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Effect of Different Plant Densities, Nutrient Levels and Varieties on Growth, Yield and Yield Contributing Characters of Soybean (*Glycine max* (L.) Merrill)

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***ABSTRACT**: A field experiment on soybean (*Glycine max *(L.) Merrill) under varied varieties, fertilizer levels and spacings were conducted during* kharif *2013 to study the effect of growth, yield attributes and yield. The experiment was conducted in a split plot design with 3 replications. The experiment comprised of 2 varieties, 2 levels of fertilizer doses in main plot and 4 levels of spacings in sub-plot. All the fertilizer doses were applied as basal dose at the time of sowing. Among varieties, the variety MAUS-158 recorded highest grain and straw yield, in case of fertilizer level the dose of 37.5:75:37.5 NPK Kg ha^{-1} produced maximum grain and straw yield. Whereas in spacing, the 45 x 05 cm recorded the highest yield.*

***Key words :** nutrients, soybean, spacing, varieties and yield attributes.*

INTRODUCTION

Soybean (*Glycine max* (L.) Merrill) an industrially vital and economically viable oilseed crop is often referred as 'miracle crop' because it contains higher protein and oil content (Chauhan *et al.*, 1988) and it is the cheapest source of vegetable oil. The varieties show differential behavior in their per plant requirement because of their differential growth characters. Fertilizer application is very important for achieving potential yield in all the crops. In general higher yields have been obtained from high fertility soils, but on average /poor fertility soils, high yields may be obtained by applying adequate amount of fertilizer. High soybean yields demand high fertilizer dosage, applied directly to the crop or accrued through preceding crop.

Establishment of an optimum plant density per unit area is a non-monetary input factor for getting higher soybean production. There is a considerable scope of increasing soybean yield by proper adjustment of spacing (Balyan and Mehta, 1985). Plant population and yield of crop are the important factors which are interdependent to each other. The number of plants per unit area forms a base of yield triangle. More than optimum plants ha^{-1}. tends to enhance total yield, but per plant yield reduces substantially. On the contrary, fewer plants per unit area than the optimum tend to produces higher per plant yield. But number of plants being suboptimal, which reduces the yield ha^{-1}. Keeping these in view, the present investigation was undertaken to evaluate the soybean cultivars response to doses of fertilizer and different spacings.

In Maharashtra, soybean crop was grown on an area of 38.704 Lakh ha in 2013-14 with an annual production of 48.565 Lakh metric tons and productivity of 1255 kg ha^{-1} (SOPA, 2013). For the last many years a viable crop for diversification of this system and it fits well with many crops in different cropping systems. Soybean being a legume crop is capable of fixing atmospheric nitrogen through symbiosis bu the symbiotic N-fixation alone is not enough to meet high N- requirement of this crop (Ashour and Thalooth, 1983). Potassium has long been sidelined in the crop nutrition especially in the leguminous crop where biological N-fixation is shown to be improved with potassium application (Jones *et al.*, 1977).

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MATERIAL AND METHODS

The field experiment was conducted at AICRP on Integrated Farming Systems, VNMKV, Parbhani during *kharif* 2013. The soil of the experimental field was clayey in texture, medium in available N (213 kg ha^{-1}), medium in available P (15.6 kg ha^{-1}), and high in available K (574 kg ha^{-1}). The soil was slightly alkaline in reaction (pH 7.7). The experiment was laid out in a split plot design with three replications. The treatments consisted of two cultivars viz., V_1- MAUS -71, V_2- MAUS -158 with two fertilizer levels viz., F_1- 100 % RDF (30:60:30 NPK Kg ha^{-1}), F_2- 125 % RDF (37.5:75:37.5 NPK Kg ha^{-1}) in main plot and four different spacing levels viz., S_1- 60 x 05 cm, S_2- 60 x 10 cm, S_3- 30 x 30 cm and S_4- 45 x 05 cm was tested in sub plot. Sowing of soybean was done on 23rd June, 2013 by dibbling with 2 seeds/hill. The entire dose of NPK was drilled at sowing uniformly in the plots as per treatments.

RESULTS AND DISCUSSION

Effect on growth parameters

Growth characters were studied *viz.*, plant height (cm), number of functional leaves, leaf area (cm^2), number of branches and total dry matter accumulation (gm).

