - 11.36	7.21	0.13	5.599	5.561	38.97	39.15	99.08	79.90
5	Specific gravity of seed (g/ml)	0.98 -1.08	1.03	0.06	0.0003	0.0004	1.66	2.00	69.28	2.85
6	Germination % of seed	71.50 – 86.00	78.75	1.11	11.446	15.150	4.30	4.64	75.56	7.70
7	Vigour index of seed	10.01-16.84	13.42	0.54	2.474	3.353	11.23	13.07	73.81	19.88
8	Electrical conductivity (dsm^{-1})	0.79 - 1.46	1.12	0.17	0.030	0.0316	15.75	15.95	97.08	31.97
9	1000 seed weight (g)	14.75 -40.08	27.41	6.04	21.727	131.233	17.94	44.99	16.56	15.04
10	Fodder yield per plant (g)	35.00- 435.00	235.00	6.48	3609.55	3735.60	44.14	44.91	96.63	89.39
11	Grain yield per plant (g)	5.13 - 44.83	25.05	2.58	75.549	95.560	41.35	46.51	79.06	75.74

High values of heritability along with low value of expected genetic advance were observed for the characters like electrical conductivity, days to 50 per cent flowering, germination percentage of seed, vigour index of seed and specific gravity of seed because regarding these characters, the heritability is mainly due to non additive gene effect (dominance and epitasis) hence the expected genetic advance would be low. Since the characters are mainly governed by non additive component of variation which is non fixable, heterosis breeding can be fruitfully exploited improving these characters. Thorat *et al.* (2005) reported high values of heritability along with low values of expected genetic advance for the characters electrical conductivity and specific gravity of seed.

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Organically Production of Forage Oat-Lucerne in Intercropping under Different Row Ratio

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ABSTRACT

A field experiment was conducted during *rabi* season of 2016-2017 at Navsari, Gujarat to study the production potential of forage oat – lucerne intercropping as influenced by different row ratio under south Gujarat conditions. Intercropping system had significant effect on green fodder yield, dry fodder yield, land equivalent ratio, gross returns, net returns and benefit:cost ratio. The results of the experiment showed significant increase in green fodder yield of oat and lucerne, dry fodder yield of oat under different row ratios. However, oat + lucerne in the ratio of 2:1 recorded significantly highest green fodder yield (991.14 q ha^{-1}) of oat and lucerne as well as significantly higher dry fodder yield (114.12 q ha^{-1}) of oat. The maximum land equivalent ratio (1.44) gross returns (1,98,225 ha^{-1}), net returns (1,66,341 ha^{-1}) and benefit:cost ratio (6.22).

Livestock rearing is very important part of our rural economy not only for animal products, but also for draft power.Availability of green forage to animals is the key to success of dairy enterprises and it is difficult to maintain the health and milk Production of the livestock without supply of green fodder.At present, the country faces net deficit of 61.1% green fodder, 21.9 per cent dry fodder. This situation indicates that green forage supply has to grow at 3.2 per cent to meet the deficit. As a result of deficit in fodder availability livestock suffers continuously with malnutrition for the year round in general, resulting in their production capacity at sub-optimum level. Intercropping of botanically diverse forage species like cereals and legumes appears to be one of the feasible approaches for increasing the fodder yield, utilization of land more efficiently improving fodder quality and providing stability to production (Tripathi, 1989).

MATERIAL AND METHODS

A field experiment was conducted during *rabi*season of 2016-2017 at College Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari.The soil of experimental the field was clayey in texture, having pH 7.8, low in organic carbon content (0.44%), low in available nitrogen (206.50 kg ha^{-1}), medium in available phosphorus (38.20 kg ha^{-1}) and fairly rich in available potassium (323.18 kg ha^{-1}).

The experiment was laid out in Randomized Block Design and replicated four times, six treatments comprising of T_1 sole oat, T_2 sole lucerne, four row ratios of T_3 oat + lucerne (1:1), T_4 oat + lucerne (1:2), T_5 oat + lucerne (2:1) and T_6 oat + lucerne (2:2) were evaluated in present study. The oat and lucerne cultivars Kent and Anand lucerne-2 were used as test crop respectively for oat and lucerne were sown, 30 cm spacing in row proportion as per treatments in third week and fourth week of November. The seed rate under sole and intercropping was maintained at 100 and 25 kg/ha, respectively for oat and lucerne. Recommended dose of fertilizer was applied to both the component crops as basal application. The crop was raised under irrigated conditions with recommended agronomic practices. Total two cuts were taken with the first cut at 54 days after sowing and second cut at 52 days after sowing. The growth parameters, viz. initial plant population/metre row length, plant height and dry matter accumulation (g $plant^{-1}$) were recorded at each cutting. Green fodder yield recorded immediately after harvest of crops, whereas dry fodder yield of oat was recorded after sun drying at each cut. The plant samples were collected from each plot for dry matter accumulation, crude fibre and estimation of nitrogen for crude-protein content following standard procedure. The economics was calculated on the basis of prevailing market prices of different inputs and output.

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RESULTS AND DISCUSSION

Green and dry fodder yields

Green fodder and dry fodder yields were significantly affected by different intercropping treatments (Table 1). The total green fodder (991.14 q/ha) was highest under oat + lucerne in 2:1 row ratio and significantly superior to the other intercropping systems and sole stand of oat and lucerne.The increase in total green fodder yield of oat-lucerne intercropping system in 2:1 row ratio was 42.37 and 45.95 per cent over sole oat and sole lucerne, respectively. The data also indicated that all systems of oat + lucerne showed yield advantage over sole oat and sole lucerne. However, total forage yield was greater because of contribution of oat. The increase in total green fodder and dry matter yields in the intercropping systems might be owing to better utilization of space and light interception coupled with nutrient contribution of leguminous fodder to cereal. The results are in agreement to those to Kumar (2005), Sharma *et al* (2009) and Deore*et al.* (2013).

The data on total dry fodder yield clearly indicated that various treatments of sole and intercropping systems significantly differed among each other. The maximum total dry fodder yield (114.12 q ha^{-1}) was obtained under sole oat but it was found statistically at par with T_5 oat + lucerne 2:1 row ratio (101.08 q ha^{-1}). Oat in 1:1, 1:2 and 2:2 row ratio reduced the dry fodder yield over sole cropping of oat. However, total dry fodder yield of sole oat is closely followed by oat + lucerne in 2:1 row ratio. These results confirmed findings of Patel *et al.* (2008), Surve *et al.,* (2012) and Chaplot (2014).

Table 1: Green fodder yield of oat and lucerne at first and second cut as influenced by different row ratio under intercropping system

Treatment	Green fodder yield (q/ha)				
	Oat		Lucerne		Total
	First cut	Second cut	First cut	Second cut	
T_1 : Sole Oat	430.75	265.38	-	-	696.13
T_2 : Sole Lucerne	-	-	372.25	306.83	679.08
T_3 : Oat + Lucerne (1:1)	268.13	169.06	231.19	188.44	856.81
T_4 : Oat + Lucerne (1:2)	218.44	132.63	298.69	248.19	897.95
T_5 : Oat + Lucerne (2:1)	381.94	234.88	202.88	171.44	991.14
T_6 : Oat + Lucerne (2:2)	255.94	178.13	225.68	194.13	853.86
CD at 5%	49.82	30.86	30.93	30.22	51.48

Table 2: Dry fodder yield of oat as influenced by different row ratio under intercropping system

Treatment	Dry fodder yield(q ha^{-1})		
	First cut	Second cut	Total
T_1: Sole Oat	70.10	44.03	114.13
T_2: Sole Lucerne	-	-	-
T_3: Oat + Lucerne (1:1)	42.55	27.73	70.28
T_4: Oat + Lucerne (1:2)	33.83	21.75	55.58
T_5: Oat + Lucerne (2:1)	62.58	38.50	101.08
T_6: Oat + Lucerne (2:2)	39.70	29.68	69.38
S.E (m) ±	2.47	1.94	2.67
C.D at 5%	7.64	5.98	8.23

Table 3: Economics of oat and lucerne as influenced by different row ratio under intercropping system

Treatment	Cost of production (Rs ha^{-1})	Gross realization (Rs ha^{-1})	Net realization (Rs ha^{-1})	BCR	LER
T_1 : Sole Oat	29681	139226	109545	3.69	1.00
T_2 : Sole Lucerne	34320	135816	101496	2.96	1.00
T_3 : Oat + Lucerne (1:1)	32000	171362	139362	4.35	1.25
T_4 : Oat + Lucerne (1:2)	32696	179590	146894	4.49	1.31
T_5 : Oat + Lucerne (2:1)	31073	198228	167155	5.38	1.44
T_6 : Oat + Lucerne (2:2)	32000	170772	138772	4.34	1.24

Land equivalent ratio (LER)

Land-equivalent ratio (LER) calculated from combined intercrop yield was higher in all intercropping system, than either of the sole crops, i.e. oat and lucerne. This clearly indicated greater biological efficiency of the intercropping treatments (Table 2). The significantly highest mean LER (1.44) was recorded in intercropping of oat and lucerne planted in the row ratio of 2:1, followed by oat + lucerne 1:2 row ratio (LER=1.31). It showed that to produce combined mixture yield by growing sole stand would require 44% more land. Land-equivalent ratio for intercropping where it was more than 1, indicating suitability of the practice in quantitative term. The present findings are in accordance with those of Patel and Rajgopal (2003), Kumar *et al.* (2005), and Surve *et al.* (2012).

Economics

All the intercropping systems recorded higher gross and net returns as well as monetary advantages than sole cropping of component crops (Table 2) indicating thereby that intercropping being a productive and remunerative system of cultivation. The intercropping of oat and lucerne under different row ratio increase gross and net returns. The highest gross and net returns (1,98,225 and 1,66,341 ha^{-1}) were recorded in oat and lucerne 2:1 row ratio followed by oat +lucerne in 1:2 row ratio (1,79,590 and 1,46,082 ha^{-1}). This was due to higher productivity of the system than other intercropping and sole cropping treatments.Similar results has been also reported by Sharma *et al.* (2008), Singh *et al.* (2009), Kheroar and Patra (2014), Mandal *et al.* (2014), Dhonde *et al.* (2016).

Thus, it could be inferred from the above study that oat proved to be more compatible intercrop with lucerne in 1:2 row proportion planted in uniform rows with the highest productivity, land use efficiency and monetary return.

On the basis of the results obtained in present investigation, it can be concluded that by growing fodder oat and lucerne in 2:1 row ratio increased 44 per cent green fodder yield over sole cropping provide higher economic benefit.

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Influence of Foliar Spray of Liquid Fertilizers (premix) on Yield, Biological Yield, Nutrient Uptake and Nutrient Status of Soil in Chickpea Under Irrigated Condition

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ABSTRACT

A field experiment was conducted during 2016-17 at the Research Farm of All India Coordinated Research Project on Integrated Farming System, Main centre, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (MS) with an object to find out the effect of foliar application of premix liquid fertilizers on yield, biological yield, nutrient uptake by crop and soil nutrient status in chickpea under irrigated condition.Foliar application of premix liquid fertilizer and seaweed extract were applied at an interval of 30, 45 and 60 DAS.Results revealed that seed yield and nutrient uptake by seed were found significantly higher in treatment RDF + Liquid fertilizers (premix) @ 1 litre ha^{-1} followed by RDF + Liquid fertilizers (premix) @ 1.5 litre ha^{-1}. While straw yield and biological yield were higher in RDF +Liquid fertilizers (premix) @ 1.5 litresha^{-1}. However, nutrient uptake by straw was significantly higher in RDF + Liquid fertilizers (premix) @ 1.5 litre ha^{-1} followed by RDF + Liquid fertilizers (premix) @ 1 litre ha^{-1} except phosphorus, itsuptake was higher in RDF + Liquid fertilizers (premix) @ 1 litre ha^{-1} followed by RDF + Liquid fertilizers (premix) @ 1.5 litre ha^{-1}. Total uptake of nitrogen and phosphorus was recorded higher in RDF + Liquid fertilizers (premix) @ 1 litre ha^{-1} followed by RDF + Liquid fertilizers (premix) @ 1.5 litre ha^{-1}. While, total uptake of potassium was higher in RDF + Liquid fertilizers (premix) @ 1.5 litre ha^{-1} followed by RDF + Liquid fertilizers (premix) @ 1 litre ha^{-1}. The effect of different treatments on available nitrogen, phosphorus, potassium, sulphur and iron was found to be statistically non significant.

Chickpea is one of the major pulse crop in India and in many other countries and plays an important role in the diets of vegetarians around the world. Pulses are the primary source of nourishment and when combined with cereals, provide a nutritionally balanced food for human being. Frequent consumption of pulses is now recommended by most of the health organizations (Leterme, 2002). In addition, it is a good source of energy, protein, minerals, vitamins, fibre and also contains potentially health-beneficial phytochemicals. It is a main source of vegetable protein in human diet as it contains 21per cent protein and 38-59 per cent carbohydrates (Gupta, 1989). Besides, Chickpea is also credited with the ability of atmospheric nitrogen fixation through symbiotic process and it has been estimated that chickpea has the capacity to fix 140 kg N ha^{-1} in a growing season (Rupela and Saxena, 1987). The fixed N not only can meet the requirements of the legume for maximum grain formation, but can also be available for use by subsequent crops, after mineralization of chickpea crop residues.

In India, chickpea is grown on an area of 9.93 million ha with annual production of 9.53 million tons with productivity of 960 kg ha^{-1} in *rabi*season (Anonymous, 2015[a]). Madhya Pradesh, Maharashtra, Karnataka, Andhra Pradesh and Rajasthan are the major chickpea growing states. In Maharashtra, chickpeais grown on an area of 17.74 lakh hectares with a production of 15.07 lakh tons and a productivity of 850 kg ha^{-1}. (Anonymous, 2015[b]). In Vidarbha, chickpea is grown on area of 5.53 lakh ha, with a production of 3.8 lakh tons, with a productivity of 876 kg ha^{-1} (Anonymous, 2015[c]).

Nutrients must be available in sufficient and balanced quantities for optimum plant growth. Soil contains natural reserve of plant nutrients, but these reserves are largely in unavailable forms to plants. A minor portion is released each year through biological activity or chemical processes. This release is too slow to compensate the removal of nutrients to meet crop requirements and agricultural production. During reproductive stage, root activities decrease where as more

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nutrients required at the same time for fulfillment of nutrients needs, foliar spray with nutrient solution is an alternative source.In Indian condition water scarcity during growing period and improper nutrient management practices are the major constraints of agriculture. In order to enhancing the productivity of the pulses and nutrient use efficiency foliar application of nutrients is the best option. Foliar application of nutrients results in enhancing the growth, yield and nutrient uptake in pulses.Agronomic practices of chickpea are required to be standardized for realizing yield potential. Application of nutrients through foliar sprays along with soil application has several advantages in supplementing the nutritional requirements of crops. Foliar nutrition is designed to eliminate the problems like fixation and immobilization of nutrients. Hence, foliar nutrition is being recognized as an important method of fertilization in modern agriculture.

Considering the importance of foliar application of nutrients to chickpea and the information available on foliar application of nutrients to chickpea was very meagre. Hence, the present study was undertaken.

MATERIAL AND METHODS

A field experiment was carried out during *Rabi* season of 2016-17 at the Research Farm of All India Coordinated Research Project on Integrated Farming Systems, Main Centre, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (MS) with an object to study the effect of foliar application of liquid fertilizers (premix) on yield, biological yield, nutrient uptake and nutrient availability in soil after harvest of chickpea under irrigated condition. The experiment was laid out in randomized block design with five treatments and four replications. The gross plot size was 8 m x 6.3 m. The net plot size was 7.4 m x 5.7 m. Details of the experimental treatments along with symbols used in plan of layout are as under viz, T1- RDF + Liquid fertilizers (premix) @ 500 ml ha^{-1}, T2- RDF + Liquid fertilizers (premix) @ 1.0 liter ha^{-1}, T3- RDF + Liquid fertilizers (premix) @ 1.5 liter ha^{-1}, T4- RDF + Sea weed extract @ 500 ml ha^{-1}, T5- Control (Only RDF). Recommended dose of fertilizers (RDF) of chickpea is 25:50:30 N, P_2O_5 andK_2O kg ha^{-1}.

Composition of liquid fertilizers (premix)

1	Heterocyclic nitrogen	20%
2	P_2O_5,	6%
3	Iron	5%
4	Sulphur	10%
5	Inert ingredients	QS

Composition of sea weed extract

1	Sea weed (*Ascophyllumnodosum) extract*	20%
2	Sulphur	200 ppm
3	Magnesium	500 ppm
4	Calcium	500 ppm
5	Sodium	5000 ppm
6	Boron	20 ppm
7	Iron	20 ppm
8	Magnese	1 ppm
9	Copper	1 ppm
10	Zinc	5 ppm
11	Other traces of cytokinins, auxins, proteins and amino acids	–

Foliar application of premix liquid fertilizer and seaweed extract were applied at an interval of 30, 45 and 60 DAS.Crop of chickpea and its variety JAKI-9218 was used for sowing at the spacing of 30 × 10cm by drilling method,sown on dated 28/10/2016 and harvested on 10/2/2017. The selected field of experiment was fairly uniform, leveled andclayey in texture. It was low in available nitrogen (206.98 kg ha^{-1}) and phosphorus (16.32 kg ha^{-1}) and medium in organic carbon(0.57 %), rich in available potassium (358.3 kg ha^{-1}) and slightly alkaline (pH 7.8) in reaction. The total rainfall during cropping period from October 2016 to February 2017 was 91.0 mm as against normal rainfall of 102.6 mm with rainy days 5 as against the normal of 7.2 days. During crop growing season, the maximum temperature was ranging from 27.3 ^{0}Cto 32.4 ^{0}C and minimum temperature varied from 8.4 ^{0}C to 14.3 ^{0}C.Bright sunshine hours were mostly lower than normal. The bright sunshine hours were lower than normal and helped the crop to utilize the available soil moisture for comparatively larger period of time.

Table 1: Monthly average weather data for October to December, 2016 & Jan., - Feb., 2017, Department of Agronomy, Dr. PDKV, Akola

Normal: 1971-2010 Actual:2016-17

S. N.	Months	T MAX (°C)		T MIN (°C)		BSH (hrs)		WS (km/hr)		RH I (%)		RH II (%)		Evap (mm)		RF (mm)		Rainy Days	
		N	A	N	A	N	A	N	A	N	A	N	A	N	A	N	A	N	A
1	Oct., 2016	33.75	31.4	18.875	19.1	7.275	7.375	5.025	1.525	76	85.7	39.25	48.65	5.4	4.1	50.9	90.5	0.75	5
2	Nov., 2016	31.68	31.14	13.96	11.6	8.66	8.58	4.56	0.32	70.8	82.58	30.4	31.48	4.86	3.86	24	0	0.28	0
3	Dec. 2016	29.48	29.75	10.70	9.60	8.70	8.25	4.68	0.75	69.75	83.83	29.00	32.95	4.28	3.65	6.10	0.00	0.18	0.00
4	Jan., 2017	29.73	29.35	11.25	10.93	8.83	7.30	5.53	0.83	71.25	80.50	28.75	36.00	4.68	3.93	7.10	0.00	0.18	0.00
5	Feb., 2017	32.52	33.76	13.2	14.56	9.38	8.72	6.2	1.8	56.6	65.4	21.8	21.4	6.7	6.64	14.5	0.5	0.28	0
	Total															102.6	91.0	7.2	5

RESULTS AND DISCUSSION

Seed yield

The result revealed (Table1) that the effect of different treatments influenced significantly the seed yield of chickpea. As the dose of liquid fertilizers (premix) increasedup to 1 L ha^{-1}, proportionally seed yield were also increased. However, further increased in dose was decreased the yield. Whereas, significantly highest seed yield (1893 kg ha^{-1}) was recorded with RDF + Liquid fertilizers (premix) @ 1 L ha^{-1} (T_2) and it was measured to be 23.15 per cent followed by RDF + Liquid fertilizers (premix) @ 1.5 L ha^{-1} (T_3), which were found statistically similar with each other. Further, next high values of seed yield were recorded in RDF + Liquid fertilizers (premix) @ 500 ml ha^{-1} (T_1) and RDF + Seaweed extract @ 500 ml ha^{-1} (T_4) which were found statistically on par with each other. Significantly inferior seed yield was recorded in control (T_5). The best results were found in (T_2), might be because of better translocation of photo assimilates toward reproductive parts instead of vegetative parts and comparable low yield in (T_3) than (T_2) was found only due diversion of more energy towards vegetative parts.The results are in accordance with the results reported by Vivek Kumar Singhal *et al.* (2015) and Rahman (2017).

Straw yield

The straw yield was increased with increasing the dose of liquid fertilizers up to 1 L ha^{-1} and decreased thereafter. Significantly highest straw yield of 2861 kg ha^{-1} was recorded with RDF + Liquid fertilizers (premix) @1.5 L ha^{-1} (T_3) followed by RDF + Liquid fertilizers (premix) @ 1 Lha^{-1} (T_2) which were at par with each other. The next better treatment in relation to straw yield was RDF + Liquid fertilizers (premix) @ 500 ml ha^{-1} (T_1). Significantly inferior straw yield of 2519 kg ha^{-1} was recorded with control (T_5) which was found to be on par with RDF + Seaweed extract @ 500 ml ha^{-1} (T_4). The increase in straw yield with foliar application of liquid fertilizers might be due to higher rate of metabolic activities due to presence of macro and micro nutrients in the liquid fertilizers which resulted in more number of branches and dry matter accumulation. These results are in accordance with the results reported by Akhila *et al.* (2017).

Biological yield

Significantly higher biological yield (4704 kg ha^{-1}) was recorded with RDF + Liquid fertilizers (premix) @ 1.5 L ha^{-1} (T_3) followed by RDF + Liquid fertilizers (premix) @ 1 L ha^{-1} (T_2) which were at par with one another. The next higher values of biological yield were recorded in RDF + Liquid fertilizers (premix) @ 500 ml ha^{-1} (T_1) and RDF + Seaweed extract @ 500 ml ha^{-1} (T_4) which were found to be statistically on par with each other. The lowest biological yield of 4055 kg ha^{-1} was observed in control (T_5). These results are in confirmation with the findings of Sarbandi and Madani (2014).

Table 2. Seed yield, straw yield and biological yield of chickpea as influenced by various treatments

Treatments	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index (%)	% increase over control
T_1 - RDF + Liquid fertilizers (premix) @ 500 ml ha^{-1}	1721	2617	4338	39.68	11.96
T_2 - RDF + Liquid fertilizers (premix) @ 1 litre ha^{-1}	1893	2784	4677	40.45	23.15
T_3 - RDF + Liquid fertilizers (premix) @ 1.5 litre ha^{-1}	1843	2861	4704	39.19	19.93
T_4 - RDF + Seaweed extract @ 500 ml ha^{-1}	1695	2613	4308	39.39	10.28
T_5 - Control (Only RDF 25:50:30 Kg NPK ha^{-1})	1537	2519	4055	37.91	-
SE (m) ±	50.65	65.98	78.11	0.95	-
CD at 5%	156.06	203.32	240.67	-	-
GM	1755	2672	4427	39.64	-

Foliar application of premix liquid fertilizer and sea weed extract were applied at an interval of 30, 45 and 60 DAS in T1, T2, T3 and T4 and compared with control.

NPK uptake by chickpeaand nutrient availability in soil at crop harvest

The nutrient uptake (Table 2) were influenced significantly by various foliar spray and recorded the means of nutrient uptake in seed and straw of chickpea were nitrogen (51.36and 51.38kg ha^{-1}), phosphorous (8.41 and 8.06kg ha^{-1}) and potassium (19.48 and 48.85 kg ha^{-1}).

Uptake of Nitrogen

Maximum nitrogen uptake (61.46 kg ha^{-1}) was observed with RDF + Liquid fertilizers (premix) @ 1 L ha^{-1}which followed by RDF + Liquid fertilizers (premix) @ 1.5 Lha^{-1} and RDF + Liquid fertilizers (premix) @ 500 ml ha^{-1}. However, in straw nitrogen uptake was highest in RDF + Liquid fertilizers (premix) @ 1.5 L ha^{-1} followed by RDF + Liquid fertilizers (premix) @1 L ha^{-1}, RDF + Liquid fertilizers (premix) @ 500 ml ha^{-1} and RDF + Seaweed extract @ 500 ml ha^{-1}. The higher uptake of the nitrogen might be due to efficient translocation of nutrients to particular dose. Similar results were recorded by Gowda *et al.* (2015), Akhila (2017).

Uptake of Phosphorus

In seed, RDF + Liquid fertilizers (premix) @ 1 L ha^{-1} recorded significantly higher (10.01 kg ha^{-1}) phosphorus uptake by seed which was at par with RDF + Liquid fertilizers (premix) @ 1.5 L ha^{-1}. P uptake in straw recorded significantly higher value (9.18 kg ha^{-1}) in RDF + Liquid fertilizers (premix) @ 1 L ha^{-1} followed by RDF + Liquid fertilizers (premix) @ 1.5 L ha^{-1}. The higher uptake of nutrients might be due to better accumulation of nutrients to particular dose. Similar results were also reported by Srijitapaul (2015) and Akhila (2017). The increase in straw yield with foliar application of liquid fertilizers might be due to higher rate of metabolic activities because of presence of macro and micro nutrients in the liquid fertilizers which resulted in more number of branches and dry matter accumulation. These results are in accordance with the results reported by Deepak Kumar (2015).

