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Effect of Different Levels of Nitrogen and Phosphorus on Growth and Yield Parameter of Soybean (*Glycine max* L. Merrill)

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ABSTRACT

A field experiment was conducted at Main Agricultural Research Station, Dharwad on medium black soil during Kharif-2015. There were twelve treatment combinations consisted of three levels of nitrogen (20, 40 and 60 kg N ha^{-1}) and four levels of phosphorus (40, 60, 80 and 100 kg P_2O_5 ha^{-1}). Significantly higher plant height (55.13 cm), number of branches (7.17), total dry matter production (21.63 g), seed yield (25.77 q ha^{-1}) and haulm yield (31.32 q ha^{-1}) recorded with combined application of nitrogen @ 60 kg ha^{-1} and phosphorus @ 80 kg ha^{-1} compared to other treatments and it was on par with application of nitrogen @ 60 kg ha^{-1} and phosphorus @ 100 kg ha^{-1}.Application of nitrogen @ 60 kg, phosphorus @ 80 kg and potash @ 25 kg per hectare found optimum to get substantial soybean seed yield.

Key words:*Soybean,nitrogen, phosphorus*

INTRODUCTION

Soybean (*Glycine max* L. Merrill), is an introduced and commercially exploited crop in India. The crop is also called as “Golden Bean” or “Miracle crop” of the 21st century on account of its multiple uses. It has highest protein 40 %, oil 20 %, rich in lysine and vitamins A, B and D and also rich in mineral salts. Among the nutrients, nitrogen is a major essential plant nutrient element. It has the quickest and mostpronounced effect on plant growth and yield of crops. It tends primarily to encourage above ground vegetative growth and to impart deep green colour to the leaves. In all plants, nitrogen governs a considerable degree of utilization of potassium, phosphorus and other nutrients. Plants receiving insufficient nitrogen are stunted in growth with restricted root systems[7]. The leaves turn yellow or yellowish green and tend to drop off. Phosphorus stimulates rhizobial activity, nodule formation and thus helps in N_2-fixation. It increases the water use efficiency, improves storage quality and hardness of the bean seed coat. As phosphorus plays a role in photosynthesis, respiration, energy storage and transfer, cell division and enlargement, it has been shown to be important for growth, development and yield of soybean[5]. It helps uptake of more nutrients and balances the nitrogen deficiency in soil and assists in seed maturation. Thus, it is needed to find out proper amount of nitrogen and phosphorus required for achieving better yield of soybean. Hence, in order to verify and workout the optimum nitrogen and phosphorus dose the present investigation undertaken.

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MATERIAL AND METHODS

The field experiment was carried out at Main Agricultural Research Station, Dharwad, during *kharif* 2015 to study the "Effect of different levels of nitrogen and phosphorus on growth and yield parameter of Soybean (*Glycine max* L. Merrill)"The experiment was laid out in Randomized Complete Block Designin factorial concept and with three replications. There were twelve treatment combinations consisted of three levels of nitrogen (20, 40 and 60 kg N ha^{-1}) and four levels of phosphorus (40, 60, 80 and 100 kg $P_2O_5ha^{-1}$). One of the treatment combinations comprised the recommended dose of 40 kg N, 80 kg P_2O_5 and 25 kg K_2O per hectare. The soil was medium deep black soil with pH 7.10. The available N, P_2O_5 and K_2O contents were 252, 32.5 and 292.8 kg ha^{-1}, respectively. FYM (5 t ha^{-1}) was applied 15 days before sowing of the crop. The gross plot size was 5.0 m × 3.6 m and net plot size was 4.8 m × 3.0 m.Seeds were treated using *Rhizobium* and *PSB* @ 1250 g per hectare. Two seeds per hill were dibbled 5 cm deep in furrows at a spacing of 30 cm x 10 cm. Recommended dose of K_2O (25 kg ha^{-1}) in the form of MOP (Muriate of Potash) was applied at the time of sowing. N and P_2O_5 were applied as basal as per the treatments. The cropwas harvested at its physiological maturity. The data was statistically analysed as per the procedure given by Gomez and Gomez[4].