Data on the above parameters are presented in Table 1. Data reveal that, in general the mean plant height of all the treatments increases rapidly up to 60 DAS and thereafter the increase in plant height slowed down. The variety V_2-MAUS–158 recorded significantly the taller plant which was significantly higher over the V_1-MAUS–71. This could be attributed to genetic makeup of varieties. Similar results were quoted by Ruhul *et al.*, (2009). Similar kind of observations were at recorded in case of no. of leaves, leaf area, no. of branches and dry matter accumulation. Number of leaves per plant increased up to 60 DAS

Table 1
Mean plant height (cm), number of functional leaves plant-1,Mean leaf area (cm^2) $plant^{-1}$, Mean number of branches $plant^{-1}$ & Dry matter as influenced by different treatments during various growth stages of crop

	Plant Height (cm)		*No. of Leaves*	*Leaf area*	*No. of branches*		*Dry matter*	
Treatment	*75 DAS*	*At harvest*	*75 DAS*	*75 DAS*	*75 DAS*	*At harvest*	*75 DAS*	*At harvest*
Varieties (V)								
V_1 - MAUS-71	57.63	60.10	21.91	1373.0	3.75	4.03	28.62	30.50
V_2 - MAUS-158	65.04	66.73	25.34	1611.7	4.99	5.24	30.90	32.51
S.E. ±	1.08	1.09	0.19	24.46	0.08	0.09	0.20	0.47
C.D. at 5 %	3.76	3.76	0.68	84.52	0.28	0.31	0.72	1.63
Fertilizer levels (F)								
F_1- 100 % RDF	59.30	61.49	22.42	1428.8	4.07	4.30	29.00	30.89
F_2- 125 % RDF	63.37	65.34	24.84	1555.9	4.68	4.97	30.52	32.12
S.E.±	1.08	1.09	0.19	24.46	0.08	0.09	0.20	0.47
C.D. at 5 %	3.76	3.76	0.68	84.52	0.28	0.31	0.72	1.63
Spacings (S)								
S_1 - 60 x 05 cm	61.38	63.59	24.82	1551.3	4.68	5.10	31.41	35.33
S_2 - 60 x 10 cm	61.11	63.33	23.74	1516.8	4.41	4.65	29.86	31.84
S_3- 30 x 30 cm	57.74	58.73	23.45	1476.8	4.31	4.45	29.46	31.21
S_4- 45 x 05 cm	66.08	68.00	22.50	1424.3	4.09	4.34	28.30	30.64
S.E.±	1.38	1.35	0.43	25.47	0.11	0.09	0.42	1.06
C.D. at 5 %	4.03	3.95	1.26	74.47	0.33	0.27	1.25	3.09
Interaction (V x F)								
S.E.±	1.54	1.54	0.27	34.59	0.11	0.13	0.29	0.66
C.D. at 5 %	NS	NS	0.96	NS	NS	NS	1.01	NS
Interaction (V x S)								
S.E.±	1.96	1.92	0.61	36.03	0.16	0.13	0.60	1.50
C.D. at 5 %	NS	NS	NS	NS	NS	NS	NS	NS
Interaction (F x S)								
S.E.±	1.96	1.92	0.61	36.03	0.16	0.13	0.60	1.50
C.D. at 5 %	NS	NS	NS	NS	NS	NS	NS	NS
Interaction (V x F x S)								
S.E.±	2.77	2.71	0.87	50.95	0.23	0.19	0.85	2.12
C.D. at 5 %	NS	NS	NS	NS	NS	NS	NS	NS

of crop growth and thereafter declined up to harvest, due to senescence of old leaves at time of maturity. The results are in the line with earlier findings reported by Jadhav *et al.,* (1994). Larger leaf area resulted in more photosynthetic activities and more accumulation of carbohydrates which in turn increased dry matter accumulation. Chiezy and odunze (2005) reported parallel results in respect of total dry matter accumulation.