Uptake of Potassium

Among the various foliar spray on chickpea, RDF + Liquid fertilizers (premix) @1 L ha^{-1} recorded significantly higher potassium uptake by seed (21.56 kg ha^{-1})which was at par with RDF + Liquid fertilizers (premix) @ 1.5 Lha^{-1} and RDF + Liquid fertilizers (premix) @ 500 ml ha^{-1}. Potassium uptake by straw (52.64 kg ha^{-1}) was significantly influenced by RDF + Liquid fertilizers (premix) @1.5 L ha^{-} which was on par with RDF + Liquid fertilizers (premix) @t 1 L ha^{-1}, RDF + Liquid fertilizers (premix) @ 500 ml ha^{-1} and RDF + Seaweed extract @ 500 ml ha^{-1}. The higher uptake indicates that there was efficient translocation of nutrients due to particular dose. Similar observations were reported by Cheke (2014) and Akhila (2017)

Available nitrogen, phosphorus, potassium, sulphur and iron in soil after crop harvest

The data in respect of available nitrogen (217.43kg ha^{-1}), phosphorus (17.33kg ha^{-1}), potassium (367.02kg ha^{-1}), sulphur (14.57 mg kg^{-1}) and iron (8.42 mg kg^{-1}) in soil after harvest of crop were recorded (Table 2). The effect of different treatments on available nitrogen,

Table 3. Nitrogen, Phosphorous and potassium uptake by chickpea as influenced by foliar application of premix liquid fertilizers

Treatments	N uptake(kg ha^{-1})		P uptake (kg ha^{-1})		K uptake (kg ha^{-1})	
	Seed	Straw	Seed	Straw	Seed	Straw
T_1 - RDF + Liquid fertilizers (premix) @ 500 ml ha^{-1}	49.55	48.61	8.22	7.73	19.32	47.60
T_2 - RDF + Liquid fertilizers (premix) @ 1 litre ha^{-1}	61.46	56.26	10.01	9.18	21.56	51.72
T_3 - RDF + Liquid fertilizers (premix) @ 1.5 litre ha^{-1}	57.82	56.37	9.40	8.76	20.83	52.64
T_4 - RDF + Seaweed extract @ 500 ml ha^{-1}	46.65	49.64	7.63	7.52	18.98	47.32
T_5 - Control (Only RDF 25:50:30 Kg NPK ha^{-1})	41.32	46.00	6.77	7.12	16.73	44.99
SE(m)±	2.77	2.96	0.53	0.40	0.89	2.43
CD at 5%	8.54	9.11	1.63	1.23	2.75	7.49
GM	51.36	51.38	8.41	8.06	19.48	48.85

Table 4. Available nitrogen, phosphorus, potassium, sulphur and iron in soil after harvest as influenced by various treatments of foliar liquid fertilizers

Treatments	Available N ($kg\ ha^{-1}$)	Available P ($kg\ ha^{-1}$)	Available K ($kg\ ha^{-1}$)	Available S ($mg\ kg^{-1}$)	Available Fe ($mg\ kg^{-1}$)
T_1 - RDF + Liquid fertilizers (premix) @ 500 ml ha^{-1}	216.07	17.21	362.88	14.60	8.19
T_2 - RDF + Liquid fertilizers (premix) @ 1 litre ha^{-1}	226.16	18.23	378.56	15.21	9.27
T_3 - RDF + Liquid fertilizers (premix) @ 1.5 litre ha^{-1}	224.66	17.86	374.64	14.84	8.46
T_4 - RDF + Seaweed extract @ 500 ml ha^{-1}	210.43	16.80	362.32	14.26	8.11
T_5 - Control (Only RDF25:50:30 Kg NPK ha^{-1})	209.83	16.57	356.72	13.95	8.09
SE(m)±	5.48	0.45	9.72	0.67	0.58
CD at 5%	-	-	-	-	-
GM	217.43	17.33	367.02	14.57	8.42
Initial soil status	206.98	16.32	358.3	13.69	9.49

phosphorus, potassium, sulphur and iron was found to be statistically non significant. However, more availability was observed with RDF + Liquid fertilizers (premix) @ 1 L ha^{-1}. Similar results were also reported by Vivek Kumar Singhal *et al.* (2015) and Akhila *et al.* (2017).

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Effect of Foliar Nutrition on Growth, Yield Attributes and Seed Yield of Greengram

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ABSTRACT

Field experiment was conducted to find out the influence of foliar nutrition on growth and seed yield of greengram during *kharif*2017-18. Results indicated that foliar spray of 2 per cent Urea + salicylic acid 100 ppm at flowering stage along with basal application of fertilizers (20: 40: 20 kg N, P_2O_5, K_2O) significantly increased growth attributes viz., plant height, leaf area plant^{-1}, dry matter accumulation plant^{-1} and yield attributes viz., pods plant^{-1}, seed pod^{-1}, pod length and test weight. Further foliar spray of 2 per cent urea + salicylic acid 100 ppm recorded the highest yield of 1304 kgha^{-1} with a yield increment of 39% over absolute control. The yield enhancement might be attributed to hastened availability of N in the plant system, more chlorophyll synthesis, greater accumulation of protein in plants and efficient translocation of assimilates to reproductive parts.

The pulse form integral part of cropping system of farmer all over the country because they fit well in crop rotation and crop mixture as well. Pulses constituent an important ingredient in the vegetarian diet of developing countries like India and also ensure nutritional security of poor masses. Pulses have capacity to fix atmospheric nitrogen and well adopted low fertility and limited soil moisture condition due to deep root system. In Maharashtra this crop occupies an area of 5.11 lakh ha with production and productivity is 2.89 lakh tones and 566 kg ha^{-1}, respectively. Vidharbha region has 1.13 lakh ha area under greengram with total production 0.78 lakh tones and average productivity is 547 kg ha^{-1}. Pulses being cultivated under rainfed/summer season leads to low soil moisture, under rainfed condition even application of fertilizer at right time and right quantity may not be efficient due to soil moisture. When availability of moisture becomes scarce, application of fertilizers through foliar spray resulted in efficient absorption. Though foliar spray is not a substitute to soil application but it certainly be considered as a supplement to soil application (Upadhyay *et al*. 1992). Among the methods of fertilizer application, foliar nutrition is recognized as an important method of fertilization, since foliar nutrients usually penetrate the leaf cuticle or stomata and enters the cells facilitating easy and rapid utilization of nutrients (Latha and Nadanassababady, 2003).

The nutrients are known to alter the various physiological and biochemical functions which finally influences on the yield of the crop. Sometimes, soil applied nutrients are insufficient for crop to meet out their nutrient requirement and it may be due to non-availability of nutrients due to abrupt soilconditions, exhausted soil condition or nutrient losses through leaching and many more things which can hinder the availability of nutrients to plants and cease the plant growth, which ultimately affect the yield and quality of the crop produce. Furthermore, nutrient status is an important and deciding factor in judging the total dry matter accumulation in plants. In recent years, the use of nutrients as foliar spray is gaining importance in improving the yield potential and also the quality of produce in several crops so as to meet out their nutrient requirement in-spite of abrupt soil conditions. Foliar feeding is often the most effective and economical way to correct plant nutrient deficiencies. During the last decades, foliar feeding of nutrients has become an established procedure in crop production to increase yield and improve the quality of crop products. Keeping these view in mind, the present investigation was carried out to find out the effect of foliar application of nutrient on growth and yield of greengram.

MATERIALAND METHODS

The field experiment was conducted during *Kharif* 2017 at the farm of Agronomy Department,

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Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The soil was clayey in texture, slightly alkaline in nature. The available soil nitrogen, phosphorus and potassium were 209, 13.25, 333 kg ha^{-1} respectively. Seeds were sown in rows of 30 cm apart with a plant to plant spacing of 10 cm by adopting completely randomized block design.The recommended fertilizer dose of 20 kg N, 40 kg P_2O_5, 20 kg K_2O ha^{-1} were applied as basal through urea, DAP and muriate of potash in lines and incorporated at the time of sowing.The crop was provided with irrigation at two day after sowing and vegetative stage. The recommended packages of practices were followed for raising a good and healthy crop. The treatments viz., T_1-Absolute control, T_2- RDF alone, T_3- RDF + foliar spray of urea 2 per cent, T_4- RDF + foliar spray of DAP 2 per cent, T_5- RDF + foliar spray of thiourea 500ppm, T_6- RDF + foliar spray of 19:19:19 2 per cent, T_7- RDF + foliar spray of 00:52:34 2 per cent (at 50 per cent flowering) &13:00:45 2 per cent (at pod development), T_8- RDF + foliar spray of boron 0.25ppm, T_9-RDF + foliar spray of salicylic acid 100 ppm, T_{10}-RDF + foliar spray of urea 2 per cent + salicylic acid 100 ppm and T_{11}-RDF + foliar spray of nitrobenzene 500 ppm. Foliar sprays were executed at pre-flowering stage for all treatment except KNO_3 spray in T_7 at (pod development). five plant were selected at random from each plot for recording plant height, branches per plant, seed weight per plant, pods per plant, and 1000-seed weight at maturity and were weighed using an electric balance. Seed and biological yield were recorded on per plot basis and were converted to kg ha^{-1}. Economics was calculated by using prevailing market prices of inputs used and outputs. The data were analysed statistically using the 'F' test and critical difference (C.D) was calculated (Panse andSukhatme, 1961).

RESULTS AND DISCUSSION

Foliar spray of 2 per cent urea + salicylic acid @ 100 ppm recorded higher plant height (69.60 cm), LA (21.92dm^2) and dry matter accumulation $plant^{-1}$ (24.82 g) at 60 DAS. In the present study,the increase in plant height might be due to additional supply of nutrients through foliar application which increased the nutrient uptake and better translocation of nutrients. The increase in plant height by urea spray may be attributed to the increase in N status in plant system. Thus nitrogen containing source (urea) has increased the height substantially compared to the rest of the nutrients (Kalarani, 1991). The maximum LA at peak flowering contributes to better yielding ability in grain legumes (Thandapani, 1985), which is a pre-requisite to maximise the photosynthetic activity. The maximum leaf area (21.93 dm^2) at 60 DAS recorded with foliar spray of 2 per cent urea + salicylic acid 100ppm, whereas absolute control recorded lower leaf area (12.79 dm^2) The ureasprayed plant maintained comparatively more LA at differentstages, thus aiding in the supply of photosynthates for thedevelopment of pods and grains and also intensification ofmetabolic activity and efficient utilisation of N (Beninger, 1978). Dry matter reflects the accumulated carbohydrate in theplant. Foliar spray of 2% urea + salicylic acid (T_{10}) had a profound effect in increasing the dry matter accumulation $plant^{-1}$ (24.82 g) than other treatments. The present result are in accordance with the findings of Kannan (1986) statedthat application of urea increased the TDMP by reducing theleaf senescence.

Foliar spray of 2 per cent urea + salicylic acid 100 ppm had profound effect in improving number of pods per plant, grain weight per plant, 1000 seed weight and yield (Table 3). The number ofpods per plant was increased due to the foliar spray of 2 per cent urea + salicylic acid @ 100ppmreduces the shading of flower result in more number of pods $plant^{-1}$.Further foliageapplication of nitrogen attributed to higher chlorophyll content with enhanced photosynthetic activity and higher uptake of nutrients and there by increased plant dry matter production in the pod setting phase which might have improved the pod development and number of pods per plant. The present results in accordance with finding of Reddy *et al.* (2004) and Mudalagiriyappa*et al.* (2015).Mengal and Forster (1980) stated that seed weight has a significant contribution to the final yield of the crops. The combination of Urea and salicylic acid effectively increased the seed weight by 31 per cent over absolute control. Prasuraman (2001) recorded similar improvement in seed weight in green gram. In the present study also foliar spray of 2 per cent urea + salicylic acid 100ppm showed more grain weight (5.62 g) than control (3.86 g).Increase in grain weight $plant^{-1}$ might be due to the supply of foliage applied nitrogen and growth regulator at critical stages of the crop, leading to better photosynthetic activity and its ability to developed bold seed resulting in better development of yield components i.e. increase in number of pod, number of grain pod^{-1}, pod length resulted in increase in the grain weight per plant The present results are in accordance with the findings of Satyajit*et al.* (2003). Foliar spray of 2 per cent urea + salicylic acid @ 100ppm (T_{10}) exhibited higher yield (1304 kg ha^{-1}) with 39 per cent yield increment over absolute control followed by RDF + 2 per cent foliar spray of 00:52:34 (at 50 % flowering) & 13:00:45 (at pod development) (1303 kg ha^{-1}).

Table. 1. Effect of foliar nutrition on growth parameter of greengram

Treatments	Plant height at 60 DAS (cm)	Leaf area plant^{-1} (dm^2) at 60 DAS	Dry matter accumulation plant^{-1} (g) at 60 DAS
Absolute control	53.20	12.79	17.70
RDF alone	59.77	14.48	21.33
RDF + foliar spray of urea 2%	60.77	21.50	23.68
RDF + foliar spray of DAP 2%	60.60	19.55	23.00
RDF + foliar spray of thiourea 500 ppm	60.53	20.93	23.07
RDF + foliar spray of thiourea 500ppm	68.53	19.23	22.51
RDF + foliar spray of 00:52:34 2% (at 50% flowering) & 13:00:45 2% (at pod development)	68.37	19.23	22.51
RDF + foliar spray of boron 0.25ppm	63.33	19.23	24.58
RDF + foliar spray of salicylic acid 100 ppm	66.07	18.75	22.93
RDF + foliar spray of urea 2% + salicylic acid 100 ppm	69.60	21.92	24.82
RDF + foliar spray of nitrobenzene 500 ppm	67.00	18.84	23.49
Mean	63.42	1858	22.7
CD at 5%	8.62	2.64	3.2

Table.2. Effect of foliar nutrition on yield parameters and yield of greengram

Treatments	Number of pods plant^{-1}	Grain weight plant^{-1} (g)	Test weight (g)	Seed yield (kg ha^{-1})
Absolute control	9.43	3.86	35.60	793
RDF alone	10.20	4.54	36.20	870
RDF + foliar spray of urea 2%	14.67	5.54	38.76	1246
RDF + foliar spray of DAP 2%	11.53	4.98	38.00	973
RDF + foliar spray of thiourea 500 ppm	13.43	5.07	38.16	1081
RDF + foliar spray of thiourea 500ppm	13.57	5.37	38.44	1122
RDF + foliar spray of 00:52:34 2% (at 50% flowering) & 13:00:45 2% (at pod development)	16.33	5.60	39.18	1303
RDF + foliar spray of boron 0.25ppm	10.52	4.89	37.67	937
RDF + foliar spray of salicylic acid 100 ppm	11.30	4.95	37.68	971
RDF + foliar spray of urea 2% + salicylic acid 100 ppm	17.07	5.62	39.39	1304
RDF + foliar spray of nitrobenzene 500 ppm	12.33	5.00	38.12	1030
CD at 5%	3.6	0.90	1.08	224

The increase in seed yield are in accordance with foliar spray of growth regulator and urea might be attributed to hastened availability of N in the plant system, more chlorophyll synthesis, greater accumulation of protein in plants and efficient translocation of assimilates to reproductive parts. Seed yield of greengram is resultant product of yield attributing characters beneficial effect of foliar nutrition on yield attributes have increased the seed yield. These results are in agreement with the finding of Sarkar and Malik (2001) and Ali *et al*. (2005). In these crops, foliar spray of urea showed a distinct effect in retarding the leaf senescence and in turn produced higher dry matter and grain yield. The higher yield noticed in urea spray might also be due to longer retention of the effective photo-assimilatory surface (Prabakaran, 2002).

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Productivity of Soybean and Available Nutrient Status as Influenced by Tillage and INM Practices under Soybean-Cotton Rotation in Vertisol

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ABSTRACT

The present investigation was conducted during kharif 2016-17 with a view to study the productivity of soybean and available nutrient status as influenced by tillage and INM practices under soybean - cotton rotation in Vertisol" conducted at Research Farm, Department of Soil Science and Agricultural Chemistry, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The experiment was carried out with two main plot treatments i.e. conservation tillage (one harrowing and two weeding) and conventional tillage (one ploughing , one harrowing, two hoeing and two hand weeding) and eight sub plot treatments of integrated plant nutrient system consisting of control, 100 per cent RDF and use of chemical fertilizer along with organic source of nutrient in which 50 per cent N applied through organic sources (FYM, wheat straw, glyricidia leaf manuring (GLM), composted cotton straw, vermicompost and phosphocompost) and remaining N was applied through chemical fertilizers. The experiment was framed in randomised block design with three replications. The soil and plant samples were analysed after harvest of crop during 2016-17. The use of organics *viz*. FYM, GLM, phosphocompost and vermicompost in conjunction with chemical fertilizers registered improvement in soil organic carbon, available N, P, K, S and micronutrients viz; Zn, Fe, Mn and Cu. The significantly highest seed and straw yield of soybean was recorded with the application of phosphocompost in conjunction with chemical fertilizers followed by FYM, GLM and vermicompost under conservation tillage. Among the tillage practices, the conservation tillage was found beneficial in improving soil nutrient status. Similarly, significantly higher soybean seed and straw yield was recorded in conservation tillage as compared to conventional tillage under soybean-cotton rotation.

Soybean cultivation is continuously increasing due to its dual utility as pulse as well as oil seed crop, besides it has better market price, high protein content (40-42 %) and oil content (20-22 %). It is the cheapest and richest source of high quality protein. It supplies most of the nutritional constituents essential for human health. Hence, soybean is called as "Wonder bean" or "Miracle bean". Soybean occupies an intermediate position between legumes and oilseed.It is grown in the area which receive 800-1200 mm rainfall and on almost all types of soil. Soybean crop contributes 24-30 q ha^{-1} residues which can be recycled and nutrient content therein be harnessed for the succeeding crop besides improving the soil fertility.

In India, area under soybean cultivation is approximately 9.95 m ha with production of 12.57 MT. Maharashtra ranks 2nd in soybean cultivated area and production in country. The area under soybean crop in Maharashtra is 35.80 lakh ha of total cultivated area of the country with an average productivity of 1102 kg ha^{-1} and production 39.45 lakh MT. (Anonymous, 2016). Out of total soybean cultivated area in Maharashtra 75 to 80 per cent area is in Vidarbha. The area under soybean cultivation in Vidarbha is 25.50 lakh ha with production of 21.62 lakh MT and average productivity is 1050 kg ha^{-1}.

The soybean has great potential to produce large amount of shaded biomass. The shaded biomass has potential to improve residual soil fertility and helps in attaining higher yield of ensuing *rabi* crops. The present study has been undertaken to study the effect of various tillage and INM practices on yield and soil nutrient status under soybean grown in Vertisol.

MATERIAL AND METHODS

The field experiment was conducted on research farm of Department of Soil Science and Agricultural Chemistry. The effect of conventional and conservation tillage was assessed along with different organic and inorganic fertilizers. The study was conducted in kharif 2016-2017 and during summer the land was fallow. The effect of tillage and organic sources were studied on soil properties under soybean and cotton crop rotation.

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The experiment was carried out with two main treatments i.e. conservation tillage (CNS) (one harrowing and two weeding) and conventional tillage (CNV) (one ploughing , one harrowing, two hoeing and two hand weeding) and eight sub plot treatments of integrated plant nutrient system consisting of control, 100 per cent RDF and use of chemical fertilizer along with organic source of nutrient in which 50 per cent N applied through organic sources (FYM, wheat straw, glyricidia leaf manuring (GLM), composted cotton straw, vermicompost and phosphocompost) and remaining N was applied through chemical fertilizers. The experiment was framed in randomized block design with three replications.The N, P and K were applied in the form of urea, single super phosphate and muriate of potash. Treatment wise basal doses (half nitrogen and full phosphorus and potassium) of fertilizers were calculated and applied at the time of sowing and remaining half dose of nitrogen was applied at flowering to soybean, thoroughly mixed in the soil. The crop residues were decomposed by PDKV decomposer. FYM, wheat straw, composted cotton stalk, vermicompost and phoshpocompost and glyricidia foliage lopping applied as a source of nutrient in soil. The different organics and crop residues were applied based on NPK content. The crop residues and Glyricidia lopping were applied in between two rows of soybean and thoroughly mixed in the soil. Simultaneously the crop residue samples were collected and analyzed for nutrient composition. The treatment wise soil sample upto 20 cm depth were collected. The processed soil samples were analyzed for different soil properties following standard procedures.

RESULTS AND DISCUSSION

Productivity of Soybean

The findings showed significantly increased soybean seed yield in conservation tillage as compared to conventional tillage (Table 1). The average soybean seed yield was recorded maximum (24.64 q ha^{-1}) in conservation tillage as compared to conventional tillage (22.61 q ha^{-1}). The Similar trend was recorded in respect of straw yield. The highest soybean seed yield in conservation tillage might be due to its cumulative effect

Table 1: Effect of tillage and IPNS on soybean seed and straw yield under soybean-cotton rotation

IPNS		Soybean yield (q ha^{-1})					
		Seed			Straw		
		CNS	CNV	Mean	CNS	CNV	Mean
T_1	Control	19.70	17.44	18.57	26.66	21.48	24.07
T_2	100 % RDF	24.36	23.02	23.69	31.61	29.31	30.46
T_3	50 % N through FYM + remaining RD through chemical fertilizer	26.24	23.76	25.00	34.06	29.09	31.57
T_4	50% N through WS+ remaining RD through chemical fertilizer	24.76	21.61	23.19	32.15	26.71	29.43
T_5	50% N through GLM + remaining RD through chemical fertilizer	25.76	23.44	24.55	33.03	29.88	31.45
T_6	50 % N through composted cotton stalk+ remaining RD through chemical fertilizer	22.74	22.37	22.56	32.41	26.49	29.45
T_7	50 % N through vermicompost+ remaining RD through chemical fertilizer	26.80	24.55	25.67	33.30	32.41	32.85
T_8	100 % N through phoshpocompost+ remaining P through chemical fertilizer	26.89	24.71	25.80	34.55	32.53	33.54
	Mean	24.64	22.61		31.24	28.49	
		Tillage	**NM**	**Int.**	**Tillage**	**NM**	**Int.**
	SE (m) ±	0.53	0.45	0.64	0.37	0.74	1.05
	CD (at 5%)	1.53	1.30	1.84	1.07	2.15	3.03

of soil moisture which ultimately helps in improving nutrient supplying capacity of soil, use efficiency which directly influences on uptake of higher nutrients in conservation tillage than conventional tillage. Similar finding was reported by Khan *et al*. (2015) and Mehdi *et al*. (2016).

The highest seed yield of soybean was recorded with the application of 100 per cent N through phoshpocompost + remaining P through chemical fertilizer (25.80 q ha^{-1}) followed by the use of 50 per cent N through vermicompost + remaining RD through chemical fertilizer (25.67 q ha^{-1}). The straw yield of soybean was ranged from 24.07 to 33.54 q ha^{-1}. However the highest straw yield of soybean (33.54 q ha^{-1}) was recorded under use of 100 per cent N through phoshpocompost + remaining P through chemical fertilizer followed by 32.85 q ha^{-1} in 50 per cent N through vermicompost + remaining RD through chemical fertilizer. The increase in yield with IPNS treatments may be due addition of organics which enhances soil fertility and resulted in higher yield. These results are in close conformity with the findings Babhulkar *et al.* (2000) and Kundu *et al.* (2008). Due to solubilisation of native as well as applied nutrient fertilizers at higher level with crop residues produces complexing agents and nutrients are released after microbial decay of crop residue ultimately increase the grain yield. Similar findings were reported by Deshmukh *et al.* (2010) Ghatage *et al*. (2003) and Bhalerao *et al*., (2007).

The seed and straw yield of soybean was increased significantly in conservation tillage along with various organics over the conventional tillage. The seed yield was significantly highest with the application of 100 % N through phoshpocompost + remaining P through chemical fertilizer in conservation tillage (26.89 q ha^{-1}) over the conventional tillage indicating role of these organics in supplying nutrient to crop. This can be attributed to the combined effect of conservation tillage in improving soil properties along with FYM resulting into highest seed yield of soybean.

Chemical properties

Organic carbon

The effect of tillage on organic carbon content was found significant (Table 2). However, slightly higher values of organic carbon (6.0 g kg^{-1}) were observed in conservation tillage as compared to conventional tillage (5.8 g kg^{-1}). Conservation tillage helps in leaving crop residues to accumulate on the soil surface and increase carbon sequestration by reducing oxidation of SOC in soil as compared to conventional tillage. The significant increase in organic carbon content under conservation tillage can be attributed to less disturbance of the soil which might have helped in preservation of more carbon in soil reducing oxidation of carbon. Novak *et al.* (2009) noticed conservation tillage increases the soil organic carbon as compared to disc tillage system.

Table 2 : Effect of tillage and IPNS on organic carbon of soil after harvest of soybean under soybean- cotton rotation

	IPNS	Organic carbon (g kg^{-1})		
		CNS	CNV	Mean
T_1	Control	5.35	5.21	5.28
T_2	100 % RDF	5.68	5.59	5.62
T_3	50 % N through FYM + remaining RD through chemical fertilizer	6.37	6.17	6.27
T_4	50% N through WS+ remaining RD through chemical fertilizer	5.94	5.66	5.81
T_5	50% N through GLM + remaining RD through chemical fertilizer	6.19	6.02	6.11
T_6	50 % N through composted cotton stalk+ remaining RD through chemical fertilizer	5.88	5.62	5.75
T_7	50 % N through vermicompost+ remaining RD through chemical fertilizer	5.96	5.86	5.90
T_8	100 % N through phoshpocompost+ remaining P through chemical fertilizer	6.17	5.93	6.03
	Mean	6.00	5.80	-
		Tillage	NM	Int.
	SE (m) ±	0.04	0.08	0.12
	CD (at 5%)	0.12	0.23	0.34

The organic carbon was significantly influenced due to different IPNS treatments during the year of investigation. Application of 50 % N through FYM + remaining RD through chemical fertilizer recorded significantly more organic carbon content in soil (6.27 g kg^{-1}) after harvest of soybean followed by 50 % N through GLM + remaining RD through chemical fertilizer and application of 100 % N through phosphocompost + remaining RD through chmical fertilizer which were found to be on par with each other than that of treatments receiving inorganic fertilizers and control.

The interaction among the conservation tillage practice and application of 50 per cent N through FYM + remaining RD through chemical fertilizer recorded significantly highest organic carbon (6.37 g kg^{-1}). However, the lowest organic carbon was recorded in the treatment combination conventional tillage and control indicating only application of inorganic fertilizers could not sustain to enhance the SOC status of soil. Hence, there is need to follow conservation tillage in Vertisols along with integrated nutrient management.

Available nutrients

Available nitrogen

Available nitrogen was recorded significantly higher in conservation tillage (233.4 kg ha^{-1}) as compared to conventional tillage (220.4 kg ha^{-1}) (Table 3). The higher availability of nitrogen was recorded by Khiani and More (1984), due to harrowing than ploughing in Vertisol due to enhanced, decomposition process and mineralization of the nutrients in the soil. Improved nitrogen status after harvest of crop was due to addition of biomass which stayed long period under conservation tillage. On the contrary, the nitrogen in soil was conserved under conservation tillage due to less disturbance of soil. Similarly, the highest nitrogen recorded under conservation tillage because of less mechanical disturbance of soil. There is accumulation of significant quantity of organic carbon in soil which is positively correlated with available nitrogen of the soil. Dick (1983) reported greater amount of nitrogen under no-tilled surface (0-30 cm) soil compared to minimum and conventional tillage.

