Int.J.Curr.Microbiol.App.Sci (2017) *6*(11): 570-576

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 6 Number 11 (2017) pp. 570-576**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2017.611.069

Growth and Yield of Soybean as Influenced by Different Ratios and Levels of Nitrogen and Phosphorus under Rainfed Situations

Satyabrata Mangaraj[1*], L.H. Malligawad[2] and R.K. Paikaray[1]

[1]College of Agriculture, OUAT, Bhubaneswar, Odisha, India
[2]College of Agriculture, UAS, Dharwad, Karnataka, India
**Corresponding author*

Keywords

Rainfed, Foliar application, Seed yield, Fertilizer ratio.

Article Info

Accepted:
07 September 2017
Available Online:
10 November 2017

A B S T R A C T

A field experiment was carried out during *kharif* 2015 with thirteen ratios of nitrogen (N) and phosphorus (P_2O_5) fertilizers with constant potassium level (25 kg K_2O ha^{-1}) on soybean cultivar DSb 21 at MARS, UAS, Dharwad. The seed yield increased due to increasing N/P ratios up to 0.78. The treatment receiving N/P fertilizer ratio of 0.70 (basal application of 18 kg N, 46 kg P_2O_5, 25 kg K_2O ha^{-1} + foliar application of nitrogen @ 7 kg N ha^{-1} at initiation of flowering and foliar application of nitrogen @ 7 kg N ha^{-1} at 15 days after first foliar spray) recorded significantly higher seed yield (3217 kg ha^{-1}), number of filled pods $plant^{-1}$ (44.73), total number of pods $plant^{-1}$ (47.57), 100 seed weight (15.40 g) and seed weight $plant^{-1}$ (18.31 g). This treatment also recorded significantly higher leaf area $plant^{-1}$ (12.62 dm^2), leaf area index (4.21) and total dry matter production (34.15 g). The treatment receiving N/P fertilizer ratio of 0.78 (basal application of 40 kg N, 69 kg P_2O_5, 25 kg K_2O ha^{-1} + foliar application of nitrogen @ 7 kg N ha^{-1} through urea at initiation of flowering and foliar application of nitrogen @ 7 kg N ha^{-1} at 15 days after first spray) was on par with the N/P fertilizer ratio of 0.70.

Introduction

Soybean (*Glycine max* L. Merrill), a species of grain legume called as the "*GOLDEN BEAN*" of the 20th century is widely grown for its edible bean having numerous uses. Soybean is considered as a wonder crop due to its dual qualities *viz.*, high protein (40-43%) and oil content (20%). In addition, soybean protein has 5% lysine which is deficient in most cereals. In India, area under soybean crop is about 10.33 M ha with annual production of 8.91 Mt with an average productivity of 983 kg ha^{-1} (Anon., 2015) which is much less than world average despite it is introduced in India during 1880.

In Karnataka, soybean crop is cultivated in an area of 0.2 lakh ha with an annual production of 0.22 Mt and productivity of 1103 kg ha^{-1}.

Among the factors responsible for low productivity, inadequate fertilizer use and emergence of multiple-nutrient deficiencies due to poor recycling of organic sources and unbalanced use of fertilizers are the most important. The crop is often subjected to both water logging and soil moisture deficit in the growing season. Many a times even with normal distribution of rainfall, crop suffers from excess soil moisture during peak

flowering and pod development stages which leads to deficiency of certain nutrients, particularly nitrogen, resulted in low productivity. Application of small amounts of fertilizer N at sowing time as a starter dose of the crop improves the biological nitrogen fixation (BNF), whereas heavy doses of N reduces the efficacy of BNF leading to lower yield through excessive vegetative growth. To assure continuous N supply to the crop and to improve its efficiency, split application of N may be helpful for raising crop yield and reduce soil and water pollution due to leaching. Phosphorus is also a critical nutrient, both in respect of its supply and availability in the soil. It is also reported that poor response to the application of higher rates of inorganic phosphorus fertilizers was noticed in the soils with medium to high available phosphorus contents. Optimum nitrogen and phosphorus ratios applied as basal and foliar application in soybean crop under rainfed situation is lacking. Therefore, studies on productivity of soybean as influenced by ratios and levels of nitrogen and phosphorus were carried out in medium black clay soil of Northern Transitional Zone (Zone 8) of Karnataka state.