Table 2
Mean number of functional leaves plant^{-1} and Mean dry matter plant^{-1} (g) as influenced by (V x F) interaction at 75 DAS

	No. of leaves		*Dry matter*	
Treatment	F_1	F_2	F_1	F_2
V_1	20.37	23.46	28.25	28.98
V_2	24.46	26.23	29.75	32.06
S.E.±	0.27		0.29	
C.D. at 5 %	0.96		1.01	

Table 3
Mean number of seeds plant^{-1} as influenced by (V x F) interaction

Treatment	F_1	F_2
V_1	73.78	79.30
V_2	87.46	89.18
S.E.±	0.54	
C.D. at 5 %	1.87	

Table 4
Mean straw yield as influenced by (V x F) interaction

Treatment	F_1	F_2
V_1	1946.2	2219.7
V_2	2191.8	2482.2
S.E.±	33.49	
C.D. at 5 %	115.71	

Among the fertilizer levels application of 125% RDF (37.5:75:37.5 NPK Kg ha^{-1}) recorded significantly tallest plant over the F_1-100% RDF (30:60:30 NPK Kg ha^{-1}). Similar results was recorded in the rest of the growth parameters *viz.,* number of functional leaves, leaf area (cm^2), number of branches and total dry matter accumulation. The similar result were reported by Raut *et al.,* (2003).

In case of spacing S_4-45 x 05 cm recorded maximum plant height which was significantly higher over the rest of the spacings. But S_1 - 60 x 05 cm & S_2- 60 x 10 cm remains at par with each other. The probable reason for taller plants in narrow row spacing might be due to higher competition for the nutrient space and light which led to more intermodal length in closed spaced crop plants. Similar results

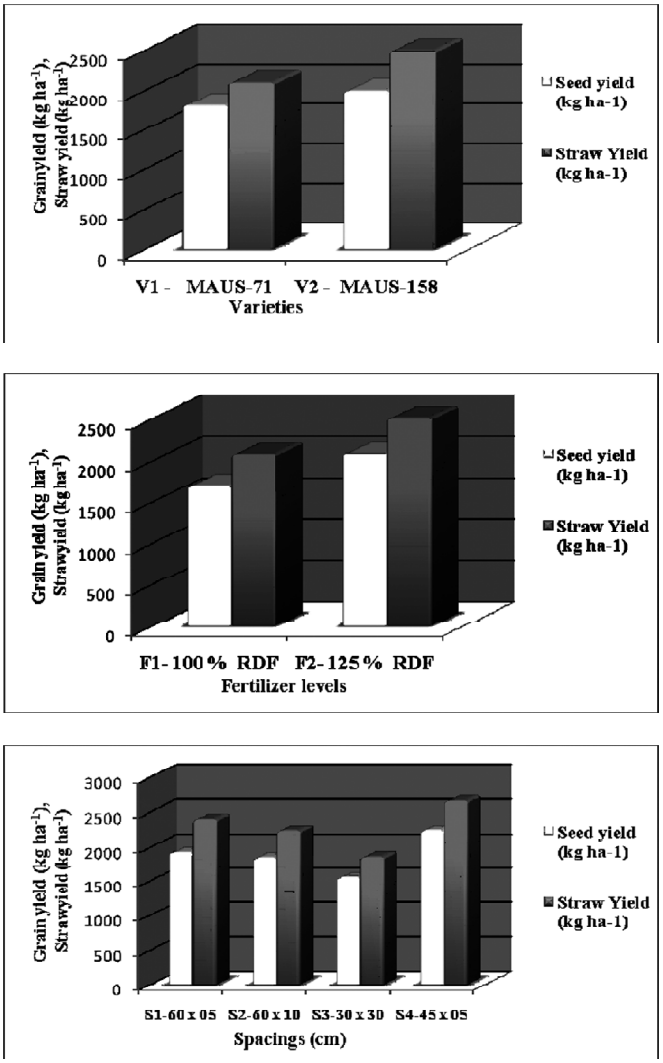

Figure 1: Grain, Straw Yield (kg ha^{-1}) as influenced by different treatments

were reported by Arora (1981). The no. of leaves, leaf area (cm^2), number of branches and total dry matter accumulation was highest in spacing S_1-60 x 05 cm^2 followed by S_2-60 x 10 cm^2, S_3-30 x 30 cm^2 and lowest in that of spacing S_4-45 x 05 cm^2. Increase in dry matter accumulation per plant was the cumulative effect of increase in various growth characters like number of branches per plant, number of leaves per plant, leaf area per plant. The results are in confirmation with Nimje (1996) & Jadhav *et al.,* (1994).