The significantly highest available nitrogen (239.9 kg ha^{-1}) was recorded with the application of 50 per cent N through FYM + remaining RD through chemical fertilizers followed by application of 100 per cent RDF (236.7 kg ha^{-1}). Increase in available N due to organic materials application could also be attributed to the greater multiplication of soil microbes which could convert organically bound N to inorganic. Babhulkar *et al.* (2000) reported that the regular application of FYM is highly essential to maintain the sustainability of soil in respect of available nutrients.

Table 3: Effect of tillage and IPNS on available N of soil after harvest of soybean under soybean-cotton rotation

	IPNS	Avail N (kg ha^{-1})		
		CNS	CNV	Mean
T_1	Control	205.0	200.9	206.9
T_2	100 % RDF	242.8	230.7	236.7
T_3	50 % N through FYM + remaining RD through chemical fertilizer	243.7	236.5	239.9
T_4	50% N through WS+ remaining RD through chemical fertilizer	234.7	222.3	228.5
T_5	50% N through GLM + remaining RD through chemical fertilizer	240.5	226.8	233.7
T_6	50 % N through composted cotton stalk+ remaining RD through chemical fertilizer	235.1	217.2	223.7
T_7	50 % N through vermicompost+ remaining RD through chemical fertilizer	236	220.8	227.7
T_8	100 % N through phoshpocompost+ remaining P through chemical fertilizer	237.1	222.0	229.7
	Mean	233.4	220.4	-
		Tillage	**NM**	**Int.**
	SE (m) ±	1.67	3.35	4.73
	CD (at 5%)	4.83	9.66	13.67

The interaction of conservation practice with various nutrient management option viz., 50 per cent N through FYM + remaining RD through chemical fertilizer recorded significantly highest available N (243.2 kg ha^{-1}).

Available phosphorus

The effect of tillage on available phosphorus was found to be significant. The significantly higher available phosphorus was observed in conservation tillage (21.80 kg ha^{-1}) as compared to conventional tillage (19.95 kg ha^{-1}). Conservation tillage involves minimum surface tillage, leaving crop residue to accumulate at the soil surface and increase in organic matter ultimately enhance availability of nutrient like phosphorus. Similar observations were also recorded by Sonune *et al*. (2012) also observed higher available P in black cotton soils and minimum tillage compared to conventional tillage. Significant variation was observed in available phosphorus due to the tillage practices. This implies that high organic carbon in soil due to conservation tillage reduces phosphorus fixation due to release of various organic acids as a results of which more phosphorus becomes readily available to plant roots in the soil.

The highest available phosphorus (23.82 kg ha^{-1}) was observed in 100 per cent N through phoshpocompost + remaining P through chemical fertilizer which was significantly superior over all the other treatments and lowest available phosphorus was observed in control (14.46 kg ha^{-1}). Available phosphorus was found maintained under balanced fertilizer use and marginal increase was obtained in the treatment where organic manures and fertilizer was applied in combination. Application of organics in combination with fertilizers increased the available phosphorus status of soil, this could be attributed to the effect of applied fertilizer and mineralization of organic sources or through solubilisation of the nutrients from the native sources during the process of decomposition. Similar observation were recorded by Tiwari *et al.,* (2002). The Interaction between tillage and IPNS on soil available P was non significant.

Available potassium

Significantly higher available potassium was observed in conservation tillage (354.12 kg ha^{-1}) as compared to conventional tillage (349.30 kg ha^{-1}). Similar

Table 4. Effect of tillage and IPNS on available macronutrients insoil after harvest of soybean and cotton under soybean-cotton rotation

	Treatments (a)Tillage	P (kg ha^{-1})	K (kg ha^{-1})	S (mg kg^{-1})
	Set I-Conservation tillage	21.80	354.12	12.39
	Set II -Conventional tillage	19.95	349.30	10.96
	SE(m)±	0.18	1.57	0.04
	CD at 5 %	0.53	4.52	0.12
	(b) Integrated plant nutrient system			
T_1	Control	14.46	314.09	9.41
T_2	100 % RDF	18.35	350.82	11.08
T_3	50 % N through FYM + remaining RD through chemical fertilizer	22.76	364.93	12.29
T_4	50% N through WS+ remaining RD through chemical fertilizer	20.46	347.50	11.46
T_5	50% N through GLM + remaining RD through chemical fertilizer	21.77	362.30	12.03
T_6	50 % N through composted cotton stalk+ remaining RD through chemical fertilizer	22.41	350.10	11.89
T_7	50 % N through vermicompost+ remaining RD through chemical fertilizer	22.96	361.99	11.57
T_8	100 % N through phoshpocompost+ remaining P through chemical fertilizer	23.82	359.10	12.07
	SE(m)±	0.52	3.13	0.08
	CD at 5 %	1.76	9.05	0.24
	(c) Interaction	**NS**	**NS**	**NS**

Table 5. Effect of tillage and IPNS on available micronutrients in soil after harvest of soybean under soybean cotton rotation

	Treatments	Micronutrient (mg kg^{-1})			
	(a)Tillage	Zn	**Fe**	**Mn**	**Cu**
	Set I-Conservation tillage	0.59	7.01	9.25	1.99
	Set II -Conventional tillage	0.52	6.69	8.94	1.90
	SE (m)±	0.011	0.11	0.22	0.04
	CD at 5 %	0.032	0.32	0.62	0.13
	(b) Integrated plant nutrient system				
T_1	Control	0.46	6.10	8.51	1.70
T_2	100 % RDF	0.47	6.36	8.75	1.74
T_3	50 % N through FYM + remaining RD through chemical fertilizer	0.61	7.22	9.62	2.21
T_4	50% N through WS+ remaining RD through chemical fertilizer	0.52	6.90	9.13	1.94
T_5	50% N through GLM + remaining RD through chemical fertilizer	0.57	6.76	9.23	1.80
T_6	50 % N through composted cotton stalk+ remaining RD through chemical fertilizer	0.54	6.93	9.00	2.08
T_7	50 % N through vermicompost+ remaining RD through chemical fertilizer	0.60	7.10	9.57	2.08
T_8	100 % N through phoshpocompost+ remaining P through chemical fertilizer	0.60	6.95	9.28	1.98
	SE (m)±	0.022	0.22	0.43	0.09
	CD at 5 %	0.064	0.64	1.24	0.27
	(c) Interaction	NS	NS	NS	NS

observation were recorded by Gaikwad and Khupse (1976) in Vertisol and reported that available potassium was higher due to harrowing than ploughing in black soil.

The highest available potassium (364.93 kg ha^{-1}) was observed with the application of 50 % N through FYM + remaining RD through chemical fertilizer followed by (362.30 kg ha^{-1}) 50% N through GLM + remaining RD through chemical fertilizer and (361.99 kg ha^{-1}) with 50% N through vermicompost + remaining RD through chemical fertilizer, 100 % N through phoshpocompost+ remaining P through chemical fertilizer (359.10 kg ha^{-1}). The increase in availability of potassium can be attributed to direct addition of potassium through fertilizers and FYM to the available pool of soil and also the interaction of organic matter added through FYM with clay reduce potassium fixation and releases potassium in soil solution. Considerable increase in soil available potassium was also reported by Katkar *et al*. (2007). The Interaction between tillage and IPNS on available potassium was non significant.

Available sulphur

Significantly higher available sulphur was observed in conservation tillage (12.39 mg kg^{-1}) as compared to conventional tillage (10.96 mg kg^{-1}) .The increased availability of sulphur might be due to enhanced decomposition process and mineralization of the organic manures in conservation tillage. Improvement in available sulphur status under crop residues and green manuring is also due to its ameliorative effect on improvement of physical and chemical properties which helps to improve the availability of native sulphur in the soil. The results corroborates with the findings reported by Bharambe *et al*. (2002) and Halemani *et al.* (2004).

The significantly highest available sulphur (12.29 mg kg^{-1}) was recorded in treatment receiving 50 % N through FYM + remaining RD through chemical fertilizer followed by with the application of 100 % N through phoshpocompost + remaining P through chemical fertilizer (12.07 mg kg^{-1}) and application of 50 % N through glyricidia green leaf manuring + remaining RD through chemical fertilizer(12.03 mg kg^{-1}). The increase in available sulphur under Phosphocompost and FYM application might be due to solubilisation of the nutrients from native sources during the process of decomposition, which in turn the conserved organics to more available sulphate form, similar results were also noted by Babhulkar *et al.* (2000). This is evidenced from the initial status of S, which was improved in all the treatments except control. This implies that use of SSP is beneficial in improving the status of S over high analysis fertilizers like DAP. The results are in the line with the findings of Bhardwaj and Owmanvar, (1994) and Jadhao *et al.* (2014). The interaction between tillage and IPNS on available sulphur was non significant.

Available Micronutrients

The effect of tillage on available Zn, Fe, Mn and Cu were found to be significant. Slightly higher available Zn, Fe, Mn and Cu were observed in conservation tillage as compared to conventional tillage. Similar results about effect of tillage on the distribution of DTPA extractable Mn, Cu, Fe and Zn in soil was reported by Shuman and Hargrove (1984).

The available Zn, Fe, Mn and Cu content in soil was enhanced over initial available Zn, Fe, Mn and Cu where organics like FYM, Phospocompost, green manuring and crop residues were included. It supplies nutrients and added to the soil through the process of mineralization and which showed residual effect of previous year crops. The lowest available Zn, Fe, Mn and Cu was observed under control. The higher available Zn, Fe, Mn and Cu was recorded with application of 50 per cent N through FYM + remaining RD through chemical fertilizer and application of 100 per cent N through phoshpocompost+ remaining P through chemical fertilizer.This might be due to the mineralization of organically bound forms of Zn, Fe, Mn and Cu in the organic materials, which encouraged the formation of organic chelates of higher stability (Bellakki *et al.* 1998). The other possible reason for increased availability of micronutrients could be an enhanced microbial activity in the soil and consequent release of complex organic substances (chelating agents), which could have prevented micronutrients from precipitation, fixation, oxidation and leaching. The results are in conformity with Guled *et al.* (2002) and Ismail *et al.* (1998). The Interaction between tillage and IPNS on available Zn, Fe, Mn and Cu were non significant.

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Phosphorus Requirement of Soybean Grown in Vertisol

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ABSTRACT

The present investigation was undertaken during 2017-18 at Research Farm, Department of Soil Science and Agricultural Chemistry, Dr. PDKV, Akola. The experiment was laid out in Randomized Block Design with five treatments and four replications. The objective of study was to re-assess the phosphorus doses applied to soybean in the region. The treatments comprised various levels of phosphorus viz. 0, 45, 60, 75 and 90 kg ha^{-1} along with recommended dose of nitrogen and potassium @ 30 kg to each treatment. The soil of experimental site was deep black belongs to order Vertisols, particularly *Typic Haplustert* and calcareous in nature. Grain and straw yield of soybean, total uptake of N, P and K were significantly increased due various levels of phosphorus. It was increased with every successive increase in levels of phosphorus. The various levels of phosphorus did not have significant influence on protein content of soybean. The number of nodules per plant and dry weight of nodules were influenced significantly with increase in the levels of phosphorus. The various levels of phosphorus found equally beneficial in nodulation of soybean over control. The higher P use efficiency was recorded at 60 kg P ha^{-1} (14.92 %) followed by 75 kg P ha^{-1}. However, the phosphorus recovery was observed highest with 75 kg P ha^{-1}. The effect of various levels of phosphorus on soil nutrient status was found non-significant, except that of available phosphorus, which was significantly influenced with incremental levels of phosphorus along with the recommended dose of nitrogen and potassium.

Low native soil phosphorus (P) availability with poor utilization efficiency of added P is a major constraint limiting the productivity of soybean grown on Vertisols in Indian semi-arid tropics. Soybean being a legume, requires high amount of phosphorus as it plays an important role in energy transformation and biochemical reactions including biological N fixation. When P fertilizers added to soil, a part of P is utilized by the plants (15-20 %) and remaining P is (80-85%) fixed in the form of insoluble P in the soil in less available form. Due to poor solubility of native soil P, sometimes there is a buildup of insoluble P as a result of chemical P application (Dubey,1997). The use of fertilizer P is limited by its high cost and therefore, mobilization of such insoluble P accumulated in soil is of practical importance. In this context it is imperative to re-assess the recommended dose of P to soybean crop which is in practice since last two decades.

MATERIAL AND METHODS

A field experiment was conducted at Research Farm, Department of Soil Science and Agricultural Chemistry, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *Kharif* season of 2017-18. The treatments comprised of various levels of phosphorus viz. 0, 45, 60, 75 and 90 kg ha^{-1} along with recommended dose of nitrogen and potassium @ 30 kg for each treatment tried in Randomized Block Design with four replications. The soil of experimental site was deep black belongs to Vertisols particularly Vertic Inceptisol , calcareous in nature with pH 8.24 (slightly alkaline to alkaline in nature). The soil was low in organic carbon, available N, P and Zn and rich in available K. The plant and soil samples were collected and analysed for nutrient content and uptake. The chemical analysis was performed by standard procedures (Jackson 1973 and Piper 1966) after harvest of crop. The seed and straw yield of soybean was recorded. The data were subjected to statistical analysis (Panse and Sukhatme, 1978).

RESULTS AND DISCUSSION

Soybean yield

The application of phosphorus significantly influenced the grain yield of soybean (Table 1). The highest grain yield was recorded with the application 90 kg P_2O_5 ha^{-1} which was statistically at par with 60 and 75 kg P_2O_5 ha^{-1} along with recommended dose of N and K. Further,

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the grain yield was increased due to application of various levels of phosphorus was 21per cent, 40 per cent, 51 per cent and 54 per cent higher with the P levels 45 kg (T_2), 60 kg (T_3), 75 kg (T_4) and 90 kg (T_5), respectively over control treatment. It clearly showed the response of soybean crop to phosphorus application was up to 60 kg P ha^{-1} (T_3). Although, the seed and straw yield was increased at higher levels of phosphorus application, however the difference between yield levels with treatments T_4 and T_5 were 11per cent and 3 per cent only when compared with T_3 (P @ 60 kg ha^{-1}). The yield levels obtained were very low due to dry spell (33-36 MW) during grand growth period of soybean crop.

Straw yield

Significantly highest straw yield was recorded with the application 90 kg P_2O_5 ha^{-1}, however, the P levels 90 kg, 75 kg and 60 kg P ha^{-1} were at par with each other. These results are in conformity with finding of Umale *et al.* (2002), Kausadikar *et al.* (2003) and Chavan *et al.* (2008).

Table 1: Effect of various levels of phosphorus levels on yield and protein content of soybean

Treatments	Yield (qha^{-1})		Protein
	Soybean Grain	Straw	%
T_1 – 0.0 kg P ha-1	4.53	6.18	37.72
T_2 – 45 kg P ha^{-1}	5.48	7.51	37.98
T_3 - 60 kg P ha^{-1}	6.38	8.24	38.20
T_4 – 75 kg P ha^{-1}	6.85	8.48	38.19
T_5 – 90 kg P ha^{-1}	6.97	8.59	38.37
SE (m) ±	0.20	0.093	0.31
CD at 5 %	0.61	0.289	-

Nutrient content and Uptake

The effect of various levels of phosphorus on N and K content in grain and straw was found non–significant. However, phosphorus content in soybean grain and straw was influenced significantly with the application of various levels of phosphorus. The highest phosphorus content in soybean grain (0.62%) and straw (0.26%) was recorded with the application of phosphorus 90 kg P ha^{-1} along with recommended dose of nitrogen and potassium. However, which was at par with the application of 75 kg P ha^{-1} along with recommended dose of N and K.

The application of various levels phosphorus significantly influenced the nitrogen, phosphorus and potassium uptake by soybean and significantly highest total uptake was recorded with application of 90 kg P ha^{-1} which was statistically at par with the application of 75 kg and 60 kg P ha^{-1} (Table 2). These results are supported by the findings of Shubhangi *et al.* (2014).

In general, the lower values of uptake of nutrients (NPK) recorded in this experiment was due to long dry spell occurred during grand growth period of the crop (33 - 36 MW), resulted in low yield levels.

Phosphorus use efficiency and Phosphorus recovery

The phosphorus use efficiency (Table 3) was increased with the incremental levels of phosphorus and the higher P use efficiency was recorded with the application of 60 kg P ha^{-1} (14.9 %) followed by application of 75 kg P ha^{-1} (14.1 %). However, the phosphorus recovery (in terms of removal as against addition) was increased

Table 2. Nutrient uptake by soybean as influenced by phosphorus levels

Treatments	Nutrient Uptake (kg ha^{-1})								
	Nitrogen			Phosphorus			Potassium		
	Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total
T_1 – 0.0 kg P ha^{-1}	27.35	8.09	35.45	2.10	1.07	3.23	3.0	9.66	12.07
T_2 – 45 kg P ha^{-1}	33.25	9.99	43.24	3.90	1.57	4.50	3.81	11.82	15.63
T_3 - 60 kg P ha^{-1}	39.04	11.18	50.19	3.55	1.98	5.53	4.52	13.26	17.78
T_4 – 75 kg P ha^{-1}	41.86	11.47	53.34	3.93	2.18	6.12	5.24	13.75	19.00
T_5 – 90 kg P ha^{-1}	42.80	11.86	54.66	4.33	2.29	6.63	5.36	14.06	19.42
SE (m) ±	1.084	0.252	1.19	0.20	0.139	0.16	0.242	0.033	0.45
CD at 5 %	3.38	0.786	3.69	0.64	0.433	0.50	0.754	0.105	1.14

with the levels of phosphorus and highest phosphorus recovery was observed with 75 kg P ha^{-1} (8.82%). However, it was decreased at higher level of phosphorus 90 kg P ha^{-1}. *The results are in accordance with the findings of* Laharia *et al.* (2015).

Table 3: P use efficiency, P recovery and Root Nodulation

Treatments	P Use Efficiency (%)	P Recovery (%)	Nodulation at 60 DAS	
			Nodules ($plant^{-1}$)	Dry weight (mg $plant^{-1}$)
T_1 - 0.0 kg P ha^{-1}	-	-	18.10	0.092
T_2 -45 kg P ha^{-1}	11.60	6.46	21.78	0.109
T_3 - 60 kg P ha^{-1}	14.92	8.78	23.41	0.128
T_4 -75 kg P ha^{-1}	14.11	8.82	24.57	0.134
T_5 -90 kg P ha^{-1}	12.34	8.65	24.98	0.143
SE (m) ±	-	-	1.15	0.009
CD at 5 %	-	-	3.58	0.029

Root Nodulation

There was significant effect of phosphorus on number of root nodules and its dry weight $plant^{-1}$ at (60 DAS). The root nodules and dry weight was significantly increased with the increasing levels of phosphorus along with recommended dose N and K over control (Table 3). The highest root nodules were noted with the application of 90 kg P ha^{-1} along with recommended dose of N and K (24.98 nodules $plant^{-1}$). However, all the P levels were found statistically at par. It also implies that the phosphorus application helps in formation of root nodules which ultimately increased the number of root nodules per plant. Similar finding are also reported by Devi *et al*. (2012) and Dhage *et al*. (2014).

Available Nutrient Status

The application of varying levels of phosphorus did not influence significantly the organic carbon, available N, K and S status of soil after harvest of soybean. There was numerical increase in the available nutrient status of soil (Table 4). Whereas, significantly highest available phosphorus (16.89 kg ha^{-1}) was recorded with the application of 90 *kg* P ha^{-1}. However, it was at par with application of 75 kg P ha^{-1} (15.23 kg ha^{-1}) and 60 kg P ha^{-1} (13.58 kg ha^{-1}). The increases in the status of available P with incremental and optimal use of phosphorus has also reported by Tiwari *et al*. (2002) and Jadhao *et al.* 2014.

Table 4: Effect of different levels of phosphorus on available nutrient status of soil

Treatments			OC(g kg^{-1})	Available Nutrients (kg ha^{-1})			Sulphur
				N	P	K	(mg kg^{-1})
T_1	-	0.0 kg P ha^{-1}	5.94	155	10.87	385	7.18
T_2	-	45 kg P ha^{-1}	5.98	161	12.21	391	8.30
T_3	-	60 kg P ha^{-1}	6.08	161	13.58	393	8.42
T_4	-	75 kg P ha^{-1}	6.10	163	15.23	393	8.50
T_5	-	90 kg P ha^{-1}	6.10	165	16.89	395	8.59
		SE (m) ±	0.062	2.27	0.68	4.60	0.38
		CD at 5 %	-	-	2.14	-	-
		Initial value	5.92	152	10.66	387	8.26

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Effect of Different Crop Residues and Amendments on Chemical Properties of Salt Affected Soils of Purna Valley

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ABSTRACT

The present experiment was conducted to assess the effect of different crop residues and chemical amendments on chemical properties of salt affected soils of Purna valley. The soil samples from six sites of Purna valley of Vidarbha region were collected and analyzed for various chemical properties. The initial soil chemical analysis revealed that, these soils were moderately to very strongly alkaline in reaction (pH 7.50 – 8.47), electrical conductivity varied from 0.12 to 0.22 dS m^{-1}. The exchangeable sodium percentage of salt affected soils of Purna valley varied from 5.12 to 9.86. Based on the higher ESP (9.86) value of salt affected soils of Dapura village, laboratory incubation study was conducted. A 5 kg soil was filled in the earthen pot. The soil in each filled pots were amended with different crop residues and chemical amendments. The treatments consists of control (T1), gypsum @ 2.5 t ha^{-1}(T2), cotton stalk @ 5 t ha^{-1} (T3), soybean straw @ 5 t ha^{-1} (T4), FYM @ 5 t ha^{-1} (T5), wheat straw @ 5 t ha^{-1} (T6) and sulphur as per gypsum eqv. @ 2.5 t ha^{-1} (T6). The experiment was laid out in CRD with seven treatments replicated three times. The soil samples were analyzed for chemical properties at 0 and 60 days of incubation. The results of the present experiment revealed that, the pH was significantly reduced (8.15) with the application of sulphur @ 2.5 t ha^{-1} and gypsum @ 2.5 t ha^{-1} (8.26), lowest EC was recorded with the application of gypsum @ 2.5 t ha^{-1} (0.20 dS m^{-1}) and sulphur @ 2.5 t ha^{-1} (0.21 dS m^{-1}), the CEC of soils was found to be non-significant. The exchangeable cations viz; Ca^{++}, Mg^{++} and K^{+} was recorded to the extent of 36.30, 9.90 and 1.05 cmol (P^{+}) kg^{-1} with the application of gypsum @ 2.5 t ha^{-1} However, lowest exchangeable Na^{+} was recorded with the application of Gypsum @ 2.5 t ha^{-1} indicating application of gypsum @ 2.5 t ha^{-1} was found beneficial to reclaim salt affected soils of Purna valley.

Salt-affected soils occur in all major physiographic regions of India. Salts released by weathering of silicate minerals are important original sources and are responsible for enrichment of soils and water at specific favoured locations. Soil enriched with neutral salts is termed as saline while the one with salts capable of alkaline hydrolysis as alkali or sodic. Salt affected soils of Purna valley are developed on basaltic alluvium under arid and semi-arid conditions. The Purna valley of Vidarbha region is an east-west elongated basin with slight covering to the south occupying the part of Amravati, Akola and Buldhana districts of Vidarbha and extends from 20°45' to 21°15' N latitude and 75°25' to 77°45' E longitude with east-west length of 100-150 km having width of about 10 to 60 km covering an area of about 4.69 lakh hectares distributed in Amravati (1738 sq. km), Akola (1939 sq. km) and Buldhana (1015 sq. km) districts. The salts have varying degree of deterioration i.e. salinity or sodicity and salinity-sodicity (Anonymous, 2010).

The high pH, exchangeable sodium and presence of carbonates and bicarbonates in sodic soil and the high amounts of soluble salts in saline soils, not only adversely influence the physico-chemical and fertility properties of these soils and their ability to support plant growth, but also profoundly influence the soil biological condition-diversity of microbial species, their numbers and activities in soil. Yet researches worldwide have concentrated very largely, only on the physico-chemical aspects of the degradation of soils due to sodification or salinization both. The effect of physical and chemical degradation are readily apparent, while the effects of biological degradation induced due to the decline in soil organic matter and biomass carbon levels are more subtle. It was only in the beginning of seventies of the 20th century, that increasing attention was paid to the microbiological attributes and biological activities of salt affected soils and how chemical and biological reclaimation measures bring about the amelioration of these soils and promote soil health.

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In view of significant role of soil organic materials in improving salt affected soil, attempt have been made to reclaim salt affected soils of Purna valley having varying degrees of ESP. The laboratory experiment was conducted to reclaim salt affected soils with different crop residues, FYM and chemical amendments.

MATERIAL AND METHODS

The present investigation was carried at Dr. PDKV, Akola (M.S.) to study the effect of different crop residues and chemical amendments on chemical properties of salt affected soils of Purna valley. In order to know the physico-chemical properties of the experimental soil, the soil samples (0-20 cm) were collected from six sites viz; Paral, Dapur, Ner, Pastul, Hingana and Ugwa villages of Purna valley with the help of GPS on the basis of earlier characterization and existing field variability.

The collected soil samples were subjected to chemical analysis viz; pH, EC, ESP, exchangeable cations (Ca^{++}, Mg^{++}, N^+ and K^+). On the basis of ESP of salt affected soils from different villages, the soil sample having high ESP (9.86) were used for laboratory incubation study. Five kg air-dried soil sieved through 2 mm sieve were placed in pots. Crop residues, FYM, gypsum, sulphur added in to the pots as per the treatment viz; Control (T1), Gypsum @ 2.5 t ha^{-1} (T2), Cotton stalk @ 5 t ha^{-1} (T3), Soybean straw @ 5 t ha^{-1} (T4), FYM @ 5 t ha^{-1} (T5), Wheat straw @ 5 t ha^{-1} (T6) and Sulphur as per gypsum eqv. @ 2.5 t ha^{-1} (T7). Moisture content of soil were adjusted to field capacity and maintained throughout the incubation period. Incubation were carried out for 60 days. The experiment was laid out in CRD with seven treatments replicated three times.