RESULTS AND DISCUSSION

Growth parameters

Application of nitrogen @ 60 kg ha^{-1} recorded significantly higher plant height (54.04 cm), number of branches $plant^{-1}$ (6.91), total dry matter production (20.66 g) at harvest and at 60 DAS significantly higher leaf area (10.18 dm^2 $plant^{-1}$) and leaf area index (3.38) compared to 20 and 40 kg N ha^{-1}. Among the phosphorus, application of phosphorus @ 80 kg ha^{-1} recorded significantly higher plant height (52.19 cm), number of branches $plant^{-1}$ (6.51), total dry matter production (19.76 g) at harvest and at 60 DAS significantly higher leaf area (9.83 dm^2plant^{-1}) and leaf area index (3.28) compared to 60 and 40 kg P_2O_5 ha^{-1} but it was on par with 100 kg P_2O_5 ha^{-1}. In interaction effect application of nitrogen @ 60 kg ha^{-1} and phosphorus @ 80 kg ha^{-1} recorded significantly higher plant height (55.13 cm), number of branches $plant^{-1}$ (7.17), total dry matter production (21.63 g) at harvest (Table-1) and significantly higher leaf area (10.58 dm^2 $plant^{-1}$) and leaf area index (3.53) at 60 DAS (Table-2) compared to other treatment combinations but it was on with application of nitrogen @ 60 kg ha^{-1} and phosphorus @ 100 kg ha^{-1}. It is mainly attributed to application of nitrogen and phosphorus accelerated the photosynthetic rate leading to more production of carbohydrates, it involved in nodulation and being the constituent of ATP which regulate vital metabolic processes in the plant, helping in root formation and nitrogen fixation. dry matter production depends on the photosynthetic capacity of the plant which in turn depends on the dry matter accumulation in leaves, leaf area and leaf area index. This is in conformity with the findings of Shafii *et al*[8]., Geeta and Radder[3], Malik *et al*[6]., Singh *et al*[10]. and Yadravi and Angadi[13].

Yield and yield parameters

Application of nitrogen @ 60 kg ha^{-1} recorded significantly higher number of pods $plant^{-1}$ (47.4), seed weight $plant^{-1}$(14.84 g) seed yield (24.44 q ha^{-1}) and haulm yield (29.75 q ha^{-1}) compared to 20 and 40 kg N ha^{-1}. Among the phosphorus, application of phosphorus @ 80 kg ha^{-1} recorded significantly higher number of pods $plant^{-1}$(45.7), seed weight $plant^{-1}$(13.79 g) seed yield (22.57 q ha^{-1}) and haulm yield (27.52 q ha^{-1}) compared to 60 and 40 kg P_2O_5 ha^{-1} but it was on par with 100 kg P_2O_5 ha^{-1}. In interaction effect application of nitrogen @ 60 kg ha^{-1} and phosphorus @ 80 kg ha^{-1} recorded significantly higher number of pods $plant^{-1}$(49.9), seed weight $plant^{-1}$(15.91 g) [Table-3], seed yield (25.77 q ha^{-1}) and haulm yield (31.32 q ha^{-1}) [Table-4] compared to other treatment combinations but it was on with application of nitrogen @ 60 kg ha^{-1} and phosphorus @ 100 kg ha^{-1}.However, test weight and harvest index show non-significance difference among the nitrogen, phosphorus and interaction effect. It is mainly attributed to application of nitrogen and phosphorus involved in energy transformations, activation of enzymes in carbohydrate metabolism and consequently greater transformation of photosynthates into reproductive parts. These results are in line with the findings of Yadav and Chandel[12], Sohrabi *et al*[11]., Sikka *et al*[9]., Bhattacharjee *et al*[1]., and Dhage *et al*[2].

Table 1: Plant height, number of branches plant^{-1} and total dry matter production at harvest of soybean as influenced by different levels of nitrogen and phosphorus

Phosphorus (kg ha^{-1})	Plant height (cm)				Number of branches plant^{-1}				Total dry matter production (g)			
	Nitrogen (kg ha^{-1})											
	20	40	60	Mean	20	40	60	Mean	20	40	60	Mean
40	45.76	51.40	52.63	**49.93**	5.23	6.07	6.40	**5.90**	16.33	17.57	19.37	**17.76**
60	47.33	52.03	52.90	**50.76**	5.47	6.37	6.57	**6.13**	16.50	18.90	19.70	**18.37**
80	48.07	53.37	55.13	**52.19**	5.60	6.77	7.17	**6.51**	16.97	20.67	21.63	**19.76**
100	48.47	53.60	55.50	**52.52**	5.87	6.93	7.50	**6.77**	17.10	20.80	21.93	**19.94**
Mean	**47.41**	**52.60**	**54.04**		**5.54**	**6.53**	**6.91**		**16.73**	**19.48**	**20.66**	
	S.Em±		**CD at 5 %**		**S.Em±**		**CD at 5 %**		**S.Em±**		**CD at 5 %**	
Nitrogen	0.22		0.66		0.08		0.22		0.17		0.49	
Phosphorus	0.26		0.76		0.09		0.26		0.19		0.57	
Interaction	0.45		1.32		0.15		0.45		0.33		0.98	