Effect on yield contributing characters

In soybean the yield contributing characters are *viz.,* number of pods per plant, pods weight per plant, seed weight per plant, number of seeds per pod and number of seeds per plant were recorded & showed in Table 5

Table 5
Mean number of pods plant^{-1} Mean pod weight plant^{-1} (g), seed weight plant^{-1} (g), number of seeds pod^{-1}, number of seeds plant^{-1} and 1000 seeds weight (g) of soybean as influenced by different treatments

Treatments	*No. of pods at harvest*	*Pod weight plant^{-1} (g)*	*Seed weight plant^{-1} (g)*	*No. of seeds pod^{-1}*	*No. of seeds plant^{-1}*
Varieties(V)					
V_1 - MAUS-71	34.75	17.36	9.54	2.02	76.54
V_2 - MAUS-158	42.29	20.55	12.44	2.14	88.32
S.E. ±	0.40	0.24	0.21	0.04	0.54
C.D. at 5 %	1.39	0.84	0.73	NS	1.87
Fertilizer levels (F)					
F_1- 100 % RDF	36.15	17.92	10.08	2.04	80.62
F_2- 125 % RDF	40.89	20.00	11.89	2.12	84.24
S.E.±	0.40	0.24	0.21	0.04	0.54
C.D. at 5 %	1.39	0.84	0.73	NS	1.87
Spacings (S)					
S_1 - 60 x 05 cm	42.62	19.70	11.67	2.09	85.04
S_2 - 60 x 10 cm	38.88	19.08	11.34	2.07	83.03
S_3- 30 x 30 cm	38.13	18.63	10.70	1.84	82.20
S_4- 45 x 05 cm	34.46	18.43	10.25	2.31	79.45
S.E.±	1.17	0.22	0.34	0.07	0.70
C.D. at 5 %	3.42	0.66	1.01	0.22	2.06
Interaction (V x F)					
S.E. ±	0.57	0.05	0.34	0.76	0.30
C.D. at 5 %	NS	NS	NS	2.64	NS
Interaction (V x S)					
S.E.±	1.66	0.10	0.32	1.00	0.49
C.D. at 5 %	NS	NS	NS	NS	NS
Interaction (F x S)					
S.E.±	1.66	0.10	0.32	1.00	0.49
C.D. at 5 %	NS	NS	NS	NS	NS
Interaction (V x F x S)					
S.E.±	2.34	0.15	0.45	1.41	0.69
C.D. at 5 %	NS	NS	NS	NS	NS

Mean number of pods per plant was recorded at 60 DAS and same were increased gradually till harvest of the crop. The number of pods differs significantly in different cultivars. Anetor and Akinrinde (2006) showed the significant differences between different varieties in respect of number of pods per plant.

The yield contributing characters *viz*., number of pods, pods weight per plant, seed weight per plant, number of seeds per pod and test weight were maximum in variety MAUS-158 followed by MAUS-71. The differences in seed weight were mainly due to genetic characters of the varieties under study. Sharief *et al*., (2010) found significant differences in yield contributing characters of different varieties.

Similarly, in case of nutrient levels, 125% RDF produced highest number of pods per plant, pods weight per plant, seed weight per plant and number of seeds per pod followed by 100% RDF. The similar results were observed by Jayapaul and Ganeshraja (1990).

Whereas that of spacing, the effect on number of pods per plant was pronounced. The performance of spacing S_1 (60 x 05 cm) with regard to number of pods per plant was higher followed by S_2-60 x 10 cm^2, S_3-30 x 30 cm^2 and S_4-45 x 05 cm^2. Similar results were reported by Kumar and Badiyala (2005).

Spacing S_1 (60 x 05 cm) recorded significantly highest pod weight, number of seeds per pod, number of seeds per plant over rest of spacing but was found at par with spacing S_2 (60 x 10 cm). Effects of different row spacings were evident on seed weight per plant. S_1 (60 x 05 cm) recorded significantly highest seed weight per plant over spacing S_4 (45 x 05 cm) but found at par with S_2 (60 x 10 cm) and S_3 (30 x 30 cm). The more no. of pods in wider spacing may be due to more space for the development of the crop as compared to the rest of the spacings. Similar results were reported by Nimje (1996).