Soil pH was determined in soil suspension (1:2) by a glass electrode pH meter after equilibrating soil with water for 30 min with occasional stirring (Jackson, 1973). Electrical conductivity was determined by conductivity bridge (Jackson, 1973). Cation exchange capacity was determined by saturating soil with 1 N NaOAC (sodium acetate pH 8.2), after removal of excess, sodium acetate by washing with alcohol, the absorbed sodium was extracted by washing with 1 N (NH_4OAC (ammonium acetate pH 7) and the leachate was made upto known volume. Na^+ present in the leachate was determined with flame emission spectrophotometer (Jackson, 1973). Exchangeable cations were determined by leaching the soils in 1 N KCI TEA, buffer solution (pH 8.2) and titrating the leachate with standard EDTA solution using mureoxide and EBT as an indicator (Jackson, 1967). Exchangeable sodium and potassium were determined by leaching the soil with 1 N ammonium acetate (pH 7) solution, Na^+ and K^+ from the leachate were estimated by using Flame photometer given by Page (1983). The exchangeable sodium percentage was determined by the following expressions.

$$ESP = \frac{Ex.\,Na}{CEC} \times 100$$

RESULTS AND DISCUSSION

Initial chemical Properties

The soil samples of Purna valley were analyzed for various chemical properties. The pH of surface soil varied between 7.50 to 8.47, indicating that these soils are moderately to very strongly alkaline in reaction. The electrical conductivity of soil-water suspension (1:2) of Purna valley soil ranged from 0.12 to 0.22 dS m^{-1}. The exchangeable sodium percentage varied from 5.12 to 9.86.

The exchangeable Ca^{2+} content of these soils varied from 31.39 to 45.26 cmol (p^+) kg^{-1}. The exchangeable Mg^{2+} ranged from 10.21 to 11.81 cmol (p^+) kg^{-1}. The exchangeable Na^+ and K^+ content of these soils varied from 3.21 to 5.78 cmol (p^+) kg^{-1} and 0.86 to 1.05 cmol (p^+) kg^{-1} respectively. The cation exchange capacity (CEC) of these soil varied from 52.17 to 62.73 cmol (p^+) kg^{-1}.

Changes in chemical properties of salt affected soils

pH and electrical conductivity

The pH and electrical conductivity at the start of incubation study was 8.51 and 0.24 dSm^{-1} respectively. The pH was significantly reduced with the application of sulphur @ 2.5 t ha^{-1} (8.15) and gypsum @ 2.5 t ha^{-1} (8.26).

The electrical conductivity was slightly decreased under almost all the treatments as compared to initial. However, lowest electrical conductivity was recorded with the application of gypsum @ 2.5 t ha^{-1} (0.20 dS m^{-1}) and sulphur @ 2.5 t ha^{-1} (0.21 dS m^{-1}). This decrease

Table 1. Effect of different crop residues and chemical amendments on chemical properties of soil (after 60 days incubation)

Treatment	pH (1:2)	EC (1:2) dS m^{-1}	Organic Carbon (%)	Total N (%)	C:N Ratio	ESP
T_1 Control	8.50	0.24	0.45	0.037	12.16	8.8
T_2 Gypsum @ 2.5 t ha^{-1}	8.26	0.20	0.46	0.039	11.79	7.33
T_3 Cotton stalk @ 5 t ha^{-1}	8.46	0.23	0.47	0.042	11.19	8.61
T_4 Soybean straw @ 5 t ha^{-1}	8.41	0.22	0.48	0.043	11.16	8.37
T_5 FYM @ 5 t ha^{-1}	8.39	0.22	0.49	0.044	11.13	8.01
T_6 Wheat straw @ 5 t ha^{-1}	8.44	0.23	0.47	0.041	11.46	8.42
T_7 Sulphur @ 2.5 t ha^{-1}	8.20	0.21	0.46	0.040	11.50	7.59
SE (m) ±	0.04	0.01	0.006	0.001	0.004	0.004
CD at 5%	0.017	0.03	0.01	0.003	0.01	0.012
Initial value	8.51	0.24	0.44	0.037	11.89	8.77

Table 2. Effect of different crop residues and chemical amendments on chemical properties of soil (after 60 days incubation)

Treatment	Exchangeable Cations cmol (P$^+$) kg^{-1}				CEC cmol (p$^+$) kg^{-1}
	Ca^{2+}	Mg^{2+}	Na^{2+}	K$^+$	
T_1 Control	32.46	9.26	5.15	0.96	58.51
T_2 Gypsum @ 2.5 t ha^{-1}	36.30	9.90	4.30	1.05	58.63
T_3 Cotton stalk @ 5 t ha^{-1}	32.42	9.50	5.04	0.96	58.48
T_4 Soybean straw @ 5 t ha^{-1}	32.86	9.54	4.94	0.97	58.52
T_5 FYM @ 5 t ha^{-1}	34.80	9.70	4.70	0.98	58.64
T_6 Wheat straw @ 5 t ha^{-1}	33.12	9.50	4.94	0.96	58.62
T_7 Sulphur @ 2.5 t ha^{-1}	34.10	9.85	4.45	0.97	58.60
SE (m) ±	0.17	0.01	0.02	0.004	0.006
CD at 5%	0.53	0.03	0.06	0.012	N.S.
Initial value	32.35	9.28	5.14	0.95	58.59

in the pH and electrical conductivity might be due to the rapid reaction of acid with soluble Na_2CO_3 and its neutralization (Dahiya and Abrol, 1974, Abrol *et al.,* 1975). On the other hand, gypsum solubilize slowly and do not react with the soluble $Na_2 CO_3$ to some extent, which help to increase their effectiveness in replacing exchangeable sodium (Verma *et al*., 1985).

Exchangeable cations

The exchangeable cations i.e. Ca^{++}, Mg^{++}, Na^+ and K^+ at the start of incubation study were 32.43, 9.28, 5.14 and 0.95 cmol (P$^+$) kg^{-1} soil respectively. The application of gypsum @ 2.5 t ha^{-1} recorded significantly highest exchangeable Ca^{++} (36.30 cmol (p+) kg^{-1}) followed by sulphur @ 2.5 t ha^{-1} (34.10 cmol (p+) kg^{-1}). Among the organics, application of FYM @ 5 t ha^{-1} recorded significantly highest exchangeable Ca^{++} (34.80 cmol (p$^+$) kg^{-1}) followed by wheat straw @ 5 t ha^{-1} (33.12 cmol (p$^+$) kg^{-1}) and soybean straw @ 5 t ha^{-1} (32.86 cmol (p$^+$) kg^{-1}). In case of exchangeable Mg^{++}, application of gypsum @ 2.5 t ha^{-1} and sulphur @ 2.5 t ha^{-1} recorded highest value viz., 9.90 and 9.85 cmol (p$^+$) kg^{-1} soil, respectively. However, these treatments were found at par with each other.

The exchangeable Na^+ was significantly decreased with the application of gypsum @ 2.5 t ha^{-1}

(4.30 cmol (p^+) kg^{-1}) and sulphur @ 2.5 t ha^{-1} (4.45 cmol (p^+) kg^{-1}). Among organics, application of FYM @ 5 t ha^{-1} found beneficial in decreasing exchangeable Na^+ (4.70 cmol (p^+) kg^{-1}) followed by soybean straw @ 5 t ha^{-1} (4.91 cmol (p+) kg^{-1}) and wheat straw @ 5 t ha^{-1} (4.94 cmol (p^+) kg^{-1}). The exchangeable K^+ was slightly increased with the application of crop residues and chemical amendment. This increase in the exchangeable K^+ was higher in the treatment gypsum @ 2.5 t ha^{-1} (1.05 cmol (p+) kg^{-1}). Similar work was also reported by Shila *et al*. (1986). They observed the increase in exchangeable Ca^{++} and Mg^{++} with the incorporation of FYM regardless of the state of sodification is explainable with decrease in exchangeable Na^+ in sodic soil.

Cation exchange capacity and Exchangeable Sodium Percentage

The cation exchange capacity of soil at the start of incubation study was 58.59 cmol (p^+) kg^{-1}. The CEC of soil was found to be non-significant. The exchangeable sodium percentage of salt affected soils of Purna valley at the start of incubation study was 8.77. The application of gypsum @ 2.5 t ha^{-1} recorded significantly lowest ESP (7.33) followed by sulphur @ 2.5 t ha^{-1} (7.59). Among the organics, application of FYM @ 5 t ha^{-1} recorded significantly lowest ESP (8.07) followed by soybean straw @ 5 t ha^{-1} (8.37). The decrease in ESP with the application of gypsum (T_2) and sulphur (T_7) may be associated with the reduction in the exchangeable Na^+.

CONCLUSION

Based on results of present study, it is concluded that the soil chemical properties were adversely affected in salt affected soils. These properties can be improved with the application of organics (FYM and crop residues) and chemical amendments (gypsum and sulphur). The added organics will have significant bearing on microbial function and cycling of nutrient element, hence, chemical composition of organics needs to be considered while planning the crop residues addition to the soil.

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Response of Liquid Fertilizer (Premix) on Growth, Yield and Economics of Irrigated Chickpea

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ABSTRACT

Field experiment was conducted in *Rabi* season 2016-17 at AICRP on Integrated Farming System, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (MS) with an object to find out the effect of foliar applicationof premix liquid fertilizers on growth, yield and economics of chickpea under irrigated condition. Foliar application of premix liquid fertilizer and seaweed extract were applied at an interval of 30, 45 and 60 DAS. Results revealed that as the dose of liquid fertilizers (premix) increasedup to 1 L ha^{-1}, proportionally seed yield were also increased. However, further increased in dose was decreased the yield. Whereas, significantly highest seed yield (1893 kg ha^{-1})was recorded with RDF + Liquid fertilizers (premix) @ 1 L ha^{-1}and it was measured to be 23.15 per cent followed by RDF + Liquid fertilizers (premix) @ 1.5 L ha^{-1}, which were found statistically similar with each other. The straw yield was increased with increasing the dose of liquid fertilizers up to 1 L ha^{-1} and decreased thereafter. Significantly highest straw yield of 2861 and biological yield of 4704 kg ha^{-1}, respectively were recorded with RDF + Liquid fertilizers (premix) @1.5 L ha^{-1}followed by RDF + Liquid fertilizers (premix) @ 1 L ha^{-1} which were at par with each other. The harvest index was not significantly influenced by various treatments. Whereas,the numerically highest harvest index was recorded with spray of liquid fertilizers (premix) @ 1 L ha^{-1}. Significantly maximum gross monetary and net monetary returns Rs.87847 ha^{-1} and Rs. 59542 were recorded with RDF + Liquid fertilizers (premix) @ 1 L ha^{-1} followed by RDF + Liquid fertilizers (premix) @ 1.5 L ha^{-1} (which were at par with each other. Similarly, the benefit : cost ratio was maximum with RDF + Liquid fertilizers (premix) @ 1 Lha^{-1} i.e. 3.10 followed by RDF + Liquid fertilizers (premix) @ 500 ml ha^{-1}.

Chickpea is one of the major pulse crop in India and in many other countries and plays an important role in the diets of vegetarians around the world. Pulses are primary sources of nourishment and when combined with cereals, provide a nutritionally balanced food for human being. Frequent consumption of pulses is now recommended by most of the health organizations (Leterme, 2002). In addition, it is a good source of energy, protein, minerals, vitamins, fibre and also contains potentially health-beneficial phytochemicals. It is a main source of vegetable protein in human diet as it contains 21% protein and 38-59% carbohydrates (Gupta, 1989). Besides, Chickpea is also credited with the ability of atmospheric nitrogen fixation through symbiotic process and it has been estimated that chickpea has the capacity to fix 140 kg N ha^{-1} in a growing season (Rupela and Saxena, 1987). The fixed N not only can meet the requirements of the legume for maximum grain formation, but can also be available for use by subsequent crops, after mineralization of chickpea crop residues.

In India, chickpea is grown on an area of 9.93 million ha with annual production of 9.53 million tons with productivity of 960 kg ha^{-1} in *rabi* season (Anonymous, 2015[a]). Madhya Pradesh, Maharashtra, Karnataka, Andhra Pradesh and Rajasthan are the major chickpea growing states. In Maharashtra, chickpeais grown on an area of 17.74 lakh hectares with a production of 15.07 lakh tons and a productivity of 850 kg ha^{-1}.(Anonymous, 2015[b]). In Vidarbha, chickpea is grown on area of 5.53 lakh ha with a production of 3.8 lakh tons, with a productivity of 876 kg ha^{-1} (Anonymous, 2015[c]).

Agronomic practices of chickpea are required to be standardized for realizing yield potential. Application of nutrients through foliar sprays along with soil application has several advantages in supplementing the nutritional requirements of crops. Foliar nutrition is designed to estimate the problems like fixation and immobilization of nutrients. Hence, foliar nutrition is being recognized as an important method of fertilization in modern agriculture. This method provides for utilization

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of nutrients more efficiently and for correcting deficiencies rapidly. Recently, new generation of special fertilizers have been introduced exclusively for foliar feeding and fertilization. Specialized fertilizers are a better source of foliar application (Vibhute, 1998). These fertilizers have different ratios of N, P and K which are highly water soluble and so amenable for foliar nutrition (Jayabhai *et al*. 1999). In almost pulses, to the extent of foliar drop determine the yield and yield attributing characters. The retention of flowers is possible through foliar application of growth regulators as well as macro nutrients during flower initiation and pod development stages along with soil application of nutrients (Chaurasia *et al*., 2005). During reproductive stage, root activities decreases where as more nutrients required at the same time for fulfillment of nutrients needs, foliar spray with nutrient solution is an alternative source. In Indian condition, water scarcity during growing period and improper nutrient management practices are the major constraints of agriculture. In order to enhancing productivity of chickpea and nutrient use efficiency foliar application of nutrients is the best option.

Considering the importance of foliar application of nutrients to chickpea and the meager information on the aspect this study was undertaken.

MATERIAL AND METHODS

A field experiment was carried out during *Rabi*s eason of 2016-17 at AICRP on Integrated Farming Systems, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (MS) with an object to study the effect of foliar application of premix liquid fertilizers on growth, yield and economics of chickpea under irrigated condition. The experiment was laid out in randomized block design with five treatments and four replications. The gross plot size was 8 m x 6.3 m. The net plot size was 7.4 m x 5.7 m. Details of the experimental treatments along with symbols used in plan of layout are as under *viz*, T1- RDF+ Liquid fertilizers (premix) @ 500 ml ha^{-1} at 30, 45 and 60 DAS, T2- RDF + Liquid fertilizers (premix) @ 1.0 liter ha^{-1} at 30, 45 and 60 DAS, T3- RDF + Liquid fertilizers (premix) @ 1.5 liter ha^{-1}at 30, 45 and 60 DAS, T4- RDF + Sea weed extract @ 500 ml ha^{-1}at 30, 45 and 60 DAS, T5- Control (Only RDF 25:50:30 kg NPK ha^{-1}).

Composition of liquid fertilizers (premix)

1	Heterocyclic nitrogen	20%
2	P_2O_5,	6%
3	Iron	5%
4	Sulphur	10%
5	Inert ingredients	QS

Composition of sea weed extract

1	Sea weed (*Ascophyllum nodosum)* extract	20%
2	Sulphur	200 ppm
3	Magnesium	500 ppm
4	Calcium	500 ppm
5	Sodium	5000 ppm
6	Boron	20 ppm
7	Iron	20 ppm
8	Magnese	1 ppm
9	Copper	1 ppm
10	Zinc	5 ppm
11	Other traces of cytokinins, auxins, proteins and amino acids	–

Foliar application of premix liquid fertilizer and seaweed extract were applied at an interval of 30, 45 and 60 DAS of crop. While common dose of recommended fertilizers were applied to all treatments. Crop of chickpea and its variety JAKI-9218 was used for sowing at the spacing of 30 × 10 cm by drilling method, sown on dated 28/10/2016 and harvested on 10/2/2017. The selected field of experiment was fairly uniform, leveled and clayey in texture. It was low in available nitrogen (206.98 kg ha^{-1}) and phosphorus (16.32 kg ha^{-1}) and medium in organic carbon (0.57%), rich in available potassium (358.3 kg ha^{-1}) and slightly alkaline (pH 7.8) in reaction. The total rainfall during cropping period from October 2016 to February 2017 was 91.0 mm as against normal rainfall of 102.6 mm with rainy days 5 as against the normal of 7.2 days. During crop growing season, the maximum temperature was ranging from 27.3 ^{0}C to 32.4 ^{0}C and minimum temperature varied from 8.4 ^{0}C to 14.3 ^{0}C. The bright sunshine hours were lower than normal and helped the crop to utilize the available soil moisture for comparatively larger period of time.

RESULTS AND DISCUSSION

Effect of different treatments on growth of chickpea

Foliar application of liquid fertililzers (premix) along with RDF increased growth attributes of chickpea significantly over control (Table 1). In general, a gradual increase in plant height, number of branches, dry matter accumulation, number of functional leaves and leaf area were observed increasing with liquid fertililzers (premix) application. Though these parameter are not significantly affected by foliar applications of liquid fertililzers (premix) up to 500 litre ha^{-1}. The data indicated that application of RDF + Liquid fertilizers (premix) @ 1.5 litre ha^{-1} (T_3) recorded significantly higher plant height, number of branches, total dry matter, number of functional leaves and leaf area plant^{-1}, but found statistically at par with RDF + Liquid fertilizers (premix) at 1 litre ha^{-1} (T_2) treated plot regarding all the observations taken at different DAS.

The better crop growth of chickpea might be due to the presence of macro as well as micro nutrients like N, P, S and Fe in liquid fertilizers (premix). Presence of P in it proliferates root development, thereby, making the plants more able to mine adequate nutrients from the deeper layer of soil and influence crop maturity as a whole. The trace element Fe inspires redox reaction of respiration and photosynthesis. Supply of nutrients through foliar application in addition to RDF might have enhanced photosynthesis, cell division and cell elongation which allow the plant grow faster. Similar findings have also been reported by Shukla *et al.* (2013) in chickpea, Cheke (2014) in black gram, Ganga *et al.* (2014) in chickpea, Mamathashree (2014) in pigeon pea and Mudalagiriyappa *et al.* (2016) in chickpea.

The data on mean seed yield (1755 kg ha^{-1}), straw yield (2672 kg ha^{-1}), biological yield (4427 kg ha^{-1}) and harvest index (39.64 %) were influenced significantly by various treatments and presented in Table 1.

Table 1. Effect of different treatments on growth attributes of chickpea

Treatments	Plant height (cm)				Number of functional leaves plant^{-1}			Leaf area plant^{1} (dm^2)		
	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
T_1	22.06	39.5	45.23	45.24	52.25	217.5	287	1.12	7.98	12.25
T_2	21.78	42.38	46.7	46.7	51	231.75	293	1.06	8.4	13.91
T_3	22.11	43.75	47.25	47.26	51.75	249.27	305.5	1.19	9.09	14.13
T_4	21.4	40.08	43.64	43.64	52.72	213.25	270	1.27	7.68	11.96
T_5	21.77	37.5	40.41	40.41	51.25	194.87	246.75	1.13	5.89	10.07
SE(m)±	0.72	0.88	0.87	0.87	3.67	6.14	6.32	0.1	0.42	0.58
CD at 5%	—	2.71	2.69	2.69	—	18.62	19.16	—	1.31	1.8

TreatmentsTotal dry matter plant^{1} (g)Number of branches plant^{-1}

	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS
T_1	1.68	9.58	22.31	22.13	7.4	13.95	17.59
T_2	1.57	11.25	24.68	24.67	7.08	14.6	19.31
T_3	1.46	11.63	25.25	25.08	6.9	15.3	19.75
T_4	1.75	9.38	21.97	21.36	6.43	11.81	16.15
T_5	1.52	7.81	17.75	17.67	7.33	9.63	13.01
SE(m)±	0.15	0.58	0.9	0.87	0.22	0.54	0.66
CD at 5%	—	1.79	2.77	2.68	—	1.66	2.04

Table 2. Seed yield, straw yield, biological yield and harvest indexof chickpeaas influenced by various treatments

Treatments	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index (%)	% increase over control
T_1 - RDF + Liquid fertilizers (premix) @ 500 ml ha^{-1}	1721	2617	4338	39.68	11.96
T_2 - RDF + Liquid fertilizers (premix) @ 1 litre ha^{-1}	1893	2784	4677	40.45	23.15
T_3 - RDF + Liquid fertilizers (premix) @ 1.5 litre ha^{-1}	1843	2861	4704	39.19	19.93
T_4 - RDF + Seaweed extract @ 500 ml ha^{-1}	1695	2613	4308	39.39	10.28
T_5 - Control (Only RDF 25:50:30 Kg NPK ha^{-1})	1537	2519	4055	37.91	-
SE(m)±	50.65	65.98	78.11	0.95	-
CD at 5%	156.06	203.32	240.67	—	-
GM	1755	2672	4427	39.64	-

Foliar application of premix liquid fertilizer and sea weed extract were applied at an interval of 30, 45 and 60 DAS in T1, T2, T3 and T4 and compared with control.

Seed yield

The result revealed (Table 2) that the effect of different treatments influenced significantly the seed yield of chickpea. As the dose of liquid fertilizers (premix) increasedup to 1 L ha^{-1}, proportionally seed yield were also increased. However, further increased in dose was decreased the yield. Whereas, significantly highest seed yield (1893 kg ha^{-1})was recorded with RDF + Liquid fertilizers (premix) @ 1 L ha^{-1} (T_2) and it was measured to be 23.15 per cent followed by RDF + Liquid fertilizers (premix) @ 1.5 L ha^{-1} (T_3), which were found statistically similar with each other. Further, next high values of seed yield were recorded in RDF + Liquid fertilizers (premix) @ 500 ml ha^{-1} (T_1) and RDF + Seaweed extract @ 500 ml ha^{-1} (T_4) which were found statistically on par with each other. Significantly inferior seed yield was recorded in control (T_5). The best results were found in (T_2), might be because of better translocation of photo assimilates toward reproductive parts instead of vegetative parts and comparable low yield in (T_3) than (T_2)was found only due diversion of more energy towards vegetative parts.The results are in accordance with the results reported by Vivek Kumar Singhal*et al.* (2015) and Rahman (2017).

Straw yield

The straw yield was increased with increasing the dose of liquid fertilizers up to 1 L ha^{-1} and decreased thereafter. Significantly highest straw yield of 2861 kg ha^{-1} was recorded with RDF + Liquid fertilizers (premix) @1.5 L ha^{-1} (T_3) followed by RDF + Liquid fertilizers (premix) @ 1 Lha^{-1} (T_2) which were at par with each other. The next better treatment in relation to straw yield was RDF + Liquid fertilizers (premix) @ 500 ml ha^{-1} (T_1). Significantly inferior straw yield of 2519 kg ha^{-1} was recorded with control (T_5) which was found to be on par with RDF + Seaweed extract @ 500 ml ha^{-1} (T_4).The increase in straw yield with foliar application of liquid fertilizers might be due to higher rate of metabolic activities due to presence of macro and micro nutrients in the liquid fertilizers which resulted in more number of branches and dry matter accumulation. These results are in accordance with the results reported by Akhila *et al.* (2017).

Biological yield

Significantly higher biological yield (4704 kg ha^{-1}) was recorded with RDF + Liquid fertilizers (premix) @ 1.5 L ha^{-1} (T_3) followed by RDF + Liquid fertilizers (premix) @ 1 Lha^{-1} (T_2) which were at par with one another. The next higher values of biological yield were recorded in RDF + Liquid fertilizers (premix) @ 500 ml ha^{-1} (T_1) and RDF + Seaweed extract @ 500 ml ha^{-1} (T_4) which were found to be statistically on par with each other. The lowest biological yield of 4055 kg ha^{-1} wasobserved in control (T_5). These results are in confirmation with the findings of Sarbandi and Madani (2014).

Harvest index

The data in Table 1 showed that the harvest index was not significantly influenced by various treatments.

Table 3.Economics of chickpea as influenced by various foliar spray treatments

Treatments	Cost of cultivation (Rs. ha^{-1})	GMR (Rs. ha^{-1})	NMR (Rs. ha^{-1})	B:C
T_1 - RDF + Liquid fertilizers (premix) @ 500 ml ha^{-1}	27405	80122	52717	2.92
T_2 - RDF + Liquid fertilizers (premix) @ 1 litre ha^{-1}	28305	87847	59542	3.10
T_3 - RDF + Liquid fertilizers (premix) @ 1.5 litre ha^{-1}	29605	86000	56395	2.90
T_4 - RDF + Seaweed extract @ 500 ml ha^{-1}	28024	79028	51004	2.82
T_5 - Control (Only RDF 25:50:30 Kg NPK ha^{-1})	26365	72089	45725	2.73
SE (m) ±	-	2112.11	2112.11	-
CD at 5%	-	6508.04	6508.04	-
GM	27940	81017	53077	2.90

Cost of liquid fertilizers (premix) is Rs. 600 $Litre^{-1}$ and sea weed extract Rs. 600 $Litre^{-1}$
Selling rate of chickpea : *Seed Rs. 4200 q^{-1} and straw Rs. 300 q^{-1}*

Whereas,the highest harvest index was recorded with spray of liquid fertilizers (premix) @ 1 L ha^{-1} (T_2).

Economic studies

Means of gross monetary returns (Rs. 81017 ha^{-1}), net monetary returns (Rs. 53077 ha^{-1}) and B:C ratio (2.90) were influenced by various treatments (Table 2).

Gross monetary returns

Results revealed (Table2) that the maximum gross monetary returns of Rs.87847 ha^{-1} was recorded with RDF + Liquid fertilizers (premix) @ 1 L ha^{-1} (T_2) followed by RDF + Liquid fertilizers (premix) @ 1.5 L ha^{-1} (T_3) which were at par with each other. The next higher values of gross monetary returns were recorded in RDF + Liquid fertilizers (premix) @ 500 ml ha^{-1} (T_1) and RDF + Seaweed extract @ 500 ml ha^{-1} (T_4) which were found to be statistically on par with each other. The lowest gross monetary returnRs. 72089 ha^{-1} was observed in control (T_5). Similar results were obtained by Navaz *et al.* (2017).