Materials and Methods

A field experiment was conducted at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad, Karnataka during *kharif* 2015. The soil was texturally clay soil, neutral in pH, medium in available of nitrogen (301.56 kg N ha^{-1}) and phosphorus (28.23 kg P_2O_5 ha^{-1}) with high in available of potassium (386.32 kg K_2O ha^{-1}), high in organic matter content (0.76%) and normal in salt content (0.72 dSm^{-1}).The experiment was laid out in a randomized complete block design with three replications. The experiment consists of 13 N/P fertilizer ratios and levels viz., T_1 -0.00 (Control), T_2 – 0.00 (0 kg N, 0 kg P_2O_5 and 25 kg K_2O ha^{-1}), T_3 -0.50 (40 kg N, 80 kg P_2O_5 and 25 kg K_2O ha^{-1}), T_4 – 0.50 (40 kg N, 80 kg P_2O_5 and 25 kg K_2O ha^{-1}), T_5 -0.70 (32 kg N, 46 kg P_2O_5 and 25 kg K_2O ha^{-1}) T_6 – 0.46 (32 kg N, 69 kg P_2O_5 and 25 kg K_2O ha^{-1}), T_7 – 0.40 (32 kg N, 80 kg P_2O_5 and 25 kg K_2O ha^{-1}), T_8 – 0.43 (40 kg N, 46 kg P_2O_5 and 25 kg K_2O ha^{-1}), T_9 – 0.58 (40 kg N, 69 kg P_2O_5 and 25 kg K_2O ha^{-1}), T_{10} -0.50 (40 kg N, 80 kg P_2O_5 and 25 kg K_2O ha^{-1}), T_{11} – 1.17 (54 kg N, 46 kg P_2O_5 and 25 kg K_2O ha^{-1}), T_{12} – 0.78 (54 kg N, 69 kg P_2O_5 and 25 kg K_2O ha^{-1}), T_{13} – 0.68 (54 kg N, 80 kg P_2O_5 and 25 kg K_2O ha^{-1}). Foliar application of nitrogen (N) was taken in the form of urea @ 2.00 % at initiation of flowering (i.e., in the treatment T_4) or at initiation of flowering and 15 days after first spray (i.e., in the treatments from T_5 to T_{13}).Soybean cultivar DSb 21 was used with a spacing of 30 cm between rows and 10 cm within row.

The land was prepared to a fine tilth before sowing of soybean seed. The seed treatment was done with *Rhizobium* and P solubilisers @ 15 g kg^{-1} seeds. Weeding and plant protection measures were undertaken as per need of crop. The crop was grown with one life saving irrigation. It was scheduled in between post flowering and pod formation period because of no rainfall in that period to reduce flower drop and enhance pod formation The observations on growth, yield attributes and yield were recorded at 30, 60 days and at harvest. Growth and yield parameters like plant height, number of branches, leaf area, total dry matter accumulation and pod number were recorded from five tagged plants in each plot, while seed yield, haulm yield, threshing per cent and harvest index were recorded on plot basis.

Calculation of leaf area (dm^2 $plant^{-1}$)

Leaf area was measured by disc method as suggested by Vivekanandan *et al.*, (1972). 50

discs of known size were taken through cork borer from randomly selected leaves from five plants. Both discs and remaining leaf blades were oven dried at 75^0 C for two days and leaf area was calculated by using formula.

$$LA = \frac{W_a \times A}{Wb}$$

Where

LA – Leaf area per plant
A= Area of discs (dm^2)
W_a- Weight of all leaves + discs
W_b – Weight of 50 discs

The analysis and interpretation of data were studied using the Fischer's method of analysis of variance technique as described by Gomez and Gomez (1984).

The level of significance used in 'F' and 't' test was P = 0.05. Critical difference values were calculated wherever the 'F' test was significant. The means differences among the treatments were compared by Duncan Multiple Comparison Test (DMRT) at 0.05 level of probability.

Results and Discussion

Effect on yield and yield attributes

Effect of different ratios and levels of nitrogen and phosphorus fertilizers and foliar application of nitrogen through urea had significant effect with respect to growth and yield of soybean.

The highest seed yield and haulm yield of soybean (3217 kg ha^{-1} and 3788.3 kg ha^{-1} respectively) was observed in the treatment receiving N/P fertilizer ratio of 0.70 i.e., basal application of 18 kg N, 46 kg P_2O_5 and 25 kg K_2O + foliar application of 7 kg N ha^{-1} each at flower initiation and 15 days after first foliar spray when compared to control (2059 and 2551 kg ha^{-1}, respectively) and recommended dose of fertilizer N/P ratio of 0.50 (2590 and 3051 kg ha^{-1}, respectively) without foliar application of nitrogen. Threshing per cent and harvest index did not differ significantly with respect to application of different ratios and levels of nitrogen and phosphorus fertilizers (Table 1).