Table 6
Mean Seed yield, straw yield (kg ha^{-1}) as influenced by different treatments

Treatments	*Seed yield (kg ha^{-1})*	*Straw Yield (kg ha^{-1})*
Varieties (V)		
V_1 - MAUS-71	1788.4	2082.9
V_2 - MAUS-158	1981.3	2482.2
S.E. ±	40.88	23.68
C.D. at 5 %	141.27	81.82
Fertilizer levels (F)		
F_1- 100 % RDF	1691.0	2069.0
F_2- 125 % RDF	2078.7	2496.2
S.E.±	40.88	23.68
C.D. at 5 %	141.27	81.82
Spacings (S)		
S_1 - 60 x 05 cm	1921.4	2393.4
S_2 - 60 x 10 cm	1840.8	2235.5
S_3- 30 x 30 cm	1539.3	1853.4
S_4- 45 x 05 cm	2237.8	2647.9
S.E.±	63.93	75.29
C.D. at 5 %	186.32	219.43
Interaction (V x F)		
S.E.±	57.82	33.49
C.D. at 5 %	NS	115.71
Interaction (V x S)		
S.E.±	90.41	106.48
C.D. at 5 %	NS	NS
Interaction (F x S)		
S.E.±	90.41	106.48
C.D. at 5 %	NS	NS
Interaction (V x F x S)		
S.E.±	127.86	150.59
C.D. at 5 %	NS	NS

Effect on yield

Seed yield is a function of yield attributes. Straw yield was an augmenting effect of increased vegetative growth through plant height, number of branches and number of leaves per plant. The highest seed and straw yields (kg ha^{-1}) of soybean crop was recorded by variety MAUS-158 (1981.3 and 2482.2 kg ha^{-1} respectively) followed by variety MAUS-71 (1788.4 and 2482.2 kg ha^{-1}. respectively). Tung and Pamela (2005) and Rattiyaporn *et al.,* (2012) reported the similar results regarding the grain and straw yields. In case of nutrient levels, the highest grain and straw yields (kg ha^{-1}.) were recorded with the application of 125% RDF followed by 100% RDF. Chiezy and odunze (2005) reported the same results.

The spacing S_4 (45 x 05 cm) recorded highest seed yield ha^{-1} which was significantly superior over rest of the spacings. These might be due to higher seed yield per plant which occurred from increased pod number, pod weight per plant and number of seeds per plant in case of spacing S_4 (45 x 05 cm). Similar results were reported by Tourino *et al.,* (2002).

Profound effect on straw yield ha^{-1} was noted due to different spacings. Spacing S_4 (45 x 05 cm) produced higher straw yield which was significantly superior over rest of the spacings. This may be due to more intra row space available for plant growth and hence profuse branching, more number of leaves, highest plant height and maximum dry matter as a result of these highest straw yield in case due to optimum plant population density ha^{-1} in 45 x 05 cm spacing. These results are in conformity with Kacha *et al.,* (1990).

Interaction effect

The interaction of V x F was found to be significant in influencing the number of functional leaves plant^{-1} and total dry matter at 75 DAS. Data presented in Table 2; indicating that, interaction of V_2F_2 at 75 days of crop age recorded significantly higher number of functional leaves than all the other combinations of varieties and fertilizer levels. The combinations of V_2F_2 recorded significantly higher dry matter plant^{-1} (g) accumulation (32.06 g) over V_1F_1, V_1F_2 and V_2F_1.

The interaction of V x F was found to be effective in influencing the number of seeds plant^{-1} and data presented in Table 3. Among all the combinations V_2F_2 produced maximum number of seeds plant^{-1} (89.18), followed by V2F1 (87.46), V2F2 (79.30) and at last V1F1 (73.78).

Data from Table 4 indicated that, interaction in between varieties and fertilizer (V x F) levels was significant. The combinations of V_2F_2 (2482.2) recorded significantly higher straw yield over V_1F_1, V_1F_2 and V_2F_1. Among all the least was found in V1F1 (1946.2)

REFERENCES

Anonymous, (2013), Area, production and productivity estimates of soybean in Indiain *Kharif* (Monsoon), 2012-13, *www.sopa.org/crop.po.doc*

Anetor M. O. and E. A. Akinrinde, (2006), Response of soybean (*Glycine max* (L.) Merrill) to lime and phosphorous fertilizer treatments on an acidic alfisol of Nigeria, *Pakistan J. Nutrition*, **5**(3): 286-293.