Net monetary returns

Significantly maximum net monetary returns Rs. 59542 ha^{-1} was recorded with RDF + Liquid fertilizers (premix) @ 1 L ha^{-1} (T_2) followed by RDF + Liquid fertilizers (premix) @ 1.5 L ha^{-1} (T_3) which were at par with each other. The next better treatment was RDF + Liquid fertilizers (premix) @ 500 ml ha^{-1} (T_1). The lowest net monetary returns was recorded in control (T_5) which was found to be at par with RDF + Seaweed extract @ 500 ml ha^{-1} (T_4). Similar results were obtained by Akhila*et al.* (2017).

Benefit : cost ratio

The data showed that, the benefit : cost ratio was maximum with RDF + Liquid fertilizers (premix) @ 1 Lha^{-1} (T_2) i.e. 3.10 followed by RDF + Liquid fertilizers (premix) @ 500 ml ha^{-1} (T_1). The lowest benefit to cost ratio was recorded with control (T_5). The difference in B:C ratio might be due to the cost of liquid fertilizers and productivity of the crop.

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Quality of Weed Biomass Compost As Influenced By Different Sources of Compost and Decomposing Cultures Under Pit Method

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ABSTRACT

A field experiment entitled "Quality of weed biomass compost as influenced by different sources of compost and decomposing cultures under pit method" was conducted at the Centre for Organic Agriculture Research and Training Farm, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (Maharashtra) during the year 2018-19. The experiment was laid out in Factorial Randomized Block Design with four weed biomass i.e. *Cassia tora, Sorghum helepense*, Mix weed species and *Parthenium hysterophorus* with three cultures which comprised S-9, PDKV and control without culture. The combinations of twelve treatments were replicated three times. The size of pit was 50 x 50 x 50 cm^3 used for weed biomass composting. The reduction in weight and volume was higher in *Sorghum helepense* than mix weed, *Parthenium hysterophorus* and *Cassia tora* compost. Among the three decomposing cultures, PDKV culture recorded higher decline in weight and volume of compost. Mix weed compost recorded fast reduction in C:N ratio (15.13:1) up to 90 DAF and became stable than *Cassia tora* (16.98:1), *Parthenium hysterophorus* (19.25:1) and *Sorghum helepense* compost (19.88:1). PDKV culture accelerated the speed of decomposition, decline C:N ratio early (15.48:1) followed by S9 (18.45:1) and control without culture (19.65:1). After decomposition of mix weed biomass, nitrogen (1.36%), phosphorus (0.65%) and potassium content (0.59%) increased more when compared with *Cassia tora*, *Sorghum helepense* and *Parthenium hysterophorus* biomass. PDKV culture recorded higher increase in nitrogen (1.35%), phosphorus (0.65%) and potassium content (0.59%) followed by S9 and control without culture. Mix weed compost recorded statistically higher bacterial, fungal and actinomycetes count than *Cassia tora*, *Sorghum helepense* and *Parthenium hysterophorus* compost. PDKV culture recorded higher microbial count followed by S9 and control without culture.

External inputs in farming system not nly deteriorate soil health but also increase the cost of inputs. Use of organic source of fertilizer assumed as costly inputs, not easily available in market and heavy transport cost mislead the concept of organic farming. In field, weed biomass like *Parthenium hysterophorus*, mixed weed, *Cassia tora*, *and Sorghum helepense* are available in huge quantity. Available weed biomass should be utilized as a source of organic fertilizer. By converting this biomass into valuable compost. The traditional method of composting is a slow process and takes more than six months. Also the product thus prepared contains very low quantity of nutrients. Moreover, because of their wide C:N ratio, these agricultural wastes and weed biomass are known to reduce the availability of important mineral nutrients to growing plants through immobilization in to organic form during their decomposition. Thus, it necessary to speed up the process of decomposition and to test feasibility of different weed biomass and decomposing culture. Hence, this trial was done to utilize available weed biomass in appropriate decomposing method with active microbial cultures to harvest quality compost in the field itself and helpful to organic growers and marginal farmers.

MATERIAL AND METHODS

A field experiment entitled "Quality of weed biomass compost as influenced by different decomposing cultures under pit method" was conducted at the Centre for Organic Agriculture Research and Training Farm, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (Maharashtra) during the year 2018-19. The experiment was laid out in Factorial Randomized Block Design with four weed biomass at pre flowering stages i.e. *Cassia tora*, *Sorghum helepense*, Mix weed species and *Parthenium hysterophorus* with three cultures which comprised S-9, PDKV and control without culture. The combinations of twelve treatments were replicated three times. The size of pit was 50 x 50 x 50 cm^3 used for weed biomass composting. The observations on changes

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in microbial dynamics and major nutrient were recorded. The end of decomposition was judged by changes in C:N ratio of these decomposing materials.

FLOW CHART OF COMPOST

The 0.5 m^3 of compost pit was prepared

↓

Mother culture was made by thoroughly mixing 5 kg dung, 10 litre water and 50 gram decomposing culture.

↓

All side of the pit were wetted by sprinkling thin slurry of dung, water and decomposing culture

↓

At bottom, 10 cm thick layer of weed biomass was spread evenly

↓

Then spread thick slurry of prepared from mixture of dung, water and decomposing culture

↓

Likewise four layers were filled up to ground level

↓

Last 5^{th} layer of 20cm was filled with same procedure in dome shaped

↓

This layer was plastered with thick slurry of 7 kg dung, 4 kg soil and four litre water

↓

Temperature was monitored at 7 days of interval

↓

Final compost
(Total initial weed biomass 45 kg per pit)

RESULTS AND DISCUSSION

A. Effect of different sources of compost and decomposing cultures on weight and volume of compost

Source of compost

The data presented in Table 1 revealed that *Sorghum helepense* weed biomass indicated statistically higher reduction in weight (54.48%) and volume (53.33%) of compost over initial weight and volume of compost at start of filling of compost pit. However, compost prepared from mix weed and *Parthenium hysterophorus* recorded reduction in weight and volume to a tune of 53.00 and 51.33 per cent, 51.66 and 50.00 per cent, respectively. Lowest reduction in weight and volume of compost was observed in compost made from *Cassia tora* which was about 48.55 and 48.66 per cent, respectively. Attayee *et al.* (2017) reported that recovery yield of compost obtained from *Parthenium* + cow dung (3:1) was 52.2 per cent.

Decomposing culture

Decomposing cultures were recorded significant difference in reduction weight and volume of compost material during composting period (Table 1). Among the three decomposing culture PDKV decomposing culture recorded significantly higher reduction in weight and volume of compost which was about 54.66 and 53.33 per cent during decomposition span followed by S9 decomposing culture and without culture. These cultures were found less efficient than PDKV decomposing culture. However, all these two decomposing cultures were found significantly effective over compost pit without microbial culture.

It indicated that decomposition rate of PDKV decomposing culture was significantly higher than other decomposing culture used in experiment. The reduction in the weight and volume of weed biomass added in compost pit or heap due to active microbial population digest carbohydrates and two-thirds of the carbon is respired and the remaining one third combined with nitrogen in the living cells. Similar results were in agreement with findings by Pande (1978), Somani *et al.* (1982), Potdukhe (1990) and Terdal (2005).

Interaction effect

Interaction effect between sources of compost application and decomposing cultures were found non significant for change in weight and volume of compost.

B. Effect of different sources of compost and decomposing cultures on C:N ratio of compost

Source of compost

The data from Table 1 clearly indicated that reduction in Carbon: Nitrogen ratio (C:N ratio) of matured compost, recorded noticeable decrease from initial stage with different treatment. Out of four weed biomass highest

Table 1. Change in weight (kg), volume (m^3) and C:N ratio of compost as influenced by different treatments.

Treatment	Change in weight			Change in volume			C:N Ratio	
	Initial (kg)	Final (kg)	Reduction in wt. (%)	Initial (m^3)	Final (m^3)	Reduction in vol. (%)	Initial	Final (90 DAF)
A) Source of compost (weed biomass)								
W1- *Cassia tora*	60	30.87	48.55	0.15	0.077	48.66	26.3:1	16.98 : 1
W2- *Sorghum helepense*	60	27.31	54.48	0.15	0.070	53.33	37.2:1	19.88 : 1
W3- Mix weeds	60	28.02	53.00	0.15	0.073	51.33	34.3:1	15.13 : 1
W4-*Parthenium hysterophorus*	60	29.00	51.66	0.15	0.075	50.00	24.7:1	19.25 : 1
SE (m) ±	-	0.71	-	-	0.002	-	-	-
CD at 5%	-	2.09	-	-	0.005	-	-	-
B) Decomposing culture								
C1- S9 culture	60	28.90	51.83	0.15	0.073	51.33	-	18.45 : 1
C2- PDKV culture	60	27.20	54.66	0.15	0.070	53.33	-	15.48 : 1
C3- Without culture	60	30.30	49.50	0.15	0.077	48.66	-	19.65 : 1
SE (m) ± -	0.62	-	-	0.001	-	-	-	
CD at 5%	-	1.81	-	-	0.004	-	-	-
Interaction A x B								
SE (m) ± -	1.23	-	-	0.003	-	-	-	
CD at 5%	-	NS	-	-	NS	-	-	-
GM -	28.8	51.95	-	0.073	-	-	17.83 : 1	

Table 2. NPK content as influenced by different treatments

Treatment	Nitrogen content (%)		Phosphorus content (%)		Potassium content(%)	
	Initial	Final	Initial	Final	Initial	Final
A) Source of compost (weed biomass)						
W1- *Cassia tora*	1.58	1.32	0.36	0.60	0.44	0.57
W2- *Sorghum helepense*	1.08	1.23	0.28	0.58	0.36	0.53
W3- Mix weeds	1.42	1.36	0.42	0.65	0.52	0.59
W4-*Parthenium hysterophorus*	1.88	1.28	0.34	0.61	0.44	0.55
SE (m) ±	-	0.03	-	0.02	-	0.01
CD at 5%	-	0.09	-	0.05	-	0.04
B) Decomposing culture						
C1- S9 culture	-	1.28	-	0.61	-	0.55
C2- PDKV culture	-	1.35	-	0.65	-	0.59
C3- Without culture	-	1.25	-	0.58	-	0.54
SE (m) ±	-	0.03	-	0.02		0.01
CD at 5%	-	0.08	-	0.04		0.04
Interaction A x B						
SE (m) ±	-	0.05	-	0.03	-	0.02
CD at 5%	-	NS	-	NS	-	NS
GM	-	1.29	-	0.61	-	0.56

reduction in C:N ratio was recorded with mix weed compost. Initial C:N ratio of mix weed were 34.3:1 which reduced after decomposition process to 15.13:1. Lowest reduction in C:N ratio was recorded with *Parthenium hysterophorus* from 24.7:1 to 19.25:1. *Cassia tora* and *Sorghum helepense* recorded intermediate values of C:N ratio at 90 DAF (16.98:1 and 19.88:1, respectively). Decomposition of organic matter is affected by carbon and nitrogen ratio whereas excessively higher C:N ratio resulted in to slower decomposition rate than optimum C:N ratio. Similar results were also reported by Sasidharan *et al.* 2013.

Decomposing culture

Decomposing cultures were recorded decreased in total C:N ratio of compost material during composting period. Among the three decomposing culture PDKV decomposing culture recorded significantly higher decrease in total C:N ratio to about 15.48:1 followed S9 decomposing culture. The inoculated compost pit with decomposing culture was superior over compost pit without culture. Somani *et al.* (1982) reported that the decomposition is faster when C:N to of substrate is lower. Similar observation were reported Pande (1978), Yadav and Subbarao (1977), Bhasme *et al.* (2006) and Jeyapriya and Shaseetharan (2008).

C. Effect of different sources of compost and decomposing cultures on NPK content of compost

Sources of compost

The data presented in table 2 revealed that final compost showed significant differences among source of compost in respect to NPK content (%). The compost derived from mix weed at 90 DAF recorded statistically higher nitrogen, phosphorus and potassium content to a tune of 1.36, 0.65 and 0.59 per cent, respectively, followed by *Cassia tora* (1.32, 0.60 and 0.57%), *Parthenium hysterophorus* (1.28, 0.61 and 0.55%) and *Sorghum helepense* (1.23, 0.58 and 0.53%). The results are in confirmation with the findings of Kumar *et al.* (2012), Sasidharan *et al.* (2013) and Attayee *et al.* (2017).

Decomposing cultures

Decomposing cultures noted NPK content (%) with significant differences among themselves. PDKV culture observed significantly higher with total nitrogen (1.35%), phosphorus (0.65%) and potassium content (0.59%) during decomposition followed by S9 cultures. Without culture found lower in NPK content than PDKV and S9 culture. However all these two decomposing cultures were found significantly effective over without decomposing cultures in compost pit. Similar records of availability of nitrogen, phosphorus and potassium content were stated by Nallathambi and Marimuthu (1993), Bharne *et al.* (2003), Raut *et al.* (2003) and Rao (2007).

Interaction effect

Interaction effect regarding total nitrogen, phosphorus and potassium content between sources of compost and decomposing cultures were not found significant.

D. Effect of different sources of compost and decomposing cultures on microbial dynamics during composting

Sources of compost

Data concerned to microbial count, significant differentiation was evident among sources of compost *viz., Cassia tora*, *Sorghum helepense*, Mix weed and *Parthenium hysterophorus* during composting. Bacterial, fungal and actinomycetes population increased significantly throughout the decomposition process of weed biomass. Mix weed compost recorded statistically highest microbial count at 30, 60 and 90 DAF whereas *Sorghum helepense* compost recorded lowest population of bacteria, fungi and actinomycetes count. *Cassia tora* and *Parthenium hysterophorus* compost recorded intermediate values of bacteria, fungi and actinomycetes count at 30, 60 and 90 DAF.

The data clearly indicated that in mix weed compost observed higher activity of microbes earlier than other weed compost might be due to the smaller size of weed biomass and lower C.N ratio. Towards neutrality population count of microbial population increase profoundly which is the indicator of maturation of compost. Such phenomenon was recorded in their studies by Gaur *et al.* (1971) reported the increased trend of bacterial population. Similar result was reported by Gaur and Mukherjee (1980), Niranjane *et al.* (1993), Juma and McGill (1998) and Goyal *et al.* (2005).

Decomposing cultures

All decomposing cultures were recorded significant differences in increasing of microbial count

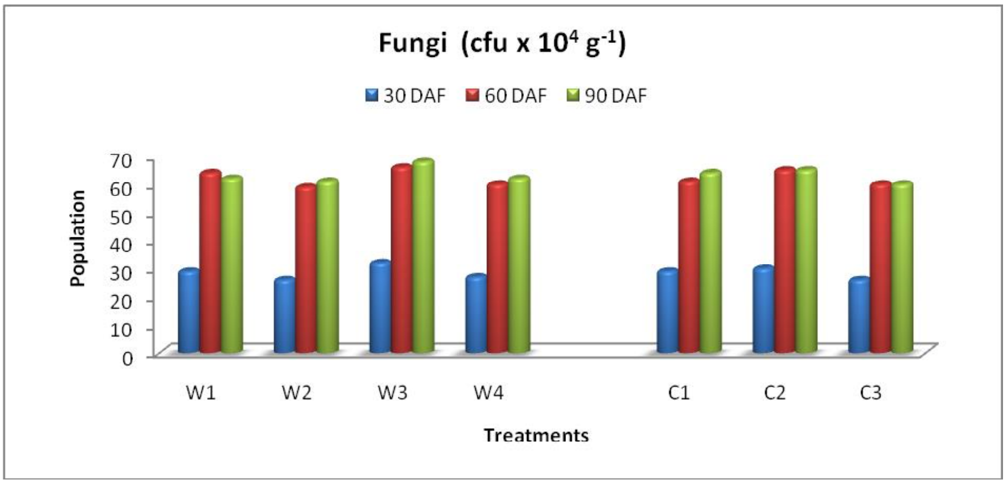

Fig. 1. Bacterial count as influenced by different treatment during decomposition of weed biomass

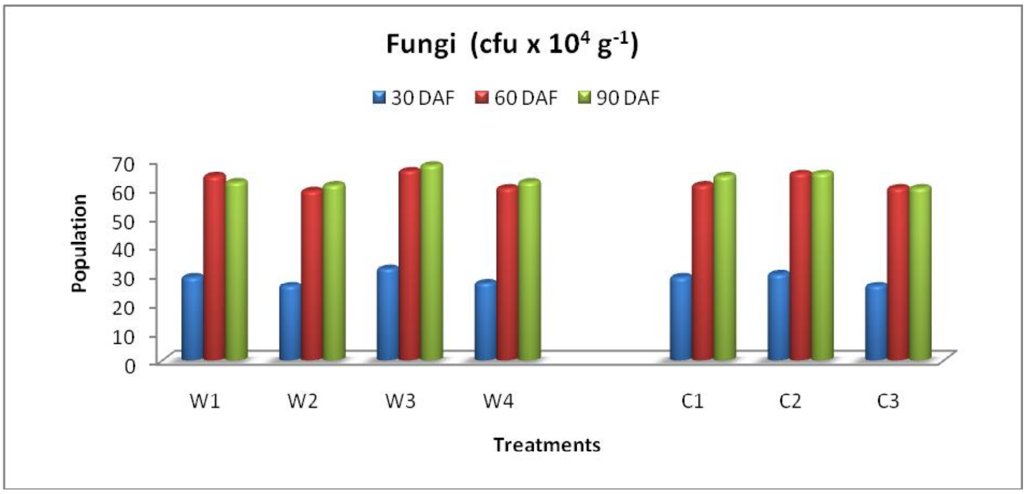

Fig. 2. Fungal count as influenced by different treatment during decomposition of weed biomass

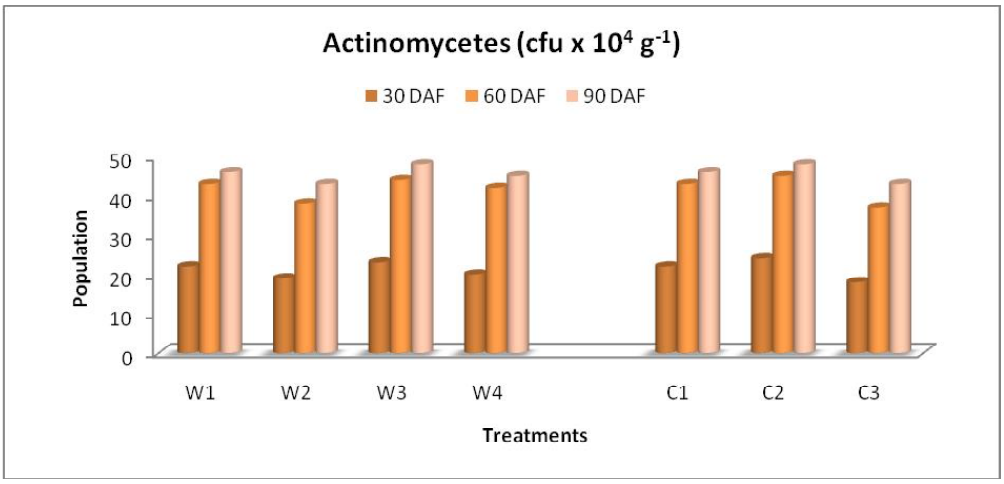

Fig. 3. Actinomycetes count as influenced by different treatment during decomposition of weed biomass

during decomposition period. Among the three decomposing cultures, PDKV decomposing culture recorded significantly higher increase in microbial count at 30, 60 and 90 DAF followed by S9 culture and without microbial culture.

Interaction effect

Interaction effect regarding microbial population was not recorded significant result between sources of compost and decomposing cultures.

CONCLUSION

The results concluded that, Mix weed was most useful for production of compost followed by *Cassia tora, Parthenium hysterophorus* and *Sorghum helepense*. PDKV decomposing culture was found to be most effective inoculant for decomposition of weed biomass followed by S9 culture and without culture (Dung slurry).

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Major and Micronutrients Uptake and Productivity of Cotton + Greengram Intercropping System as Influenced by Long-term Integrated Nutrient Management in Vertisols

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ABSTRACT

A field study was superimposed on a existing long term experiment initiated since 1987-88to asses the impact of continuous integrated application of chemical fertilizers and manures on major and micronutrients uptake and productivity of cotton + greengram(1:1) intercropping system in Vertisols. The experiment was initiated since 1987-88 on Vertisols at the same site and with the same randomization laid out with eight treatments in three replications at Research field of AICRP for Dryland Agriculture,Dr PDKV Akola, Maharashtra. The eight treatments comprised of control, 100 per cent RDF(50:25:00 kg NPK ha^{-1}) through chemical fertilizers, 50 per cent RDF through chemical fertilizers,50 per cent N through FYM/gliricidia, 50 per cent N through fertilizers + 50 per cent N through FYM/gliricidia +100% P_2O_5 ha^{-1}through fertilizers and 100 per cent N ha^{-1}through gliricidia + 100 per cent P_2O_5 ha^{-1}through fertilizers.The results indicated that the highermajor and micronutrients uptake and productivity of cotton + greengram intercropping system was observed with integrated nutrient management comprising 50 per cent N through FYM + 50 per cent N + 100 per cent P_2O_5 ha^{-1} through fertilizersfollowed by 50 per cent N through gliricidia+ 50 per cent N +100 per cent P_2O_5 ha^{-1} throughfertilizers, indicating the substitution of 50 per cent N either through FYM or gliricidiaas the most promising approach from the view point of considerable enhancement in major and micronutrients uptake and productivity of cotton + greengram intercropping system in Vertisols under semi arid conditions.

Cotton (G*ossypium* spp.) is one of the most important cash crops of India.Among different species of cotton, *Gossypiumhirsutum* and *Gossypiumarborium* are commonly grown in Maharashtra and used in textile industries for manufacture of cloth. Besides this, it is also used for several other purposes like making threads and for mixing in other fibers. India ranks first in the world having an area of 109.57 lakh ha with the production of 339.17 lakh bales.

Maharashtra is one of the leading cotton growing states in India having 38.06 lakh ha^{-1}area under cotton cultivation which is one third of country's area of cotton cultivation with the production of 80.59 lakh bales.Vidarbha is a major cotton and cotton-based cropping system growing region in central India where it is grown predominantly as rainfed crop on medium to deep Vertisol(Anonymous, 2016).

Greengram (*Vignaradiata*) is an excellent source of high (25%) quality protein. It belongs to leguminosae family and is believed to be native of central Asia. It can be raised on wide array of soil ranging from red lateritic soils of south India to black cotton soils of Maharashtra.

In India, the area under greengram is about 3.55 Mha with production of 1.80 MT and productivity of 512 kg ha^{-1} whereas, Maharashtra has about 5.11 lakh ha area and production is 2.89 lakh tones with productivity of 566 kg ha^{-1}.The area under greengram in Vidarbha is 1.13 lakh ha^{-1} and production of 0.78 lakh tones with productivity of 547 kg ha^{-1} (Anonymous, 2016[a]).

In Vidarbha cotton is grown predominantly as a rainfed crop. As such in Vidarbha region about 89 per cent cultivable land is under rainfed farming and rainfed cotton crop production has direct bearing on the agrarian economy of the region. The cotton productivity of Vidarbha region is low due to imbalanced use of fertilizers, erratic distribution of rainfall, low adoption of improved agro-techniques and decline in soil health.

Integrated plant nutrient management is an intelligent use of optimum combination of organic, inorganic and biological nutrient sources in specific crop, cropping system and climatic situation so as to achieve and sustain optimum yield and to improve or maintain soil physical, chemical and biological properties. Integrated plant nutrient managementis beneficial to maintain soil

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fertility, sustainable agricultural production and increase availability of nutrients from all resources and minimizing loss of nutrients.

MATERIAL AND METHODS

A study was conducted during 2016-17 on the existinglong term experiment initiated during 1987-88in Vertisols at Research field of AICRP for Dryland Agriculture, Dr PDKV, Akola, Maharashtra. The experiment is the part of long term experiment that was taken on same site since 1987-88 without changing randomization under rainfed condition in randomized block design with eight treatments replicated thrice. The eight treatments comprising organic and inorganic sources of fertilizer were: T_1- Control; T_2 -100 per cent N + 100 per cent P_2O_5through chemicalfertilizers;T_3- 50 per cent N + 50 per cent P_2O_5through chemicalfertilizers; T_4 -50 per cent N throughgliricidia ; T_5 -50 per cent N throughFYM ; T_6 -50 per cent N through chemicalfertilizers + 50 per cent N gliricidia+100 per cent P_2O_5ha^{-1}fertilizers ;T_7 -50 per cent N fertilizers + 50 per cent N ha^{-1}FYM + 100 per cent P_2O_5 ha^{-1}fertilizers ; T_8 -100 per cent N ha^{-1}gliricidia + 100 per cent P_2O_5 ha^{-1} fertilizers.The plant samples were collected after harvest of crops and were analyzed for nutrient content as per standard methods. The yield of cotton and green gram was recorded and expressed in appropriate unit. The data was subjected to statistical analysis as per Panse and Sukhatme (1987).

RESULTS AND DISCUSSION

Nutrient uptake by cotton and greengram

The data on total nutrient uptake by cotton and greengramas influenced by long term effect of various nutrient management treatments are presented in Table 1 and 2, respectively.

Nutrient uptake by cotton

The total uptake of nitrogen by cotton varied from 33.9 to 68 kg ha^{-1}and the significantly higher total nitrogen uptake (68.0 kg ha^{-1}) by cotton was recorded in treatment 50 per cent N fertilizers + 50 per cent N ha^{-1} FYM + 100% P_2O_5 ha^{-1} fertilizerswhich was on par with 50 per cent N and 100 per cent N through gliricidia combined with 100 per cent P_2O_5 ha^{-1}through fertilizers.

The uptake of N increased due to the combined application of inorganics in combination with organicswhich increased the concentration of N in seed and stalk. This may be due to addition of FYM and gliricidia green leaf manuring which contains larger amount of N in their leaves and that facilitates higher rate of mineralization process, also effective root system and increased concentration of nutrients in soil solution as well as better soil physical environment coupled with sufficiency of moisture and nutrients helped in better uptake of nutrients and thus results in higher uptake of nitrogen by the plant as compared to the inorganic fertilizers alone. The 50 per cent substitution of inorganic fertilizers by FYM/ gliricidia was helpful in increasing uptake of N. The results are in conformity with the finding of Rao and Janawade (2009), Thimmareddy *et al.* (2013), Naik (2016), Khambalkar *et al.*(2017)andJadhao *et al.(*2018).