Similar results were obtained by Yan *et al.,* (2015) where application 45 kg N and 70 kg ha^{-1} P_2O_5 (N/P ratio of 0.64) along with manure significantly increased seed yield 3090.28 kg ha^{-1} and 3576.39 kg ha^{-1} in two cultivars of soybean. These findings were also well supported by Siddique *et al.,* (2007), Ghosh *et al.,* (2006) and Shivkumar and Ahlawat (2008).

Seed yield is mainly dependent on source sink relation. Under rainfed agro ecology, application of 2% urea at flower initiation and 15 days thereafter will enhance the movement of photosynthates from source to sink during the seed filling stage. As the reproductive parts get more photosynthetic assimilate, an increase in seed yield is resulted.

The improvement in the yield components such as number of pods $plant^{-1}$, pod weight $plant^{-1}$, seed weight $plant^{-1}$ (g) and 100 seed weight (g) ultimately results into increase in seed yield.

Among the different yield components, total number of pods $plant^{-1}$ (47.57), weight of dry pod $plant^{-1}$ (24.73 gg) and seed weight $plant^{-1}$ (18.31 g) were greater with N/P ratio of 0.70 over recommended dose of fertilizer (N/P ratio of 0.50 without foliar application of N) (Table 2). Such differences with respect to yield components were reported earlier by Rana and Badiyala (2014); Begum *et al.,* (2015).

Table.1 Yield of soybean as influenced by different ratios and levels of nitrogen and phosphorus fertilizers

Treatment	N/P Ratio	Quantity of nutrients (NPK) applied (kg ha^{-1})					Seed yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	Threshing %
		Application at sowing			Foliar application of N				
		N	P_2O_5	K_2O	flowering initiation	15 days after 1st spray			
T_1	**0/00 (0.00)**	0	0	0	0	0	2059 f	2551 e	64.58
T_2	**00/00 (0.00)**	0	0	25	0	0	2444 e	2976 d	69.86
T_3	**40/80 (0.50)**	40	80	25	0	0	2590 de	3051 cd	75.10
T_4	**40/80 (0.50)**	33	80	25	7	0	3054 ab	3525 ab	72.78
T_5	**32/46 (0.70)**	18	46	25	7	7	3217 a	3788 a	74.84
T_6	**32/69 (0.46)**	18	69	25	7	7	3055 ab	3513 ab	74.17
T_7	**32/80 (0.40)**	18	80	25	7	7	2974 ab	3519 ab	72.01
T_8	**40/46 (0.43)**	26	46	25	7	7	2842 b-d	3317 bc	71.64
T_9	**40/69 (0.58)**	26	69	25	7	7	2902 bc	3479 ab	72.83
T_{10}	**40/80 (0.50)**	26	80	25	7	7	2939 ab	3483 ab	72.82
T_{11}	**54/46 (1.17)**	40	46	25	7	7	2650 c-e	3164 cd	71.97
T_{12}	**54/69 (0.78)**	40	69	25	7	7	3204 a	3703 a	75.88
T_{13}	**54/80 (0.68)**	40	80	25	7	7	3086 ab	3629 ab	73.28
		S.Em±					89.40	98.60	4.34
		LSD (p=0.05)					276.044	304.456	NS

Table.2 Yield attributes of soybean as influenced by different ratios and levels of nitrogen and phosphorus fertilizers

Treatment	N/P Ratio	Quantity of nutrients (NPK) applied (kg ha^{-1})					Total pods (plant^{-1})	Pod weight (g plant^{-1})	Seed weight (g plant^{-1})
		Application at sowing			Foliar application of N				
		N	P_2O_5	K_2O					
T_1	**00/00 (0.00)**	0	0	0	0	0	31.20 e	14.48 h	9.53 c
T_2	**00/00 (0.00)**	0	0	25	0	0	33.77 e	16.51 g	11.97 b
T_3	**40/80 (0.50)**	40	80	25	0	0	38.13 d	18.57 f	13.73 b
T_4	**40/80 (0.50)**	33	80	25	7	0	41.83 bc	21.87 cd	16.09 b
T_5	**32/46 (0.70)**	18	46	25	7	7	47.57 a	24.73 a	18.31 a
T_6	**32/69 (0.46)**	18	69	25	7	7	42.77 bc	22.00 b-d	16.21 b
T_7	**32/80 (0.40)**	18	80	25	7	7	42.50 bc	21.75 cd	15.76 b
T_8	**40/46 (0.43)**	26	46	25	7	7	40.50 cd	20.06 d-f	14.96 b
T_9	**40/69 (0.58)**	26	69	25	7	7	41.83 bc	21.38 c-e	15.51 b
T_{10}	**40/80 (0.50)**	26	80	25	7	7	41.77 bc	21.59 c-e	15.73 b
T_{11}	**54/46 (1.17)**	40	46	25	7	7	39.93 cd	19.51 c-f	14.27 b
T_{12}	**54/69 (0.78)**	40	69	25	7	7	47.33 a	24.01 ab	18.17 a
T_{13}	**54/80 (0.68)**	40	80	25	7	7	45.23 ab	22.74 a-c	16.71 b
		S.Em±					1.12	0.67	0.65
		LSD (p=0.05)					3.454	2.056	2.010