Arora S. K., (1981), Effect of different dates of sowing and spacing on growth and yield of soybean variety MACS-41, M.Sc. (Agri) dissertation submitted to P.K.V, Akola.

Ashour N. I. and Thalooth A. T., (1983), Effect of soil and foliar application of nitrogen during pod development on the yield of soybean (*Glycine max*) plants, *FieldCropsResearch*, **6**: 261

Balyan J. S. and N. K. Mohta, (1985), Effect of plant population on promising varieties of soybean, *Indian J. Agron*, **30**(3): 370-373.

Chauhan G. S., Verma N. S. and Bains G. S., (1988), Effect of extrusion processing on nutritional quality of protein in rice-legume blends, *Nahrung*, **32**(1): 43.

Chiezey U. F. and A. C. Odunze, (2005), Soybean response to application of poultry manure and P fertilizer in the Subhumid Savanna of Nigeria, *J. Ecology and Natural Environ*, **1**(2): 25-31.

Jones G. D., Lutz J. A. and Smith T. J., (1977), Effect of phosphorus and potassium on soybean nodules and seed yield, *Agronomy journal*, **69**(6): 1003-6.

Jadhav P. J., Bachchhav S. M., Jadhav A. S. and N. L. Bote, (1994), Pattern of leaf area and dry production as influenced by nitrogen, row spacing and plant densities of soybean, *J. Maha. Agric. Univ.*, **49**(7): 400-403.

Jatinder Kumar and D. Badiyala, (2005), Effect of seed rate row spacing and sowing time on yield and yield attributes of soybean, *Legume res.*, **28**(4): 288-290.

Jayapaul P. and V. Ganeshraja, (1990), Studies on response of soybean varieties to nitrogen and phosphorus, *Indian J. Agron*, **33**(3): 329-330.

Kacha R. P., M. M. Modhwadia, J. C. Patel, D. A. Tank and B. B. Kaneria, (1990), Response of soybean to row spacings and levels of NP fertility, *Indian J. Agron*, **35**(3): 317-319.

More S. R., S. N. Mendhe and H. S. Kolte, (2006), Growth and yield attributes of soybean as influenced by nutrient management, *J. of Soil and Crops*, **18**(1): 154-1.

Pawar V. P., (1978), Response of soybean (*Glycine max*) varieties to graded level of N and P. M.Sc (Agri) Thesis, submitted to M.A.U. Parbhani.

Rattiyaporn Jaidee, Anan Polthanee and Patchare Saenjan, (2012), Growth and yield of soybean cultivars as affected by ground water levels and phosphorus rates grown under greenhouse and field conditions, *Australian J. Crop Sci.*, **6**(1): 81-92.

Raut S.S., V. D. Basole, R. D. Deotale S. R. Ilmulwar and S. B. Kadwe, (2003), Effect of hormone and nutrients on morpho-physiological characters and yield of soybean, *J. Soils and Crops.*, **13**: 135-139.

Ruhul Amin, A. K. M., S. R. AJahan, M. F. Karim and Mirza Hasanuzzaman, (2009), Growth Dynamics of Soybean (*Glycine max* L.) as Affected by Varieties and Timing of Irrigation, *American-Eurasian J. Agron.*, **2**(2): 95-103.

Sharief A. E. M., S. E. El-Kalla, A. M. Salama, and E. I. Mostafa, (2010), Influence of organic and inorganic fertilization on the productivity of some soybean cultivars, *crop & environ*, **1**(1): 6-12.

Tourino M. C. C., Rezende P. M. de and N. Salvador, (2002), Row spacing, plant density and intra row plant spacing uniformity effect on soybean yield and agronomic characteristics, *Prequisa Agropecuria Brasileira*, **37**(8): 1071-1077.

Tung L. D. and G. F. Pamela, (2005) Yield and seed quality of modern and traditional soybean [*Glycine max* (L.) Merrill] under organic, biodynamic and chemical production practices, *Omonrice*, **15**: 75-85.