The significantly higher total P uptake (20.7 kg ha^{-1}) by cotton was observed with the application of 50 per cent N fertilizers + 50 per cent N ha^{-1} FYM + 100 per cent P_2O_5 ha^{-1} fertilizersand it was also found to be on par with application 50% N through gliricidia combined with 100% P_2O_5 ha^{-1}through fertilizers. The application of FYM/ gliricidia with chemical fertilizers was better than the fertilizer application alone and it increased the uptake of phosphorus from soil. The improvement in soil physical condition caused due to addition of organics is beneficial for enhanced uptake in INM treatments. The organics also help in reducing fixation of phosphorus, which improves the availabilityand efficient use of added phosphorus. The results are in confirmation with the findings of Garrido *et al.* (2009), Rao and Janawade (2009), Thimmareddy *et al.* (2013), Naik (2016), Khambalkar *et al.*(2017)andJadhao*et al.* (2018).

The total uptake of potassium ranged from 25.1 to 52.8 kg ha^{-1}and significantly higher total K uptake (52.8 kg ha^{-1}) was recorded in treatment (T_6) and was on par with treatment (T_7). The increase in total potassium uptake was due to incorporation of organic material like FYM, gliricidia along with inorganic fertilizers which contains larger amount of potassium and on decomposition, release of organic acids that solubilize native K and which may get available to the plant. It is attributed to the greater capacity of organic colloids to hold K ions on the exchange sites which enhanced the availability of potassium resulting in more uptake. Similar results have also been quoted by Rao and Janawade (2009), Thimmareddy *et al.* (2013) and Jadhao *et al*.(2018).

Nutrient uptake by greengram

The significantly higher total N uptake (57.16 kg ha^{-1}) by greengram was observed with application of 50 per cent N fertilizers + 50 per cent N ha^{-1} FYM + 100 per cent P_2O_5 ha^{-1} fertilizers(T_7), and it was found to be on par with the application50 per cent N and 100 per cent N through gliricidia in combination with chemical fertilizer application The lowest(T_6 & T_8). Total N uptake (32.47 kg ha^{-1}) by greengram was observed in treatment T_1 *i.e.* control.

The higher total uptake of phosphorus (6.44 kg ha^{-1}) by greengram was significantly influenced by the application of FYM for 50 per cent N substitution along with chemical fertilizers in *Kharif*. It was found to be on par with treatment of integration of chemical fertilizers with gliricidia green leaf mauring (T_6).

Significantly higher amount of P uptake by plant might be due to application of FYM/ gliricidia with chemical fertilizers which increases the availability of phosphorus in the soil. This includes production of organic acids through decomposition of organic matter and a consequent release of phosphate ions, production of hydrous oxides which reduces soil P fixation. Similar results were also reported by Mahavishnan *et al.* (2005), Pathak *et al.* (2005),Garrido *et al.* (2009), Rao and Janawade (2009), Naik (2016) and Khambalkar *et al*.(2017).

The significantly higher total K uptake by greengram (23.55 kg ha^{-1}) was observed in treatment 50 per cent N fertilizers + 50 per cent N ha^{-1} FYM + 100 per cent P_2O_5 ha^{-1} fertilizers and it was found to be on par with 50 per cent N through fertilizers + 50 per cent N throughgliricidia +100 per cent P_2O_5 ha^{-1} fertilizers and treatment with application of 100 per cent N ha^{-1}gliricidia + 100 per cent P_2O_5 ha^{-1} fertilizers(T_8).The lowest total K uptake (10.05 kg ha^{-1}) by greengram was observed in treatment T_1 i.e. control.

There was an increasing uptake of potassium by greengramunder INM ($T_6$to T_8). The improvement in the total uptake of potassium in INM is associated with the residual effect of organics to enhance soil quality resulting into better availability of nutrients. Thus, the data clearly indicated that, for efficient utilization of potash, it is essential to apply organics. Similar results were also

Table 1. Uptake of major nutrients by cotton as influenced by long-term effect of INM under cotton + greengram intercropping system

Treatments		Uptake of major nutrientsbycrops(kg ha^{-1})					
		Cotton			Greengram		
		N	P	K	N	P	K
T_1	Control	33.9	9.5	25.1	32.47	3.50	10.05
T_2	100% N + 100% $P_2O_5$$ha^{-1}$ fertilizers	55.2	16.8	42.6	52.34	5.39	17.00
T_3	50% N + 50% P_2O_5 ha^{-1} fertilizers	41.6	12.9	34.3	46.59	4.78	15.07
T_4	50% N ha^{-1}gliricidia	37.0	11.6	32.3	43.96	4.41	14.33
T_5	50% N ha^{-1} FYM	37.9	11.6	32.2	47.47	4.68	15.61
T_6	50% N fertilizers + 50% N gliricidia + 100% P_2O_5 ha^{-1}fertilizers	63.9	20.2	52.8	56.03	6.21	23.06
T_7	50% N fertilizers + 50% N ha^{-1}FYM + 100% P_2O_5 ha^{-1} fertilizers	68.0	20.7	52.3	57.16	6.44	23.55
T_8	100% N ha^{-1}gliricidia + 100% P_2O_5 ha^{-1}fertilizers	55.8	17.2	45.4	53.34	5.82	22.34
	SE (m) ±	2.8	0.9	2.3	2.19	0.20	0.79
	CD at 5%	8.2	2.6	6.8	6.50	0.59	2.34

reported by Mahavishnan *et al*. (2005),Garrido *et al*.(2009), Rao and Janawade (2009), Naik (2016) and Khambalkar *et al*. (2017).

Micronutrientsuptake by cotton

Iron uptake

The micronutrients are found to be essential in plant nutrition. Iron contributed in formation of chlorophyll and also helps in availability of other major nutrient to the plants. The highest total uptake of iron by cotton was recorded in 50 per cent N through fertilizers + 50per cent N ha^{-1} through FYM + 100per cent P_2O_5 ha^{-1}through fertilizers (T_7), which was found at par with 50per cent N through fertilizers + 50per cent N through gliricidia +100per cent $P_2O_5ha^{-1}$fertilizers(T_6). It was observed that the iron uptake by cotton was significantly influenced by INM treatments (Table 2). The increase in uptake of iron may be due to the more availability of iron in organic sources (FYM, green mauring, crop residues). The similar results were also reported by Lal and Mathur (1989) and Mali (2012).

Manganese uptake

After 30^{th} year of experiment, higher total uptake of manganese by cotton was recorded with the application of 50per cent N through fertilizers + 50 per cent N through FYM + 100 per cent P_2O_5 ha^{-1} through fertilizersand was found at par with 50 per cent N through fertilizers + 50 per cent N through gliricidia +100 per cent P_2O_5 ha^{-1}through fertilizers .Manganese uptake increased with conjoint application of organics and inorganic fertilizers and also due to high yield of cotton.

Copper uptake

The highertotal uptake of copper by cotton was recorded with the application of 50 per cent N through fertilizers + 50 per cent N ha^{-1} through FYM + 100 per cent P_2O_5through fertilizers and was found at par with 50 per cent N through fertilizers + 50 per cent N through gliricidia +100 per cent P_2O_5 through fertilizers and lowest uptake was found in control.The increase in uptake of copper in INM treatments was due to the use of crop residues, green manure and FYM which helps in enhancing the uptake of micronutrients by crop.

Zinc uptake

The total zinc uptakeby cotton in treatmentsT_6 & T_7 was found at par with each other (Table 2). The uptake of zinc was increased in organics (FYM, gliricidia green leaf mauring) in combination with chemical fertilizers over control. Total zinc uptake by cotton was significantly higher under 50 per cent N through FYM along with chemical fertilizers (T_7) over only chemical fertilizers. The zinc uptake was considerably reduced under control.

Prasad *et al.* (2010) reported increased zinc uptake in INM treatments with the use of green manuring, crop residues and FYM which helps to enhance availability of all the nutrients and get readily available to crop. The

Table 2. Uptake of micronutrients by cotton as influenced by long-term effect of INM under cotton + greengram intercropping system

Treatments		Uptake of micronutrients by cotton (g ha^{-1})			
		Fe	Mn	Cu	Zn
T_1	Control	280.6	41.5	27.8	49.7
T_2	100% N+ 100% $P_2O_5ha^{-1}$throughfertilizers	479.2	75.9	50.0	100.1
T_3	50% N+ 50% P_2O_5 ha^{-1}throughfertilizers	380.3	57.9	39.9	75.4
T_4	50% N ha^{-1}throughgliricidia	339.8	49.9	34.9	64.6
T_5	50% N ha^{-1} FYM	360.8	51.2	34.2	65.5
T_6	50% N fertilizers + 50% N gliricidia +100% P_2O_5 ha^{-1} fertilizers	558.7	93.6	58.9	118.7
T_7	50% N fertilizers + 50% N ha^{-1}FYM + 100% P_2O_5 ha^{-1} fertilizers	565.5	98.9	60.3	120.9
T_8	100% N ha^{-1}gliricidia + 100% P_2O_5 ha^{-1} fertilizers	493.2	81.2	49.4	102.5
	SE (m) ±	21.9	3.5	2.44	4.46
	CD at 5%	65.3	10.5	7.24	13.25

increase in uptake of micronutrients may be due to the availability of these nutrients in organic sources. The similar results were also reported by Mali (2012).

Micronutrientsuptake by greengram

Iron uptake

The significantly higher iron uptake by greengram was recorded with theapplication of 50 per cent N through FYM with chemical fertilizers (T_7) over only chemical fertilizers (Table 3). It was also observed that the uptake of greengram increased under the integrated nutrient management as compared to only chemical fertilizers. The increase in uptake of iron may be due to the more availability of iron in organic sources (FYM, gliricidia green leaf mauring, crop residues).

Manganese uptake

The total uptake of manganese by greengram in treatments T_6&$T_7$was found at par with each other (Table 3). The uptake of manganese was found to be higher under integrated nutrient management as compared with no manure, no chemical fertilizers. Similar results were reported by Lal and Mathur (1989) and Mali (2012).

Copper uptake

The highest total uptake of copper by greengramwas observed in 50 per cent N fertilizers + 50 per cent N ha^{-1} FYM + 100 per cent P_2O_5 ha^{-1} fertilizers (T_7)and was found at par with 50 per cent N fertilizers + 50 per cent N gliricidia +100 per cent P_2O_5 ha^{-1}fertilizers (T_6).The increase in uptake of copper in INM treatments was due to the use of crop residues, green manure and FYM which helps in enhancing the uptake of micronutrients by crop.

Zinc uptake

The total zinc uptake in greengramwas significantly higher under 50 per cent N through FYM with chemical fertilizers (T_7) over control. It was also observed that the zinc uptake in greengram increased under the integrated nutrient management as compared to only chemical fertilizers. Prasad *et al.* (2010) reported increased zinc uptake in INM treatments with the use of green manuring, crop residues and FYM which helps to enhance availability of all the nutrients and get readily available to crop.

Yield of crops in cotton + greengram intercropping system

The yield of cotton and greengram after 30th cycle (2016-17) showed considerable increase due to integrated nutrient management in comparison to only chemical fertilizers (Table 4). The substitution of 50 per cent N by

Table 3. Uptake of micronutrients bygreengram as influenced by long-term effect of INM under cotton + greengram intercropping system

Treatments		Uptake of micronutrients by greengram(g ha^{-1})			
		Fe	Mn	Cu	Zn
T_1	Control	313.5	64.1	38.2	45.2
T_2	100% N+ 100% P_2O_5ha^{-1} fertilizers	458.8	96.9	57.2	77.1
T_3	50% N+ 50% P_2O_5 ha^{-1} fertilizers	428.2	83.6	45.9	68.2
T_4	50% N ha^{-1}gliricidia	397.2	79.8	45.8	58.2
T_5	50% N ha^{-1} FYM	442.7	85.6	50.1	64.6
T_6	50% N fertilizers + 50% N gliricidia + 100% P_2O_5 ha^{-1} fertilizers	564.5	109.9	66.0	90.8
T_7	50% N fertilizers + 50% N ha^{-1} FYM + 100% P_2O_5 ha^{-1} fertilizers	589.1	112.6	66.3	93.2
T_8	100% N ha^{-1}gliricidia + 100% P_2O_5 ha^{-1} fertilizers	549.3	104.2	60.8	77.9
	SE (m) ±	17.4	3.23	1.89	2.62
	CD at 5%	51.6	9.58	5.62	7.79

Table 4. Yield of crops as influenced by long-term effect of INM under cotton + greengram intercropping system

Treatments		Cotton(q ha^{-1})	Greengram(q ha^{-1})		
		Seed cotton	Stalk	Grain	Straw
T_1	Control	8.35	14.96	9.36	4.13
T_2	100% N + 100% $P_2O_5 ha^{-1}$ fertilizers	12.67	21.70	11.05	5.31
T_3	50% N + 50% P_2O_5 ha^{-1} fertilizers	10.18	18.71	11.01	4.92
T_4	50% N ha^{-1} gliricidia	9.02	17.40	10.81	4.70
T_5	50% N ha^{-1} FYM	9.41	17.21	11.94	4.64
T_6	50% N fertilizers + 50% N gliricidia + 100% P_2O_5 ha^{-1} fertilizers	15.15	24.50	12.29	6.19
T_7	50% N fertilizers + 50% N ha^{-1} FYM + 100% P_2O_5 ha^{-1} fertilizers	15.45	24.69	12.43	6.25
T_8	100% N ha^{-1} gliricidia + 100% P_2O_5 ha^{-1} fertilizers	13.40	21.69	12.03	5.84
	SE (m) ±	0.68	1.34	0.49	0.39
	CD at 5%	2.02	3.99	1.45	1.15

FYM/gliricidia along with chemical fertilizers was found superior among all the treatments. However, inclusion of organics was found beneficial in increasing the yield of both the crops.

Among the different sources of nitrogen substitutions, highest yield of cotton (15.45 q ha^{-1}) and greengram (12.43 q ha^{-1}) was noticed in the treatment where 50 per cent N was substituted through FYM (T_7) and was found on par with treatment where 50 per cent N was substituted through gliricidia(T_6). Significant increase in yield due to conjoint use of organics with chemical fertilizers has been reported by Selvi*et al.* (2005).

The drastic reduction in yield of both crops was noted under control, with lack of addition of organics and imbalanced use of fertilizers. Organic manure directly added an appreciable amount of major and micronutrients to soil which could contribute to the enhanced yield. In addition to this, the improved physical properties provided a desirable soil condition for root development, enhanced nutrient uptake, crop growth and yield. Similar results were recorded by Naik (2016),Khambalkar *et al.*(2017) and Shariff *et al.*(2017).

This increase in crop productivity may be due to the combined effect of nutrient supply, synergism and improvement in soil physical and biological properties. However, the yields of both the crops in 50 per cent N through fertilizer + 50 per cent N through FYM+100 per cent P_2O_5 ha^{-1} fertilizers (T_7) and 50 per cent N throughfertilizers + 50 per cent N ha^{-1} throughgliricidia + 100 per cent P_2O_5 ha^{-1}fertilizers (T_6) was found to be maintained year after year which can be ascribed to sustenance of soil health.

Present investigation showed that the results after 30[th] cycle indicated that the use of FYM orgliricidia green leaf manuring in conjunction with chemical fertilizers resulted in improvement of major and micronutrients uptake and higher productivity of cotton +greengram intercropping system. Hence, it is concluded that long term application of 50 per cent N through FYM/gliricidia + 50 per cent N through inorganics + 100 per cent P_2O_5 ha^{-1}through inorganics to cotton+greengram (1:1) intercropping system resulted in higher major and micronutrients uptake and sustaining crop productivity in Vertisols under rainfed condition.

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Site Specific Nutrient Management (SSNM) on Productivity Dynamics of Safflower Under *Rainfed* Condition

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ABSTRACT

The field experiment was conducted at oilseeds research unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *Rabi* season 2017, to know the effect of site specific nutrient management on growth and yield of safflower under *rainfed* condition. Fertilizers were applied to the crop based on uptake pattern, target yield and fertility status. The experiment was laid out in factorial randomized block design with 10 treatment combination replicated four times. The treatment comprised of different manuring and fertilizer management. Result revealed that in different manuring treatment, 5 tone FYM ha^{-1} found significantly superior over the no manure in growth, yield attributing and seed yield character such as plant height, No. of effective capsule plant^{-1}, dry matter per plant, seed weight plant^{-1}, 100 seed weight and harvest index. Among the fertilizer management treatment, application of fertilizer based on SSNM for target yield, treatment (F_3) STCR equation + Micronutrients - ZnSO4 @ 25 kg ha^{-1} + S @ 10 kg ha^{-1} recorded significantly higher growth parameters, yield contributing characters and seed yield, however 100 seed weight and harvest index found at par with treatment F_4 - ((SSNM (NPK) (deficient + 25 % rec.; Medium: rec.; high: - 25% rec.)).

Safflower (*Carthamus tinctorius* L.) is an important edible oilseed crop of the world. In the world, India is the largest producer of safflower. This occupies 2788 ha area with 1689 metric tons production and having 606 kg ha^{-1} productivity. In India, it is mainly grown in Maharashtra, Karnataka and part of Andhra Pradesh, Orissa and Bihar. In Maharashtra, Safflower is mainly grown in Marathwada region and occupies 9.5 thousand ha area with 6.8 metric tons production and having 710 kg ha^{-1} productivity, in Vidarbha region safflower occupies 2.5 thousand ha area with 1.7 metric tons production and having 657 kg ha^{-1} productivity.

The maximum yield potential of safflower can be realized by adopting suitable agronomic practice like use of fertilizer dose, timely sowing and maintaining optimum plant density (Sakir and Baslama, 2005). It is more drought resistance than other oilseeds and can produce good yield in dry region, while its salt tolerance is a valuable asset as the area affected by some degree of salinity steadily increases.

Traditionally, safflower is grown in vertisols, which are deficient in nitrogen, phosphorous, sulphur and some other micronutrient (Purvimath *et al*., 1993). However, requirement of sulphur and zinc to this crop is relatively high. It is important to increase the production of safflower by adding adequate quantity of fertilizers including micronutrients (Abbas *et al*., 1995).

The foliar application of Zn and Mn can improve the seed yield and seed quality of safflower grown under drought stress. Increase of seed yield of safflower due to zinc foliar application has been reported by Movahhedi-Dehnavi *et al.* (2009). Micronutrient elements play a critical role in plants that lead to increase the leaf area index and there by increased light absorption and increase the amount of dry matter accumulation and economic yield (Ravi and channel, 2008). Zinc also plays an important role in the production of biomass, grain yield, quality and quantity of oil (Kaya and Higgs, 2002).

Site Specific Nutrient Management (SSNM) is a concept that can be applied to any crop and any field. It is actually a “repackaging” of management concepts that have been promoted for many years. SSNM strategies includes site and season specific knowledge of crop nutrients requirements, indigenous nutrient supplies and are required to increase productivity, yield and nutrient use efficiency in different cropping systems. It includes practices that have been previously associated with Maximum Economic Yield (MEY) management, best management practices, as well as general agronomic principles. The SSNM approach eliminates wastage of

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fertilizer by preventing excessive rates of fertilization and by avoiding fertilization when the crop does not require nutrient inputs.

MATERIAL AND METHODS

A field experiment was conducted at oilseed research unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (MS), during *Rabi* 2017. The experimental soil was clay loam in texture, alkaline in reaction pH (8.12), EC (0.52 dsm^{-1}), low in available nitrogen (190.0 kg ha^{-1}), available phosphorus (23.00 kg ha^{-1}) and slightly high in available potassium (347 kg ha^{-1}). The experiment was laid out in FRBD with ten treatment combination *viz.,* Factor A consisting two treatments M_0 – No manure, M_1 – 5 tone FYM ha^{-1} and Factor B consist of site specific nutrient management treatments of F_0- control (No fertilizer), F_1- recommended NPK, F_2- SSNM (STCR equation), F_3- SSNM (STCR equation) + micronutrients (ZnSO4 @ 25 kg ha^{-1} + S @ 10 kg ha^{-1} and F_4: SSNM (NPK) (deficient + 25% rec.; medium: rec.; high: - 25 % rec.) combination replicated four times. The recommended doses of N, P and K were applied to safflower. Sowing of safflower (cv.AKS-207) was carried out on 4th October 2017 by dibbling and harvesting was done 10th march 2017. Soil sample from each plot were drown before sowing and after harvest of crop and analysed was done by standard procedure to assess the chemical properties and N, P and K contain by using standard methods. To analysis of plant uptake, plant sample were taken and analyzed. To the fertilizers management urea, single super phosphate and muriate of potash were applied. To macro and micro nutrient management, zinc sulphate and sulphur were used to supply $ZnSO_4$ and S, respectively and for the other sources of nutrient management were FYM used in Factor A. Grain and straw yields were recorded from each plot at harvest. Soil sample from each plot were drown before sowing and after harvest of crop and analysed by standard procedure to assess the chemical properties and N, P, K using standard methods. For analysis of uptake plant, plant sample were taken and analysed.

Criteria for deciding SSNM levels:

The SSNM approach involves three steps. The first step is to establish an attainable yield target. The yield target reflects the total amount of nutrients that must be taken up by the crop to produce unit quantity of economic yield. The second step is to ensure effective use of native nutrients from soil and application from external sources. The third step is to apply fertilizer to fulfil the deficit between the crop needs and indigenous supply in obtaining targeted yield and maintaining the soil fertility. Nutrient uptake by safflower is 190: 23:347 NPK kg ha^{-1}. Following STCR equation used for calculating fertilizer nutrient required of safflower crop F.N = 7.49 x T - 68.9 x S.N; F. P_2O_5: 11.38 x T – 3.34 x S. P; F. K_2O: 4.99 x T – 0.20 x S. K and target yield was taken 15 qt ha^{-1}. Further taking the supply factor into consideration, (1) if soil nutrient rating is medium- low Apply exactly removal quantity, (2) if soil nutrient rating is low- Apply 25 % more and (3) if soil nutrient rating is high – Apply 25 % less.

RESULTS AND DISCUSSION

Yield parameters of safflower:

Data pertaining to the growth parameters and yield contributing characters is presented in table no. 1, from the analysis results showed that, plant height, No. of effective capsule per plant, Dry matter $plant^{-1}$, seed weight per plant, 100 seed weight and harvest index found significant due to the main plot and subplot treatments. Among the two different manuring treatment, the significantly highest plant height, No. of effective capsule $plant^{-1}$, Dry matter $plant^{-1}$, seed weight per plant and 100 seed weight recorded with application of 5 T Manure per ha (M_1), but harvest index did not differ significantly. With respect to the different fertilizer management treatment, application of SSNM (STCR equation) + Micronutrients- $ZnSO_4$ @ 25 kg ha^{-1} + S @ 10 $kgha^{-1}$ (F_3) recorded the significantly highest values of growth parameters and yield contributing characters, however 100 seed weight and harvest index found at par with treatment F_4- ((SSNM (NPK) (deficient + 25% rec.; Medium: rec.; high: -25% rec.)). Interaction had significant effect on Dry matter and 100 seed weight, but remaining character did not differ significantly.

The improvement in plant height due to SSNM, sulphur, Zinc application might be due to proper nourishment of crop which helped in acceleration of various metabolic processes and optimum growth. Timely release of nutrients favourable for the crop growth which favoured increased activity of meristematic cells and cell elongation and hence the higher plant height and number of branches plant^{-1}. The present finding are in conformity with subramaniyan *et al.* (2001), Anand (2010), Veeramani *et al* .(2012), Rahevar *et a.l* (2017). The higher total dry matter production might be due to the improvement in plant growth parameters as result of increased in nutrient concentration in plant part which are the constituent of proteins, chlorophyll etc. which in turn resulted in increased synthesis of carbohydrates that are being utilized for build up of new cells and their accumulation leading to higher dry matter production. Similar results were also reported by Subramaniyan *et al.* (2001), Anand (2010), Veeramani *et al*. (2012) and Bholanath Saha *et al*. (2015).

Seed and Oil yield

The seed and biological yield obtained with different site specific Nutrient Management practices is presented in Table no 2. The mean safflower seed yield ranged between 910 to 1591 kg ha^{-1} and biological yield 3343 to 4291 kg ha^{-1}. The results showed that, among two different FYM management treatments, application of 5 T FYM ha^{-1} (M_1), recorded the significantly highest seed yield (1389 kg ha^{-1}) and biological yield (4086 kg ha^{-1}). With respect to the different fertilizers management treatments, the application nutrients with SSNM (STCR equation) + Micronutrients- $ZnSO_4$ @ 25 kg ha^{-1} + S @ 10 kgha^{-1} (F_3) recorded the significantly superior Seed yield (1591 kg ha^{-1}) and Biological yield (4291 kg ha^{-1}) of safflower rather than all other treatments. The fertilizer application with F_2: Site Specific Nutrients Management recorded the second highest seed yield (1413 kg ha^{-1}) of safflower, which was on par with treatment F_4: SSNM (NPK) (deficient + 25% rec.; Medium: rec.; high: -25% rec.). The lowest seed and biological yield recorded with F_0: No application of fertilizer. Interaction effect found significant for seed yield and did not differ significantly for biological yield. it might be due to enhancement in yield usually depends upon the total dry matter produced and its distribution among different parts of the plant. The higher seed yield may be attributed to higher total dry matter accumulation which in turn might be due to the availability of balanced and higher nutrition (available nitrogen, phosphorus, potassium as well sulphur and zinc) their uptake and translocation to the reproductive parts and their cumulative effect on improvement in yield attributing characters. Similar results were obtained by Mishra and Vyas (1992), Subramanivan *et al.* (2001), Biradar *et al. (*2006) Anand *et al.* (2017), Rahevar *et al.* (2017). Interaction had significant effect on 100 seed weight, but remaining character did not differ significantly.

Economics:

Economics worked out from the emerged data is presented in table 2. The economics analysis of study revealed that, significantly highest monetary advantage in terms of gross monetary returns was found with the treatment M_1 – 5 T FYM ha^{-1} for FYM application in main plot and treatment F_3- SSNM (STCR equation) + Micronutrients- $ZnSO_4$ @ 25 kg ha^{-1} + S @ 10 kg ha^{-1} in case fertilizer management in sub plot. But in respect of Net Monetary Returns application M_0: No Manure application recorded the highest values and among the different five fertilizer management practices, fertilizer management with F3- SSNM (STCR equation) + Micronutrients- $ZnSO_4$ @ 25 kg ha^{-1} + S @ 10 kg ha^{-1} recorded the highest value than rest of the treatments. Similar trend was noticed in respect to the B:C Ratio.