Table.3 Growth parameters of soybean as influenced by different ratios and levels of nitrogen and phosphorus fertilizers

Treatment	N/P ratio	Quantity of nutrients (NPK) applied (kg ha^{-1})					Plant height (cm) at harvest	Leaf area (dm^2 plant^{-1}) at 60DAS	Leaf area index at 60DAS	Total dry matter at harvest
		Application at sowing			Foliar application of N					
		N	P_2O_5	K_2O	flowering initiation	15 days after 1st spray				
T_1	**00/00 (0.00)**	0	0	0	0	0	58.69 e	6.82 c	2.27 c	20.26 h
T_2	**00/00 (0.00)**	0	0	25	0	0	61.33 d	6.96 c	2.32 c	23.31 g
T_3	**40/80 (0.50)**	40	80	25	0	0	63.17 cd	8.58 bc	2.86 bc	25.84 f
T_4	**40/80 (0.50)**	33	80	25	7	0	64.40 bc	10.92 ab	3.64 ab	29.33 c-e
T_5	**32/46 (0.70)**	18	46	25	7	7	67.00 a	12.62 a	4.21 a	34.15 a
T_6	**32/69 (0.46)**	18	69	25	7	7	64.07 bc	8.51 bc	2.84 bc	30.79 b-d
T_7	**32/80 (0.40)**	18	80	25	7	7	64.18 bc	8.86 bc	2.95 bc	29.81 c-e
T_8	**40/46 (0.43)**	26	46	25	7	7	63.60 c	10.45 ab	3.48 ab	28.35 de
T_9	**40/69 (0.58)**	26	69	25	7	7	63.67 bc	10.93 ab	3.64 ab	29.94 c-e
T_{10}	**40/80 (0.50)**	26	80	25	7	7	63.40 c	10.19 a-c	3.40 a-c	29.75 c-e
T_{11}	**54/46 (1.17)**	40	46	25	7	7	62.87 cd	7.67 bc	2.56 bc	27.62 ef
T_{12}	**54/69 (0.78)**	40	69	25	7	7	64.80 bc	10.12 a-c	3.37 a-c	32.96 ab
T_{13}	**54/80 (0.68)**	40	80	25	7	7	65.63 ab	8.95 bc	2.98 bc	31.38 bc
		S.Em±					0.60	1.01	0.34	0.77
		LSD (p=0.05)					1.866	3.134	1.045	2.391

Effect on growth parameters

The growth attributes such as plant height, number of leaves plant^{-1}, number of branches plant^{-1}, total dry matter accumulation plant^{-1} differed significantly due to different ratios and levels of nitrogen and phosphorus fertilizers at different growth stages of crop. N/P fertilizer ratio of 0.70 produced taller plant (67.00 cm) as compared to control and potassium level alone (Table 3). Similar results were also obtained by Chaturvedi *et al.,* (2012) and Lone *et al.,* (2009) where N/P ratio of 0.75 and 0.66 produced taller plants, respectively.

The increase in grain yield and yield components was inturn due to increase in growth and dry matter accumulation. Total dry matter plant^{-1} (TDMP) was improved with foliar application of nitrogen in the treatments which received different N/P fertilizer ratios. At harvest, significantly higher TDMP was observed under the treatment receiving N/P fertilizer ratio of 0.70 (34.15 g plant^{-1}) than the other treatments and control (20.69 g plant^{-1}) which is in line of findings of Chaturvedi *et al.,* (2012). Improvement in the growth in respect to plant height, stem diameter, plant spread and number of branches plant^{-1} due to increased N/P fertilizer ratio with foliar application of nitrogen resulted in an increased dry matter accumulation in all the plant parts such as leaf, stem and reproductive parts.