Table 2: Leaf areaand Leaf area indexat 60 DAS of soybean as influenced by different levels of nitrogen and phosphorus

Phosphorus (kg ha^{-1})	Leaf area (dm^2 plant^{-1})				Leaf area index			
	Nitrogen (kg ha^{-1})							
	20	40	60	Mean	20	40	60	Mean
40	8.73	9.40	9.52	**9.27**	2.91	3.13	3.17	**3.07**
60	9.02	9.56	9.78	**9.45**	3.01	3.19	3.26	**3.15**
80	9.12	9.79	10.58	**9.83**	3.04	3.26	3.53	**3.28**
100	9.25	9.94	10.71	**9.96**	3.08	3.31	3.57	**3.32**
Mean	**9.03**	**9.67**	**10.18**		**3.01**	**3.22**	**3.38**	
	S.Em±		**CD at 5 %**		**S.Em±**		**CD at 5 %**	
Nitrogen	0.10		0.30		0.03		0.10	
Phosphorus	0.12		0.34		0.04		0.12	
Interaction	0.20		0.59		0.07		0.20	

Table 3: Number of pods plant^{-1}, seed weight plant^{-1} and test weight (100 seed weight) of soybean as influenced by different levels of nitrogen and phosphorus

Phosphorus (kg ha^{-1})	Number of pods plant^{-1}				Seed weight plant^{-1} (g)				Test weight (g) (100 seeds)			
	Nitrogen (kg ha^{-1})											
	20	40	60	Mean	20	40	60	Mean	20	40	60	Mean
40	37.7	42.2	43.2	**41.0**	10.05	11.85	13.27	**11.72**	12.35	12.44	12.49	**12.43**
60	38.9	44.2	45.4	**42.9**	10.26	12.44	14.07	**12.26**	12.38	12.45	12.52	**12.45**
80	40.3	46.7	49.9	**45.7**	10.55	14.92	15.91	**13.79**	12.39	12.52	12.60	**12.50**
100	41.2	47.2	51.1	**46.5**	11.15	15.14	16.13	**14.14**	12.41	12.55	12.66	**12.54**
Mean	**39.5**	**45.1**	**47.4**		**10.50**	**13.59**	**14.84**		**12.38**	**12.49**	**12.57**	
	S.Em±		**CD at 5 %**		**S.Em±**		**CD at 5 %**		**S.Em±**		**CD at 5 %**	
Nitrogen	0.2		0.6		0.13		0.38		0.11		NS	
Phosphorus	0.3		0.9		0.15		0.44		0.12		NS	
Interaction	0.4		1.2		0.26		0.76		0.21		NS	

Table 4: Seed yield, haulm yield and harvest index of soybean as influenced by different levels of nitrogen and phosphorus

Phosphorus (kg ha^{-1})	Seed yield (q ha^{-1})				Haulm yield (q ha^{-1})				Harvest index (%)			
	Nitrogen (kg ha^{-1})											
	20	40	60	Mean	20	40	60	Mean	20	40	60	Mean
40	16.55	19.59	22.26	**19.47**	20.33	23.95	27.15	**23.81**	44.88	44.99	45.05	**44.97**
60	17.32	21.20	23.66	**20.73**	21.25	25.87	28.85	**25.32**	44.91	45.04	45.06	**45.00**
80	17.70	24.23	25.77	**22.57**	21.69	29.57	31.32	**27.52**	44.94	45.04	45.14	**45.05**
100	18.22	24.63	26.07	**22.97**	22.31	30.02	31.67	**28.00**	44.95	45.07	45.15	**45.07**
Mean	**17.45**	**22.42**	**24.44**		**21.40**	**27.35**	**29.75**		**44.91**	**45.05**	**45.10**	
	S.Em±		**CD at 5 %**		**S.Em±**		**CD at 5 %**		**S.Em±**		**CD at 5 %**	
Nitrogen	0.15		0.45		0.16		0.48		0.11		NS	
Phosphorus	0.18		0.51		0.19		0.55		0.12		NS	
Interaction	0.30		0.89		0.33		0.96		0.21		NS	

CONCLUSION

Based on the results obtained, it may be concluded that application of nitrogen @ 60 kg ha^{-1}and phosphorus @ 80 kgha^{-1} and potassium @ 25 kg ha^{-1} was optimum to achieve higher soybean seed yield.

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