CONCLUSION

The site specific nutrient management (SSNM) practice takes into account the crop nutrient demand, soil available nutrients, efficiency factor and nutrient to be supplied to obtain desired yield targets. Thus application of 5 t FYM and treatment F_3 - SSNM (STCR equation) + micronutrients - ZnSO4 @ 25 kg ha^{-1} + S @ 10 kg ha^{-1} recorded significantly higher growth parameters, yield parameters and economics of safflower as compared to other treatments.

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Table 1: Growth and Yield characters influenced by site specific nutrient management practices under rainfed condition.

Treatments	Plant height (cm)	No. of capsules plant^{-1}	No. of branches plant^{-1}	Dry Matter gm plant^{-1}	Harvest index(%)
Factor A					
M_0: No Manure	106.0	27.70	11.3	33.3	23.73
M_1: 5 t FYM ha^{-1}	109.5	28.93	13.2	41.8	23.88
SE m±	0.38	0.285	0.26	0.57	0.105
CD @ 5%	1.13	0.830	0.78	1.68	-
Factor B					
F_0: Control (No fertilizer)	97.8	20.95	10.5	32.18	23.09
F_1: Recommended NPK	105.8	26.73	11.1	35.13	23.29
F_2: SSNM (STCR equation)	111.3	30.95	13.5	39.20	23.80
F_3: F2 + Micronutrients (ZnSO4 @ 25 kg ha^{-1} + S @ 10 kg ha^{-1})	114.0	34.25	14.3	43.38	24.61
F_4: SSNM (NPK) (deficient + 25% rec.; Medium: rec.; high: -25% rec.)	109.0	28.70	11.8	37.75	24.23
SE m±	0.61	0.45	0.42	0.91	0.166
CD @ 5%	1.79	1.31	1.23	2.66	0.486
Interaction	**NS**	**NS**	**NS**	**Sig**	**NS**

Table 2: Seed yield and yield contributing character of safflower as influenced by site specific nutrient management practices under rainfed condition.

Treatments	Seed yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Seed weight (g per plant)	100 seed wt. (g)
Factor A				
M_0: No Manure	1053	3,629	12.04	5.9
M_1: 5 t FYM ha^{-1}	1516	4,086	14.07	6.3
SE m±	26.52	35.66	0.26	0.050
CD @ 5%	77.36	104.04	0.78	0.145
Factor B				
F_0: Control (No fertilizer)	883	3,343	9.2	5.78
F_1: Recommended NPK	1211	3,660	12.5	6.06
F_2: SSNM (STCR equation)	1386	4,016	14.2	6.18
F_3: F2 + Micronutrients *(ZnSO4 @ 25 kg ha^{-1} + S @ 10 kg ha^{-1})*	1656	4,291	16.0	6.43
F_4: SSNM (NPK) (deficient + 25% rec.; Medium: rec.; high: -25% rec.)	1287	3,970	13.3	6.03
SE m±	41.93	56.39	0.37	0.079
CD @ 5%	122.32	164.51	1.09	0.229
Interaction	**Sig.**	**NS**	**NS**	**Sig.**

Table 3: Economics of safflower as influenced by site specific nutrient management practices under rainfed condition

Treatments		GMR(Rs ha^{-1})	COC(Rs ha^{-1})	NMR(Rs ha^{-1})	B:CRatio
Factor A					
M_0:	No Manure	35795	16150	19645	2.22
M_1:	5 t FYM ha^{-1}	51539	23750	27789	2.17
	SEm±	901.34	-	901.32	
	CD @ 5%	2629.41	-	2630.15	
Factor B					
F_0:	Control (No fertilizer)	30016	19950	10066	1.50
F_1:	Recommended NPK	41161	22226	18935	1.85
F_2:	SSNM (STCR equation)	47119	23545	23574	2.00
F_3:	F2 + Micronutrients ($ZnSO_4$ @ 25 kg ha^{-1} + S @ 10 kgha^{-1})	56295	25775	30520	2.18
F_4:	SSNM (NPK) (deficient + 25% rec.; Medium: rec.; high: -25% rec.)	43745	22629	21115	1.93
	SEm±	1425.14	-	1425.11	
	CD @ 5%	4157.46	-	4157.38	
	Interaction	**Sig**		**NS**	

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Evaluation of Local Genotypes in Dolichos Bean (*Dolichos lablab* L .) Under Vidarbha Conditions

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ABSTRACT

A study was carried out at Dr. PDKV, Akola during *Kharif* season of 2018-19 with the objective to collect the local genotypes of dolichos bean from Vidarbha region, to study the performance under Akola conditions and to find out the suitable genotype with better yield and quality of dolichos bean. There were twenty-eight genotypes of dolichos bean along with two checks Dasara, Deepali were tested in the present study. The genotype AK-WAL/18-07 showed maximum primary branches per plant (1.63, 5.97, 10.80, 14.53 and 17.67, respectively), at 30, 60, 90, 120 and 150 DAS, respectively. The genotype AK-WAL/18-21 was expressed earliest (44.3) days to flower initiation, days to 50 per cent flowering (73.33), days to first pod set (91.10) and first harvest (101.33 days). Check variety Dipali recorded maximum pod length (17.23 cm), and ten-pod weight (145.3 g). Pod width was noticed maximum (3.72 cm) in genotype AK-WAL/18-24. Number of pods plant^{-1} were ranged from 32.98 to 266. And the genotype AK-WAL/18-07 expressed maximum pods plant^{-1} as well as pod yield plant^{-1} (201.67 q). The genotypes AK-WAL/18-21, AK-WAL/18-15, AK-WAL/18-16 reported to be earlier genotype, which might be considered as best genotypes for short duration. The maximum (21.7 %) protein content was reported by genotype AK-WAL/18-13. Whereas, the (6.36 %) fiber content was observed in genotype AK-WAL/18-17.

Dolichos bean (*Dolichos lablab* L.) belongs to the family Fabaceae, sub family Faboidene, tribe phaseoleae, sub tribe phaseolineae and the genus lablab has included several distinct species names but, it is currently regarded as monospecific. Within this genus, chromosome number varies, with 2n =20, 22, 24 (Philip 1982).

Dolichos bean is mainly grown for its green pods, while the dry seeds are used in various vegetables preparation. 100 g of green pods contain 6.7 g carbohydrates, 3.8 g protein, 1.8 g fibre, 210 mg calcium, 68.0 mg phosphorus and 1.7 mg iron. It is one of the major sources of protein in the diet of South India. The *Lablab purpureus* leaf contain 21.38 per cent of crude protein while the grain contains 20-28 per cent (Norton, 1982). The protein in *Lablab* has high levels of amino acids like lysine (6.2 %) which is low in cereal grains.

Legume crops are important food components as they are major contributors to dietary protein and oils. Large proportion of Indian population relies on grain legumes as a dietary source of protein due to economic or culture reasons. The demand for food and feed is growing with increasing population, while natural resources are limited. The yield potential of crop plant has to be significantly increased to combat the increasing demand. Considering the rapid increase in the area under dolichos bean cultivation and its popularity in day to day life, every effort is being made in order to improve the presently grown genotypes in dolichos bean. The success of crop breeding programme depends on the extended variability present in the available germplasm. Evaluation of dolichos bean germplasm is the first step in this direction since the improvement of any crop is proportional to the magnitude of its genetic variability. Besides, the knowledge of interrelationship between the yield and its contributing traits are helpful for improving the efficiency of selection. Because of above drastic alteration in climate and cultivars of Vidarbha region, there is an ample need to identify and evaluate the new high yielding genotypes of dolichos bean suitable for the region. Accordingly. the present study was undertaken at the field of Chilli and Vegetable Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola.

MATERIAL AND METHODS

The statistical design adopted for the experiment was Randomized Block Design (RBD) with three

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replications. The distance between row to row and plant to plant was keep 100 cm each. The experimental material consisted of 28 genotypes of dolichos bean (*Dolichos lablab* L.) including two checks as released varieties from Dr. P.D.K.V., Akola. All the twenty-eight genotypes of dolichos bean were tested for its growth, yield, quality.

Growth observations were recorded in respect of vine length (cm), primary branches per vine at 30, 60, 90, 120 and 150 DAS. The yield and yield contributing observations in respect to days to flower initiation, flower colour, days to 50 per cent flowering, days to first pod set, days to first harvest, yield of green pod per plant (kg), yield of green pod per hector (q) were undertaken during the period of investigation. The qualitative observations like protein content (%), fiber content (%), pod colour, pod length (cm), pod width (cm), weight of 10 green pods (g), number of pods per plant, crop duration.

RESULTS AND DISCUSSION

Growth parameters

At all the growth stages, AK-WAL/18-14 showed maximum plant height (385.83 cm), followed by AK-WAL/18-20 (381.60 cm). The minimum plant height was recorded in genotype AK-WAL/18-26 (185.70cm). It might be due to genetic characters as well as it might depends on environmental factors, which ultimately responsible for increasing the photosynthetic activities, rate of chlorophyll formation, nitrogen metabolism and auxin contents in such plants of dolichos bean, which ultimately improved the plant height. Similar results were obtained by Bairagi (2016) in dolichos bean.

Yield contributing characters

There was significantly difference between the minimum (44.3) days to first flowering in dolichos bean were recorded in genotype AK-WAL/18-21, followed by AK-WAL/18-15, AK-WAL/18-16 and check variety Dasara. While, the maximum (137.7) days to first flowering was noticed in genotype AK-WAL/18-22. The possible reason of early flowering in certain genotypes indicated adaptability of these genotypes in a particular environment, better and efficient utilization of nutrients in a relatively hostile environment, which might have resulted in early termination of vegetative phase and initiation of reproductive stage as compared to those genotypes, which took longer time to flowering. The results are in conformity with the findings of Pandey. (2012) in pea.

Significantly the minimum (101.33) days to first harvest of pods were required in genotype AK-WAL/18-21 was positively involved in earliness of pod harvesting for the vegetable purpose. The genotypes AK-WAL/18-23, AK-WAL/18-19 and AK-WAL/18-15, were found statistically at par with each other. While, maximum (185.46) days to first harvest were observed in genotype AK-WAL/18-22. Genetically early cultivars/genotypes in bean expresses poor yielding ability of green/immature pods. It is also reported to be little bit concern to the available favourable climatic conditions of the region. These results are in line with the finding of Samadia (2008) in Indian bean and Singh (2014) in french bean.

As far as the yield of green pod of dolichos bean per hector is concern, it was found, significantly the maximum (201.67 q/ha) in genotype AK-WAL/18-07. The genotypes AK-WAL/18-16 and AK-WAL/18-15 were found statistically at par with each other. However, the minimum (17.00 q) pod yield per hector was produced by the genotype AK-WAL/18-26. Genetic makeup of single genotypes is the support of favourable climatic conditions as well as agronomical practices might provide appropriate conditions for more vegetative and reproductive growth i.e. vigour of crop like dolichos bean. Similar trend and pattern were reported by Bairagi (2016) in dolichos bean.

Quality parameters

The pod length of dolichos bean exhibited significantly the maximum (17.23 cm) in check variety Dipali. And it was followed by genotype AK-WAL/18-21, AK-WAL/18-25 and AK-WAL/18-06. While, the minimum (5.13 cm) pod length was found in the genotype AK-WAL/18-10. It might be due to the fact that, genetic nature, environmental factor as well as it would depends on growth, reproductive phases and protein synthesis in the climber crop like dolichos bean and thus enhancing pod length. These results are in line with the findings of Mohan *et al*. (2009), Patel (2014) and Bairagi (2016) in dolichos bean.

As far as the pod width of dolichos bean is concern, it was noticed significantly the maximum (3.72 cm) in genotype AK-WAL/18-24 followed by check variety

Table 1. Effects of different genotypes on growth, yield and quality in dolichos bean.

S.N.	Genotypes.	Plant height (cm)	Days to flower initiation	Days to irst harvest fof pods	Yield of green pod hector^{-1} (q)	Podlength (cm)	Pod Width (cm)	Protein content (%)	Fibre content (%)
1	AK-WAL/18-01	257.05	98.7	132.67	139.33	9.57	1.41	11.1 (3.33)	1.43 (1.20)
2	AK-WAL/18-02	338.11	97.3	138.67	69.33	7.34	2.11	13.0 (3.61)	5.78 (2.40)
3	AK-WAL/18-03	355.5	133.7	179.00	37.00	9.33	1.18	12.6 (3.55)	2.93 (1.71)
4	AK-WAL/18-04	349.57	132.7	174.33	59.00	8.16	1.4	15.6 (3.95)	2.80 ()1.67
5	AK-WAL/18-05	359.38	121.3	179.00	53.33	7.47	1.44	15.5 (3.94)	2.17 (1.47)
6	AK-WAL/18-06	368.44	129.7	175.67	92.00	13.03	1.28	12.4 (3.52)	3.10 (1.76)
7	AK-WAL/18-07	315.58	124.0	176.67	201.67	10.87	1.12	17.0 (4.12)	2.13 (1.46)
8	AK-WAL/18-08	275.98	133.7	175.33	50.00	5.50	2.09	19.0 (4.36)	1.85 (1.36)
9	AK-WAL/18-09	270.29	132.7	176.67	57.00	5.29	2.07	19.0 (4.36)	1.77 (1.33)
10	AK-WAL/18-10	258.09	131.0	177.00	56.00	5.13	2.1	19.2 (4.38)	1.67 (1.29)
11	AK-WAL/18-11	326.68	101.7	128.67	33.00	6.43	2.19	13.8 (3.71)	2.32 (1.52)
12	AK-WAL/18-12	355.81	124.3	165.00	42.33	7.60	1.41	12.3 (3.51)	2.41 (1.55)
13	AK-WAL/18-13	346.53	132.0	180.67	37.00	8.45	1.29	21.7 (4.66)	3.90 (1.97)
14	AK-WAL/18-14	385.83	85.7	137.67	76.33	7.37	2.11	11.6 (3.41)	2.67 (1.63)
15	AK-WAL/18-15	328.67	64.3	126.33	152.00	11.30	0.94	16.0 (4.00)	1.11 (1.05)
16+	AK-WAL/18-16	292.74	72.0	127.33	160.33	12.80	1.46	13.3 (3.65)	3.47 (1.86)
17	AK-WAL/18-17	339.01	83.3	135.00	121.33	9.93	1.35	16.4 (4.05)	6.36 (2.52)
18	AK-WAL/18-18	339.69	86.0	150.00	73.00	12.58	0.9	16.9 (4.11)	4.64 (2.15)
19	AK-WAL/18-19	194.87	82.3	125.00	47.33	10.77	2.2	17.6 (4.20)	2.60 (1.61)
20	AK-WAL/18-20	381.60	124.3	181.00	77.00	10.87	2.2	15.6 (3.95)	2.50 (2.5)
21	AK-WAL/18-21	208.80	44.30	101.33	46.33	13.61	2.2	12.6 (3.55)	3.20 (1.79)
22	AK-WAL/18-22	360.12	137.7	185.46	53.67	9.72	0.87	12.7 (3.56)	3.60 (1.90)
23	AK-WAL/18-23	202.13	92.7	124.00	31.67	5.45	1.52	11.7 (3.42)	2.70 (1.64)
24	AK-WAL/18-24	285.80	91.7	136.67	102.67	9.87	3.72	12.9 (3.59)	2.66 (1.63)
25	AK-WAL/18-25	297.34	105.3	143.00	124.00	13.53	1.45	15.1 (3.89)	1.95 (1.40)
26	AK-WAL/18-26	185.70	105.0	145.67	17.00	7.66	0.85	11.5 (3.39)	1.50 (1.22)
27	Dasara	346.67	76.3	130.33	106.67	10.33	2.38	15.5 (3.94)	3.20 (1.79)
28	Dipali	362.47	95.3	134.00	121.33	17.23	2.77	18.5 (4.30)	3.40 (1.84)
	S.E. m.±	3.57	1.39	3.02	4.78	0.66	1.94	1.28	0.73
	CD at 5 %	10.11	3.95	8.57	13.54	1.88	5.50	3.82	2.07

Fig. in parenthesis are square root transformation values

Dipali and Dasara. While, the minimum (0.85 cm) pod width was found in the AK-WAL/18-26 in the present study. It might be due to the fact that, genetic variability of different germplasms of dolichos bean and their rate of acclimatization in the given environment. It might have also due to the larger size of the ovule. These results are in conformity with the findings of Pandey (2012) in pea and Choudhary *et al*. (2016) in Indian bean.

In the present study, protein and fiber content in pod of dolichos bean is most important qualitative character, significantly the maximum (21.7 %) protein content was observed in genotype AK-WAL/18-13. The genotypes AK-WAL/18-10, AK-WAL/18-08 and AK-WAL/18-09 were found statistically at par with each other. While, the minimum (11.1 %) protein content in green pod was recorded in AK-WAL/18-01. In general, the values obtained for proximate principles for protein content in twenty- eight genotypes, in the present study were normal and comparable with the values reported by Davari *et al* (2018) and Reddy *et al.* (2018) in dolichos bean.

The fiber content in dolichos bean had been exhibited significantly the minimum (1.11 %) in genotype AK-WAL/18-15, which was statistically at par with genotypes AK-WAL/18-01, AK-WAL/18-26. Whereas, the maximum (6.36 %) fiber content was noticed in genotype AK-WAL/18-17. This might be due to its genetic make-up and was similarly quoted by earlier workers like Chaitanya *et al.* (2013) and Davari *et al.* (2018) in dolichos bean.

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SHORT NOTES

Effect of Organic Fertilizers on Growth and Yield Contributing Characters of Chickpea (*Cicer arietinum* L.) Under Irrigated Condition

India is self-sufficient in respect of food grain production but still it is lags behind in production of pulses. Moreover, burgeoning population pressure and increasing protein malnutrition aggravate the problem and call for stepping up the pulses production. Pulses are major and cheaper source of protein, particularly for vegetarians and contribute about 14 per cent of Indian diet. Further 16.7 per cent of the total protein of an Indian average diet is derived from pulses. The inclusion of pulses as main, catch, cover, green manure and intercrop rotation in farming system are found all over the World. Among the several nutrients responsible for crop production, phosphorous and potassium play an important role. The current trend is to explore the possibility of supplementing phosphorous and potassium through chemical fertilizers with organic one to sustain yield and economic level. Integrated nutrient management is the maintenance or the adjustment of soil fertility and plant nutrient supply system to optimum level to sustain the desired crop productivity. The management of organic fertilizers might have significant effect on growth and yield of chickpea. Balanced NPK fertilization is always necessary to maintain good residual soil fertility status. Besides inorganic fertilizers the use of organic sources of nutrients to chickpea enhances productivity and fertility. Nutrient availability from organic fertilizers has been a renewed interest in the use of organic fertilizers. This interest is attributed to concerns for maintaining sustainable agricultural production while preserving the environment.

The organic fertilizers composed of compost, leaf extract, rock phosphate and ash. During the process of decomposition of organic substrates leads to the production of several organic acids, such as malonic, fumaric, succinic acids. Drought damage to plants is reduced because of increased water- holding capacity of the soils. Soil tilth is improved by making the soils easier to cultivate. The added organic matter provides a food source to soil micro-organisms. Ash is a good source of potassium, phosphorous and magnesium, in addition to these micronutrients, wood ash is also a good source of many micronutrients needed in traces for adequate plant growth. Considering the above status the present investigation entitles "Effect of organic fertilizers on growth and yield contributing characters of chickpea under irrigated condition" was undertaken for study.

A field experiment was carried out during *rabi* season, 2016-17 at the research farm of All India Coordinated Research Project on Integrated Farming System, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (MS) with an object to study the effect of organic fertilizers on yield and economics of chickpea. The field selected for the experimentation was fairly uniform and leveled. Soil of experimental plot was inceptisol and clayey (58.3%). It was low in available nitrogen (208.32 kg ha^{-1}) and phosphorous (17.65 kg ha^{-1}), moderate in organic carbon (0.58%), rich in available potassium (351.70 kg ha^{-1}) and slightly alkaline (7.7) in reaction. Rain receives mostly from south-west monsoon during June to October. The total rainfall recorded from October, 2016 to February, 2017 during crop growing season was 91.0 mm received in 5 rainy days as against normal rainfall of 102.6 mm and total rainy days of 7.2. Bright sunshine hours temperature, wind speed were lower than normal that helped the crop to utilize available soil moisture for longer period and kept the evaporation losses less which favored the crop growth. The experiment was laid out in randomized block design with eight treatments and three replications. The crop variety was JAKI-9218 drilled at the row spacing of 30 cm distance on dated 24.10.2016 under irrigated condition. The treatment details are as under, T_1- 100 per cent NPK (RDF) through chemical fertilizers, T_2-100 per cent N + 50 per cent P & K (RDF) + 50 per cent P & K (through organic fertilizers), T_3-100 per cent N (RDF) + 100 per cent P & K(through organic fertilizers), T_4- 100 per cent N (RDF) + 150 per cent P & K(through organic fertilizers), T_5- 100 per cent N (RDF) + 200 per cent P & K (through organic fertilizers), T_6- 100 per cent N & P (RDF) + 100 per cent K (through organic fertilizers), T_7- 100 per cent N & P

(RDF) + 150 per cent K (through organic fertilizers) and T_8- 100 per cent N & K (RDF) + 100 per cent P (through organic fertilizers). The recommended dose of fertilizers for chickpea is 25 + 50 + 30 NPK kg ha^{-1}. The organic fertilizers used for the experiment, by keeping the constant recommended dose of nitrogen for all the treatments and applied through chemical fertilizer only. Similarly, as per treatments, calculated recommended doses of phosphorous and potassium applied through organic fertilizers. The organic phosphatic fertilizer (pre- mixture) contains rock phosphate, compost, leaf extract of banyan, bermuda, kokum &tulsi. The pre-mixture contents 10.42 per cent phosphate, 0.43 per cent nitrogen, 7.87 per cent organic carbon, having 18.30 C: N ratio and 25 per cent moisture by weight. While, potassic fertilizer (pre- mixture) contains ash, compost & leaf extract of banyan, bermuda, kokum &tulsi. The pre-mixture contents 10 per cent potash, 15 per cent potassium humate & 7.48 per cent organic carbon. All the fertilizers and time to time field operations were carried out in the experiment as per the treatments and University recommended package of practice.

Growth contributing characters of chickpea

Data on mean of various aspects of growth viz., plant height (56.87 cm), number of branches $plant^{-1}$ (21.51), number of leaves $plant^{-1}$ (298.22), leaf area $plant^{-1}$ (12.96 dm^2) and dry matter accumulation $plant^{-1}$ (22.64g) were recorded and presented in table1.

The mean plant height was increased and marked average improvement at harvest with advancement of crop age. The higher dose of phosphorous and potassium up to 150 per cent significantly increased the plant height. The plant height was recorded significantly more (63.31cm) in treatment100 per cent N (RDF) + 150 per cent

Table 1: Growth contributing characters of chickpea at harvest as Influencedby different organic treatments

Symbol	Treatment	Growth contributing characters of chickpea				
		Plant height (cm) at harvest	Number of branches $plant^{-1}$ at harvest	Number of leaves plant @90 DAS	Leaf area $plant^{-1}$ (dm^2) @90DAS	Dry matter accumulation $plant^{-1}$ (g) at harvest
T_1	100% NPK (RDF) through chemical fertilizers	54.28	19.33	264.37	11.84	19.97
T_2	100% N + 50% P & K (RDF) + 50% P & K (through organic fertilizers)	54.62	19.58	289.05	12.94	20.73
T_3	100% N (RDF) + 100% P & K (through organic fertilizers)	59.37	20.75	298.50	12.61	22.71
T_4	100% N (RDF) + 150% P & K (through organic fertilizers)	63.31	22.63	324.99	14.63	24.54
T_5	100% N (RDF) + 200% P & K (through organic fertilizers)	60.14	24.73	336.73	15.52	26.37
T_6	100% N & P (RDF) + 100% K (through organic fertilizers)	54.15	20.13	285.52	13.29	21.53
T_7	100% N & P (RDF) + 150% K (through organic fertilizers)	55.07	23.93	308.65	14.16	24.17
T_8	100% N & K (RDF) + 100% P (through organic fertilizers)	54.04	21.00	277.93	8.73	20.89
	SE (m) ±	1.95	1.01	6.32	0.50	1.19
	CD @5%	5.93	3.06	19.16	1.52	3.62
	GM	**56.87**	**21.51**	**298.22**	**12.96**	**22.64**

P&K (through organic fertilizers) which was found at par with treatments 100 per cent N (RDF) + 200 per cent P & K (through organic fertilizers) and 100 per cent N (RDF) + 100 per cent P & K (through organic fertilizers) and superior over rest of the treatments. However, treatment T_7, T_2, T_1 and T_6 were comparable with each other. Among the various treatments, the lowest plant height was noticed in treatment T_8.The increase in plant height might be due to the application of phosphorous and potassium through organic fertilizers that may be attributed to strong exchange mechanism in soil, efficient nodulation, greater cell division and cell elongation and high root- shoot ratio is associated with potassium uptake. Similar results were also obtained by Prajapati et al. (2017).

The maximum (24.73) number of branches plant^{-1} were recorded in treatment 100 per cent N (RDF) + 200 per cent P&K (through organic fertilizers) which was at par with 100 per cent N &P (RDF) + 150 per cent K (through organic fertilizers) and 100 per cent N (RDF) + 150 per cent P&K (through organic fertilizers) respectively and significant over other treatments. However,remaining treatmentT_8, T_3, T_6, T_2 and T_1were statistically at par with each other. The lowest value for number of branches/plant was noticed in treatment T_1. Increase in number of branches might be due to application of phosphorous and potassium which increase the availability of nitrogen and other nutrients that stimulated meristematic activity of plant as a result of which cell division, cell elongation process are stimulatedthus increased number of branches plant^{-1}. Similar results were also reported by Gulpadiya *et al.* (2014).

The higher dose of phosphorous and potassium up to 200 per cent through organic fertilizers significantly increased the number of leaves plant^{-1} at 90 DAS (336.73). The number of leaves plant^{-1} was observed significantly higher in treatment 100 per cent N(RDF) + 200 per cent P&K (through organic fertilizers) which was observed at par with 100 per cent N (RDF) + 150 per cent P&K (through organic fertilizers) and superior over rests. The treatments T_7, T_3 and T_8 were observed at par with one another but significant over the rests. Whereas, treatments T_2 and T_1 were on par to each other and recorded lowest number of leaves plant^{-1}. The increase in number of leaves plant^{-1} with application of phosphorous and potassium might be due to more uptake of nutrients in plant, which enhanced crop growth by cell division in meristematic region and by activity of growing tip of the crop, which increase the plant height and ultimately increased the nodes and thus resulted in more number of leaves plant^{-1}. Results are in accordance with the findings of Prajapati *et al.* (2017).