The leaf area (12.62 dm^2 plant^{-1}) and leaf area index (4.21) of soybean were higher with the treatment receiving N/P fertilizer ratio of 0.70 at 60 DAS as compared to control (6.82 dm^2 plant^{-1} and 2.27, respectively) and recommended dose of fertilizer N/P ratio of 0.50 without foliar application (8.58 dm^2 plant^{-1} and 2.86, respectively). Thus foliar application of nitrogen increased dry weight of leaf in treatments receiving different N/P fertilizer ratios which is usually associated with increase in leaf area plant^{-1} and leaf area index. These results are in conformity with Rana and Badiyala (2014).

Based on results of present investigation, higher seed yield of soybean (3217 kg ha^{-1}) was obtained with improved fertilizer management practices involving basal application of 18 kg N, 46kg P_2O_5 and 25 kg K_2O with foliar application of 7 kg N ha^{-1} at flower initiation and 15 days after first foliar spray (N/P fertilizer ratio of 0.70) in medium black clay soil of Karnataka during *kharif* under rainfed situations.

Acknowledgement

The author is grateful to College of Agriculture, UAS, Dharwad, Dr. L.H. Malligwad for providing essential information and guidance; Dr. S. S. Angadi, Head Dept. of Agronomy, CA, UAS, Dharwad; and Institute of Organic Farming, UAS Dharwad for providing research materials and lab facilities.

References

Anonymous. Oil seed crops. Handbook of Agriculture, Published by Directorate of Information and Publication of Agriculture. *Indian Council Agric. Res.* New Delhi, 6th Edn. 1143-1144 (2015)

Begum, A., Islam, A., Ahmed, Q. M., Islam, M. A. and Rahman, M. M., Effect of nitrogen and phosphorus on the growth and yield performance of soybean. *Res. Agric. Livest. Fish.* 2 (1): 35-42 (2015).

Chaturvedi, S., Chandel, A. S., Dhyani, V. C. and Singh, A. P. (2012). Nutrient management for enhanced yield and quality of soybean (*Glycine max*) and residual soil fertility. *Legume Res.* 35 (3): 175-184.

Ghosh, P. K., Mohanty, M., Bandyopadhyay, K. K., Painuli, D. K. and Mishra, A.

K.,Effect of nutrient management growth, competition, yield advantage and economics in soybean/pigeonpea intercropping system in semi-arid tropics of India. *Field Crops Res.* 96: 90–97 (2006).

Gomez, K. A. and Gomez, A. A., *Statistical Procedures for Agricultural Research*, An international Rice Research Institute Book, Wiley- Inter Science Publication, New York, USA.pp 680 (1984).

Hanway, J. J., Corn growth and composition in relation to soil fertility. *Agron. J.* 54: 145-148(1962).

Lone, B. A., Hasan, B., Ansar, S. and Khanday, B. A., Effect of seed rate, row spacing and fertility levels on growth and nutrient uptake of soybean (*Glycine max* L.) under temperate conditions. *European J. Agron.* 4 (3): 7-10 (2009).

Rana, R. and Badiyala, D. Effect of integrated nutrient management on seed yield, quality and nutrient uptake of soybean (*Glycine max*) under mid hill conditions of Himachal Pradesh. *Indian J. Agron.* 59 (4): 641-645 (2014).

Shivakumar, B. G. and Ahlawat, I. P. S., Integrated nutrient management in soybean (*Glycine max*) –wheat (*Triticum aestivum*) cropping system. *Indian J. Agron.* 53 (4): 273-278 (2008).

Siddique, M. H, Oad, F. C., Kumbhar, A. M., and Burriro, U. A., NP requirement of soybean varieties for yield and yield components. *J. Agron*. 6 (1): 222-224 (2007).

Vivekanandan, A. S. Gunasena, H. P. M. and Sivanayagam, T., Statistical evaluation of the accuracy of three techniques used in the estimation of leaf area of crop plants. *Indian J. Agric. Sci*. 42: 857-860 (1972).

Yan, C. J. Song, S. H., Wang, W. B., Miao, S. J, Cao, Y. Q., Wang, C. L. and Zhang, L. J., Impacts of fertilization on photosynthesis, growth and yield of two soybean cultivars (*Glycine max*) in Northeast China. *Legume Res.* 38 (1): 77-84 (2015).

How to cite this article:

Satyabrata Mangaraj, L.H. Malligawad and Paikaray, R.K. 2017. Growth and Yield of Soybean as Influenced by Different Ratios and Levels of Nitrogen and Phosphorus under Rainfed Situations. *Int.J.Curr.Microbiol.App.Sci.* 6(11): 570-576.
doi: https://doi.org/10.20546/ijcmas.2017.611.069