In case of leaf area plant^{-1}, it was noticed significantly more (15.52 dm^2) in treatment 100 per cent N (RDF) + 200 per cent P&K (through organic fertilizers) which was noted at par with 100 per cent N (RDF) + 150 per cent P&K (through organic fertilizers) and 100 per cent N & P (RDF) + 150 per cent K (through organic fertilizers), respectively but superior over the rests. However, treatments T_6, T_2, T_3 and T_1 were statistically at par with each other. The lowest leaf area/ plant noted in treatment T_8. Availability of more nutrients might have helped for cell elongation and multiplication which produced more number of leaves and resulted on increasing leaf area. Such types of results were reported by Sohu*et al.*, (2015).

The weight of dry matter accumulation plant^{-1} was observed to be significantly maximum (26.37g) in treatment 100 per cent N (RDF) + 200 per cent P&K (through organic fertilizers) which was observed at par with 100 per cent N (RDF) + 150 per cent P&K (through organic fertilizers) and 100 per cent N & P (RDF) + 150 per cent K (through organic fertilizers). Whereas, remaining treatment were on par with each other. The lowest dry matter accumulation plant^{-1} were recorded in treatment T1. The reduction in dry matter accumulation plant^{-1} at harvest might be due to senescence of leaves. The increased dry matter attributed through increase in the rate of photosynthesis, leaf area and decrease in rate of respiration under the influence of P&K may be the reasons of increase in dry matter weight of different plant parts. These results corroborate the findings of Verma*et al.* (2017).

Yield contributing characters of chickpea

Data in respect of number of pods plant^{-1}, weight of podsplant^{-1}, weight of seedplant^{-1} and 100 seed weight affected by various treatments are presented in table 2. The average values for these attributes were observed to be (68.44, 20.30g, 16.71 g & 24.75g), respectively.

Table 2: Yield contributing characters of chickpea at harvest as influenced by different organic treatments

Symbol	Treatment	Yield contributing characters of chickpea at harvest					
		Number of pods plant^{-1}	Pod weight plant^{-1} (g)	Seed weight plant^{-1} (g)	100 seed weight (g)	Seed yield (kg/ha)	Straw weight (kg/ha)
T_1	100% NPK (RDF) through chemical fertilizers	61.54	18.12	14.19	22.89	1126	3074
T_2	100% N + 50% P & K (RDF) + 50% P & K (through organic fertilizers)	63.25	18.84	15.35	23.13	1188	2880
T_3	100% N (RDF) + 100% P & K (through organic fertilizers)	68.29	20.17	16.87	24.81	1796	3063
T_4	100% N (RDF) + 150% P & K (through organic fertilizers)	73.45	22.01	18.13	26.61	1942	3748
T_5	100% N (RDF) + 200% P & K (through organic fertilizers)	76.59	23.22	19.20	27.34	1972	3966
T_6	100% N & P (RDF) + 100% K (through organic fertilizers)	64.28	19.71	15.80	23.62	1682	3240
T_7	100% N & P (RDF) + 150% K (through organic fertilizers)	72.85	20.48	17.93	25.48	1849	3344
T_8	100% N & K (RDF) + 100% P (through organic fertilizers)	67.27	19.88	16.24	24.08	1271	2864
	SE (m) ±	2.36	0.93	0.72	0.72	32.69	145.21
	CD @5%	7.17	2.81	2.19	2.19	99.16	440.50
	GM	68.44	20.30	16.71	24.75	1603	3285

Effect of application of phosphorous and potassium through organic fertilizers were significantly influenced the number of pods plant^{-1}. Treatment 100 per cent N (RDF) + 200 per cent P&K (through organic fertilizers) had recorded significantly highest number of pods plant^{-1} (76.59), pod weight plant^{-1} (23.22g), seed weight plant^{-1} (19.20g) and 100 seed weight (27.34g) which were found at par with 100 per cent N (RDF) + 150 per cent P&K (through organic fertilizers) and 100 per cent N&P (RDF) + 150 per cent K (through organic fertilizers) respectively. The remaining treatments were observed to be on par amongst one another.The lower number of pods plant^{-1} was observed in treatment 100 per cent NPK (RDF) applied through chemical fertilizers. The higher photosynthetic surface for longer duration of crops and receiving higher P&K (through organic fertilizers) might have resulted in enhancing photosynthetic activity, translocation of photosynthates and protein synthesis from source to sink and thus more metabolites are directed towards the development of more pods/ plant. The present results are in accordance with the findings of Prajapati *etal.*(2017).Increase in pod weight plant^{-1} might be due to role of potassium translocation of photosynthesis and its ability to develop seeds. These findings were also collaborated with Sohu *et al.* (2015).As phosphorous helps in seed formation, the increased phosphorous levels might have increased seed weight plant^{-1}. Phosphorus also helps in early plant establishment so more photosynthates production and better source – sink relationship resulted in higher seed weight. The results are in line with the findings of Jadeja *et al.* (2016). Increase in 100 seed weight might be due to phosphorus helps in early plant establishment so more photosynthates and potassium helps in translocation of photosynthesis and its ability to develop seeds, these results are in conformity of Goud *et al.* (2012).

Yield studies

Seed yield and straw yield of chickpea were influenced significantly by different treatments (Table 2). Theaverage seed yield (1603 kg ha^{-1}) and straw yield (3285 kg ha^{-1}) were recorded.

The results revealed that the highest seed yield (1972 kg ha^{-1}) was observed in 100 per cent N (RDF) + 200 per cent P&K (through organic fertilizers) which was found at par with 100 per cent N (RDF) + 150 per cent P&K (through organic fertilizers) and showed superiority over other treatments. Treatment T_7 and T_3 were comparable to each other and recorded significantly more yield over rest of the treatments. The treatment T_6 alone observed to be significant over treatments T_8, T_2 and T_1. Whereas, lowest seed yield (1126 kg ha^{-1}) was recorded in treatment 100% NPK (RDF) applied through chemical fertilizers. The increase in seed yield is in accordance with fulfillment of essential requirement of P & K in plant biochemistry and physiology, also increased number of leaves and leaf area/ plant helped in more production of photosynthates and its translocation towards seed production. These results are in conformity with the findings of Jadeja*et al.* (2016).

Similarly, the highest straw yield (3966 kg/ha) was observed in treatment 100% N (RDF) + 200% P&K (through organic fertilizers) which was found at par with 100% N (RDF) + 150% P&K (through organic fertilizers) and showed superiority over other treatments. The treatments T_7, T_6, T_1 and T_3were comparable to one another and significant over treatments of T_2 and T_8. The lowest straw yield was observed in treatment T_8. This increase in straw yield might have attributed to the higher photosynthetic activity in chickpea plant leading to better supply of carbohydrates resulted in more number of branches and dry matter. Similar results were also reported by Patil*et al.*, (2011).

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Productivityof High Density Planting of Non Bt and Bt Cotton and Monetary Returns As Influenced By Intercropping (2: 1) System Sown on Broad Bed Furrow System Under Rainfed Condition

Cotton (*Gossypium hirsutum* L.) is a very important commercial fibre and cash crop of India; it sustains the cotton textile industry which is perhaps the largest segment of organized industries in the country. The economy of agricultural community in Vidarbha region of Maharashtra is mostly dependent on the cotton. As per CAB estimate, cotton production in India during 2017-18 is 377 lakh bales of 170 kg from 122 lakh hectares with a productivity of 524 kg lint/ha.The adoption of High density planting (Accomodation of more plants per unit area) along with better genotype with good fertilizer management and boll worm management is one of the option under rainfed to break the current trend of stagnating yield of Bt cotton and related problems under rainfed ecosystem of Vidarbha region of Maharashtra. Different cropping system not only provides organic matter to the soil but also proved to be profitable cropping system. The current concept of intercropping is to maintain optimum plant population of both the component crops by adjusting crop geometry or spatial arrangement. Paired row planting has gained prominence in recent years. Paired row planting is one way of accommodating the full population of the base crop and creating inter-space wide enough to accommodate one or two rows of the intercrop. In this technique two adjacent rows of the base crop are paired reducing inter-row space in the pair enough to minimise undue competition among plants of the base crop. The practice of growing cotton under paired row system offers greater scope in intercropping. Since the inter space available in the paired row of cotton is more it is quite possible to accommo date more rows of intercrops. It is likely that by increasing the number of rows of intercrops, the yield of intercrops could also be increased, besides normal yield of cotton. Paired row planting of cotton has been tried in large number of experiments and this has led to better or at least comparable yield of cotton (as that of sole crop) as well as extra yield of intercrop (Giri and Upadhyay, 1979; Nankar, 1981). To conserve and optimum the use of natural resources with profitability as guiding factors of sustainability farming practices have to be re designed. Hence investigated high density planting of Non Bt and Bt cotton with different intercropping system to overcome in changing climate and to improve soil health.

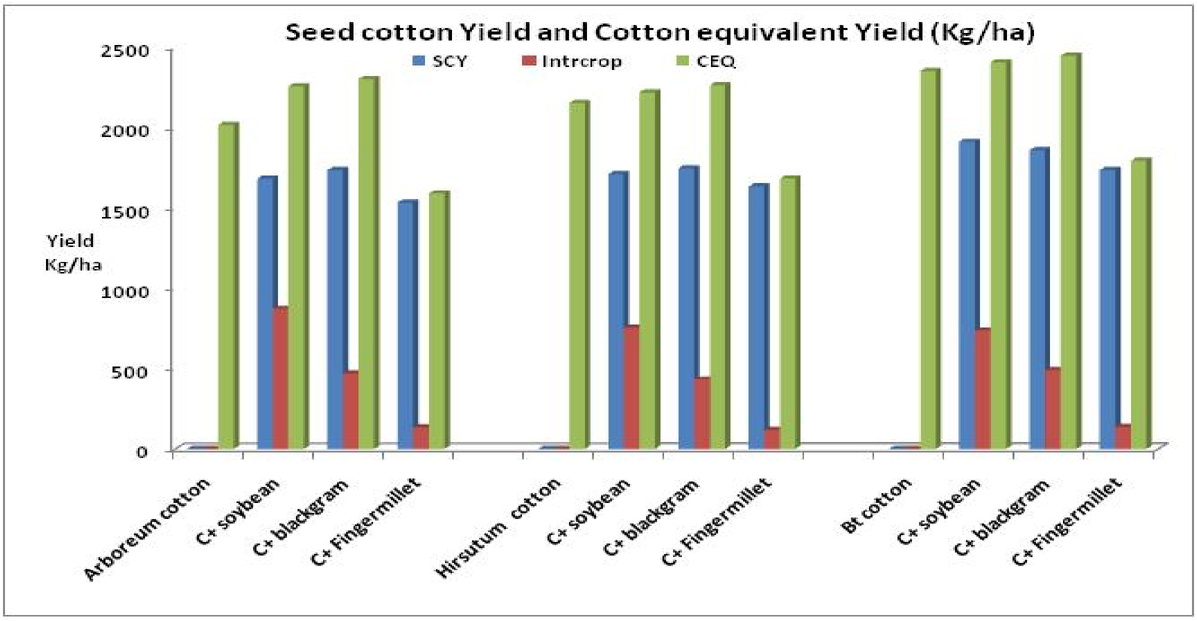
The field investigation was conducted at Cotton Research Unit, Dr.Panjabrao Deshmukh Krishi Vidyapeeth, Akola during the *Kharif* season of 2016-2017. The experiment was laid out in RBD with twelve treatments and three replications in order to study the effect of different intercrops with Arboreum,Hirsutum and Bt cotton sown on BBF under rainfed condition. Total twelve treatments in RBD withthree replication. The treatments constitute of Sole cotton, intercropping of cotton soybean, blackgram and finger millet in 2: 1 row ratio. Aroboreum (AKA 7),Hirsutum (AKH 081) and Bt cotton (PDKV JK 116) were tested with Soybean (JS 93 - 05), Blackgram (PKV Black gold) and Finger millet (CO-1) were used as intercrops in cotton. The plot size was 7.2 m x 6.0 m. The soil was clayey, medium depth and having organic carbon 4.6 g kg^{-1}, pH 8.9, EC 0.30 dSm^{-1}, available N, P and K 225, 14.4 and 342 kg ha^{-1}, respectively.

Intercropping of *Arboreum* and *Hirsutum* varietyand Bt Hybrid were grown with two rows grown on 60 cm x10 cm maintained the population of 1.1 lakh in cotton in intercrop and one row of intercrops 60 x7.5 cm. Similarly two rows of Bt cotton maintained population of 36.6 thous and (60 x 30 cm) with intercrop and one row of intercrops 60 x 7.5cm under rainfed during 2016-17. Where as in sole cotton population of 1.66 lakh (60 x 10cm)with variety and 55 thousand with Bt hybrid (60 x 30 cm) under rainfed. Bio-fertilizers were applied to cotton and intercrops. Fertilizer dose of 60:30:30 NPK kg ha^{-1} for varieties and 75: 45:45NPK kg ha^{-1} for Bt cotton and no extra fertilizer applied for intercrops.All Recommended package of practices were followed. Rainfall of the season was 826 mm in 42 rainy days. Seed cotton equivalent and economics were worked out. Oil content and protein content was analysed.

The highest SCY was recorded with Bt hybrid

Table 1: Seed cotton yield and intercrop yield and Seed cotton equivalent yield and their economics ,Oil in cotton and Protein content in intercrops.

Cotton	Intercrops	Row Ratio	SCY (Kg ha^{-1})	Intercrops yield (Kg ha^{-1})	Seed Cotton Equivalent Yield(Kg ha^{-1}	Gross Returns)(Rs ha^{-1})	Net returns (Rs ha^{-1})	B:C	Oil Content in cotton(%)	Organic carbon (g Kg^{-1})	Protein content in Intercrops (%)
***Arboreum* cotton**											
AKA7	Sole	-	2015	-	2015	83622	40172	1.92	19.5	4.5	-
AKA7	Soybean	2:1	1676	870	2258	93697	49347	2.11	19.4	4.7	41.3
AKA7	Blackgram	2:1	1735	470	2301	95503	51153	2.15	19.3	4.8	21.4
AKA7	Fingermillet	2:1	1530	132	1586	65838	23338	1.54	19.4	4.7	5.2
***Hirsutum* cotton**											
AKH081	Sole	-	2150	-	2150	89225	47105	2.11	21.8	4.6	
AKH081	Soybean	2:1	1710	755	2215	91916	48666	2.12	21.5	4.7	41.1
AKH081	Blackgram	2:1	1745	430	2263	93918	50573	2.16	21.7	4.8	21.2
AKH081	Fingermillet	2:1	1630	116	1678	69646	27296	1.64	21.5	4.6	5.3
***Bt* cotton**											
PDKV JK 116	Sole	-	2350	-	2350	97525	43675	1.81	19.1	4.5	-
PDKV JK 116	Soybean	2:1	1910	735	2401	99661	45301	1.83	18.9	4.7	41.3
PDKV JK 116	Blackgram	2:1	1855	490	2445	101483	47383	1.87	18.7	4.8	21.1
PDKV JK 116	Fingermillet	2:1	1735	135	1791	74331	20871	1.39	18.8	4.6	5.1
SE m ±					101						
CD at 5%					303						



PDKV JK 116 in sole cotton (2350 Kg ha^{-1}) followed by *Hirsutum* variety AKH 081 (2150 kg ha^{-1}) and *Arboreum* cotton AKA 7 (2015 kg ha^{-1}). The SCY might be improved due to sowing on BBF ,which improve the moisture status under dry and drain out excess water during wet period .. Similar results wer reported byPaslawar *et.al.* (2015) , Venugopalan *et. al.*(2013) and and Mohapatra S.C. and S.S. Nanda (2011).Among the intercrops short duration soybean yielded maximum followed blackgram and yield of finger millet was low. The Seed cotton equivalent yield was highest, different species of cotton intercropped with blackgram. Theseed cotton equivalent yield was maximum with Bt hybrid+ blackgram (2445 kg ha^{-1}) followed by Arboreum cotton + blackgram (2301 Kg ha^{-1}) ,whereas Finger millet suppressed the growth of cotton resulted into low yield of cotton species. The maximum gross returns were obtained from intercropping of Bt cotton +blackgram (Rs 101483 ha^{-1}) followed by *Arboreum* cotton + Blackgram, whereas B: C ratio with *Hirsutum* and *Arboreum*cotton + Blackgram (2.16). The blackgram harvesting was done after 80 days after sowing which improved the growth of cotton. The Oil content was maximum in AKH 081 (21.8 %) and lowest in PDKV JK 119 (18.7%). The organic carbon status improved in intercropping of cotton + Blackgram. Average Protein content of Soybean, Blackgram and Finger millet was (41.2,21.2 and 5.2%.)

There is great potential to improvethe productivity of SCY, monetary returns and nutritional security by adopting the high density planting of Non Bt cotton with inter-cropping of short duration pulses (2:1) on BBF under changing climate in cotton tract of Vidarbharegion. High staple length of *Arboreum* and *Hirsutum*varieties > 30 mm SL and surgical cotton < 20 mm SL varieties have a great scope in organic farming .

CONCLUSION

The high density planting of Non Bt cotton with inter-cropping of blackgram (2:1) on BBF could be condition of cotton tract of Vidarbha region of Maharashtra.

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Detection of Mycoflora from Soybean Seed

Soybean (*Glycine max L.* Merille) is one of the most important leguminous crops for seed protein and oil content. In India soybean is mostly grown in *Kharif* and the major growth period passes through rainy days. The crop can easily succumb to various diseases (Agrawal and Joshi, 1971). There are several factors responsible for the low yield of soybean. Among these the seed borne diseases are one of the most important factors. Seed-borne diseases causes losses in terms of seed quality and quantity in soybean. Agrawal *et al.* (1972) reported that the mycroflora reduces the germination percentage and seedling vigor index. It is responsible for seed rot, seedling blight, bacterial pustules, root/stem rot, foliar infection as well as pod blight diseases. Since seed is a carrier of many diseases, it can transmit diseases to other fields resulting in loss in production. The plants resulting from infected seeds will not only be diseased but may also serve as an infection foci for secondary infection of the disease. Belkar and Gade (2016), observed that *Rhizoctonia bataticola* infected plants causes the seed-borne nature in soybean.

The seed of soybean cv. JS-335 was collected from various locations of Yavatmal district of Vidarbha during Kharif. Pretreatment of seed is usually made to eliminate the saprophytic or pathogenic fungi. Seed treatment, a simple and cheaper method for control of seed borne fungi and improving germination was tried.

Six seed samples of soybean cv. JS-335 of *Kharif* grown at 6 locations / tahsils of Yavatmal district were collected. The samples were preserved in cloth bag at room temp until use for various studies. Blotter method (ISTA, 1985) was employed for detection of seed-borne fungi. Identification of fungi based on morphological characters and microscopic observation was used to confirm the identification. Each sample of 400 seeds were tested for fungi.

Hundred seeds of each sample were pretreated with 0.1 percent mercuric chloride solution for 2 min and washed with 3changes of sterilized distilled water. Hundred pretreated seeds of each sample were then tested by agar plate method. The fungi were detected 7days after incubation.

Seed dressing fungicides were assayed for studing the efficacy of various fungicides against seed borne fungi, *viz*., carbendazim (2 g kg^{-1} seed),dithane M-45 (3g kg^{-1}), thiram (3 g kg^{-1}), thiram + carbendazim (3g+1g kg^{-1}) were treated separately to seed sample of soybean cv. JS-335. Seeds with calculated amount of fungicides were shaken in conical flask for 15 minutes to achieve uniform coating of fungicides on seed. Two hundred treated and 200 untreated seeds of each sample were tested for fungi by blotter method and for germination by rolled paper towel method (ISTA, 1985).

Six seed samples of soybean cv JS-335 collected from Arni, Darvha, Digras, Ner, Pusad and Yavatmal tahsil of dist. Yavatmal. Blotter method was employed for the October harvested crop seeds of cv JS 335. Samples were collected during May. Such seeds showed association of three pathogenic /disease causing fungi *viz., Cercospora kikuchi, Phoma* sp. and *Rhizoctonia bataticola,* weak pathogenic/saprophytic fungi *ie*., *Alternaria alternate*, *Aspergillus* spp., *Cladosprium oxysporium*, *Curvularia lunata* and *Fusarium monoliformae*. The data (Table1) indicated that seed-borne fungi varied from location to location. Infection of *Cercospora Kikuchi* (Fig.1) was carried by seed produced at Digras (3.25%),Arni (2.75%) and Yavatmal (3.25 %) whereas *Cercospora* infected seed was not observed in the sample collected from Darvha, Ner and Pusad tahsils. Seeds infected with *R. bataticola* was observed in each seed lot collected from all six locations and infection level ranged between 5.25 - 11.75%.Maximum infected seed (11.75 %) was recorded in seed sample collected from Ner tahsil. Association of *Phoma* sp. was observed in seed samples collected from Pusad (2.50 %), Digras (1.50 %) and Yavatmal (1.25 %). Weak pathogens like *Alternaria alternata ,Curvularia lunata* and *Fusarium monoliformae* were predominant on seeds grown at all locations. Saprophytic fungi *viz.*, *Aspergillus* spp. was observed on seeds grown at 6 locations whereas *Cladosporium oxyspoum* was noted on seed samples collected from Arni (4.25 %),Yavatmal (3.25 %),Darvha (2.25 %) and Pusad (1.50 %) tahsils.

Table 1. Percent seed mycoflora associated, with Soybean cv JS-335 grown at 6 location.

S. N.	Fungi	Untreated (Based on 400 seed)						Pretreated (Based on 100 seed)					
		Arni	**Darvha**	**Digras**	**Ner**	**Pusad**	**Yavatmal**	**Arni**	**Darvha**	**Digras**	**Ner**	**Pusad**	**Yavatmal**
1	*Alternaria alternata*	13.25	5.00	9.25	7.75	15.75	4.75	-	-	7.00	5.00	3.00	2.00
2	*Cercospora kikuchi*	2.75	-	3.25	-	-	2.25	4.00	-	3.00	-	-	2.00
3	*Curvularia lunata*	2.75	1.50	2.25	9.25	3.50	7.75	-	-	2.00	2.00	-	-
4	*Fusarium moniliformae*	7.75	3.25	5.00	7.00	8.25	5.25	2.00	-	4.00	3.00	3.00	4.00
5	*Rhizoctonia bataticola*	11.75	5.25	5.75	10.00	6.50	8.00	4.00	2.00	3.00	7.00	1.00	9.00
6	*Phoma* sp	-	-	1.50	-	2.50	1.25	-	-	-	-	-	-
7	*Aspergillus* spp	18.25	7.75	12.00	12.25	10.75	4.25	-	-	-	-	-	-
8	*Cladosporium oxysporum*	4.25	2.25	-	-	1.50	3.25	-	-	-	-	-	-

Associations of seed-borne fungi have been reported by various workers (Vishwadhar and Sarbhoy,1987; and Sonavane *et al.*,2011 recorded higher percent of seed mycroflora on blotter paper as compaired to agar plate.

Pretreatment of seed was made to avoid the superficially growing saprophytic fungi and allow the internally seed-borne fungi to express themselves on incubated seeds. In present study, pretreatment of seed with 0.1 per cent mercuric chloride solution reduced counts of all the seed-borne fungi except *Cercospora kikuchi* (Tab.1).Pretreatment slightly increased the counts of *C. kikuchi*. This indicated that *C. kikuchi* infection, which otherwise is over grown by seed coat contaminating fast growing fungi, can become more evident after pretreatment.

Purple Stained seed of Soybean infected by *Cercospora kikuchi* (A) and Healthy seed

Tab. 2: Percentage of seed of soybean cv JS-335 showing association of fungi in blotter test and germination in paper towel method after seed treatment with fungicides.

(Observation based on 200 seed)

Fungi	**Control**	**Carbendazim (2 g kg^{-1} seed)**	**Dithane M-45 (3 g kg^{-1} seed)**	**Thiram (3 g kg^{-1} seed)**	**Thiram+ Carbendazim (3 g+1 g kg^{-1} seed)**
Alternaria alternata	19.0	3.0	5.5	2.0	0.5
Aspergillus spp	28.5	2.0	4.5	1.0	-
Cladosporium oxysporum	11.5	1.0	-	-	-
Curvularia lunata	8.5	-	1.0	0.5	1.5
Fusarium moniliformae	14.5	3.5	4.5	1.0	-
Fusarium semitectum	-	-	1.0	-	-
Phoma sp	4.5	0.5	-	-	-
Rhizoctonia bataticola	15.5	2.0	5.0	3.0	1.5
Gemination %					
Nornal	71.5	75.0	73.0	76.5	79.5
Abnormal	18.5	16.5	16.0	14.0	8.0
Hard/Dead seed	10.0	13.5	11.0	9.5	12.5

Pretreatment not only eliminated saprophytic fungi but also affected disease causing fungi like *Rhizoctonia bataticola*, *Phoma* sp. and weak pathogenic fungi *i.e. A. alternata*, *Curvularia lunata* and *F. moniliformae* to a greater extent. Similar observations are reported by Poharkar and Raut,1997; Uma Singh and Thapliyal,1999 and Mane *et al*., 2016.

In blotter method, efficacy of carbendazim, dithane M-45, thiram, thiram+carbendazim was tested against seed borne fungi and germination was taken in paper towel method. All the fungicides proved effective against seed borne fungi and in improving seed germination over untreated control (Tab.-2).

Among the fungicides, thiram+carbendazim @ (3+1 g/kg seed) was found most effective and eliminated disease causing and saprophytic fungi of 90.32 % seeds and improved the germination by 11.19 % over control. Percentage of abnormal seedlings was also low in these fungicides. Similarly thiram in combination with carbendazim has been observed effective by Agrawal *et al*.,1974; Poharkar, 1992.Ulemale *et al*., 2019 also detected mycoflora and reported that benomyl @ 3 g/kg as seed treatment was effective.

Thus location Darvha appeared safer place for seed production of soybean during *kharif*,the disease situation may not be necessarily same during normal or high rainfall year and hence testing of seeds of this location for few more years will be essential for conforming the association of fungi.

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