Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

J P P Journal of Pharmacognosy and Phytochemistry

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2017; 6(5): 1748-1751
Received: 01-07-2017
Accepted: 02-08-2017

S Mangaraj
College of Agriculture, OUAT, Bhubaneswar, Odisha, India

LH Malligawad
College of Agriculture, UAS, Dharwad, Karnataka, India

SR Pradhan
College of Agriculture, OUAT, Bhubaneswar, Odisha, India

Correspondence
S Mangaraj
College of Agriculture, OUAT, Bhubaneswar, Odisha, India

Effect of split and foliar application of urea on growth and nutrient balance sheet of rainfed soybean

S Mangaraj, LH Malligawad and SR Pradhan

Abstract

To find out the optimum N/P ratio (applied as basal or as basal and foliar application) for maximum yield of soybean crop under rainfed situations a field experiment was conducted during *kharif* 2015. The experiment consists of 13 N/P fertilizer ratios and levels. 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}). At 30 and 60 DAS, the treatment receiving N/P fertilizer ratio of 0.70 produced taller plants (24.55 and 64.67 cm) as compared to control (20.01 and 55.93 cm) and potassium level alone (21.59 and 58.63 cm) respectively. At 60 DAS, the treatment receiving N/P fertilizer ratio of 0.70 recorded higher leaf area plant^{-1} (12.62 dm^2 plant^{-1}) as compared to control (6.82 dm^2 plant^{-1}) and potassium level alone (6.96 dm^2 plant^{-1}). The balance after the harvest of soybean was the highest (164.23 kg ha^{-1}) in treatment T4 receiving, while the lowest (88.07 kg ha^{-1}) balance was observed in treatment T5 *i.e.*N/P ratio of 0.70. However, the apparent gain or loss in the available nitrogen was to extent of 188.26 kg ha^{-1} in treatment T5 receiving N/P ratio of 0.70. The maximum uptake of phosphorus (27.93 kg ha^5) was observed in treatment T6 receiving N/P ratio of 0.70. The expected phosphorus balance after the harvest of soybean was highest (91.33 kg ha^{-1}) in treatment T3.

Keywords: Soyabean, Nutrient balance, N/P ratio, Rainfed

Introduction

Soybean (*Glycine max* [L.] Merr.) is becoming increasingly popular as one of the most important legumes grown in most tropical countries because of its high nutritive value (Singh *et al.,* 2003) and its contribution to soil fertility improvement through biological nitrogen fixation (Carsky *et al.,* 2001) [1]. The approximate composition of soybean is 40-45% protein, 18-20% edible oil, 24-26% carbohydrate and a good amount of vitamins (Kaul and Das, 1986). In spite of its high yielding potential (4.5 tonne/ ha), soybean productivity is quite low in India (0.95 tonne/ha) in comparison to world average (2.3 tonne/ha)

The principal factors responsible for low productivity are inadequate fertiliser use, multiple nutrient deficiencies and unbalance use of fertilizers. (Chaturvedi *et al*., 2010) [2]. Among the essential nutrients, macro-nutrients such as nitrogen, phosphorus and potassium play a crucial role in improving plant growth and yield. Although, additions of small nitrogen fertilizer to the soil enhance nodulation in legumes, it is well known that the development of nodules and nitrogen fixation activity of root nodules is depressed when the plants are exposed to high concentrations of nitrogen. The mineral N supply may be a critical factor for soybean during reproductive stage. This high N demand during the pod development and seed maturity/ripening stages might be met by applying N after flowering. Basal application of entire quantity of recommended dose of N fertilizer (40 to 80 kg N ha^{-1}) not only reduces the symbiotic N fixation but also results in its leaching losses. Further, supplementing N through foliar application particularly under the situations of either moisture deficit situations or excessive moisture situations found beneficial in increasing the yields of soybean with higher nutrient use efficiency (NUE).

▽¤楸Ĥ擢㶕_‼ ㄚrved that continuous use of phosphatic fertilizers in the field crop production has lead to increase in the phosphorus status in the soils. Since soybean is a legume, there is possibility of reducing fertilizer requirements when suitable strains of *rhizobium* and phosphate solubilising microorganism culture are used. This also reduces the cost towards the phosphorus fertilizers. Nitrogen and phosphorus (rates and mode of application) determine plant reproductive efficiency and play a vital role in growth and development of soybean crop. Higher yields of soybean can be realized in soils with medium to higher P status under rainfed farming situations with application of nitrogen and phosphorus fertilizers in optimum ratio.

Therefore, it is imperative to find out the optimum N/P ratio (applied as basal or as basal and foliar application) for maximum yield of soybean crop under rainfed situations.

Material 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 medium black 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 and FYM@ 10 t ha^{-1} was added 15 days before sowing. The seed treatment was done with *Rhizobium* (SB 21) and PSB @ 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.

Leaf area was measured by disc method as suggested by Vivekanandan *et al.* (1972) [7]. 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.

Results and discussions

Application of different ratios and levels of nitrogen and phosphorus fertilizers and foliar application of N fertilizer through urea had significant effect on plant height, stem girth, number of branches per plant and leaf area of soybean at 30, 60 days after sowing (DAS). The plant height tended to increase as the crop growth advanced. At 30 and 60 DAS, the treatment receiving N/P fertilizer ratio of 0.70 produced taller plants (24.55 and 64.67 cm) as compared to control (20.01 and 55.93 cm) and potassium level alone (21.59 and 58.63 cm) respectively.

Effect of different ratios and levels of nitrogen and phosphorus fertilizers and foliar application of N fertilizer through urea had significant effect on number of branches $plant^{-1}$ of soybean at 30 and 60 DAS. At harvest, the treatment receiving N/P fertilizer ratio of 0.70 produced more number of branches $plant^{-1}$ as compared to control and potassium level alone. At 30 and 60 DAS the treatment receiving N/P fertilizer ratio of 0.70 also produced significantly more number of leaves $plant^{-1}$ (5.3 and 5.87) as compared to control (5.53 and 10.67) and potassium level alone (3.8 and 4.33). However it was on par with all other treatments. Plant spread of soybean was not significantly influenced by different N/P fertilizer ratios at both 30 and 60 DAS. These observations are in accordance to the findings of Shinde *et al*., 2015 [8] and Yan *et al*., 2015 [6]. Shinde *et al.* (2015) [8] in Lathur opined that application of 100 % RDF produced significantly higher plant height (57.09 cm), number of branches $plant^{-1}$ (5.83), leaf area $plant^{-1}$ (12.11 dm^2) and dry matter accumulation $plant^{-1}$ (33.32 g) at harvest in soybean followed by application of 75 % RDF and 50 % RDF.

The effect of different ratios and levels of nitrogen and phosphorus fertilizers and foliar application of N fertilizer through urea had significant effect on leaf area $plant^{-1}$ of soybean at 60 DAS. At 60 DAS, the treatment receiving N/P fertilizer ratio of 0.70 recorded higher leaf area $plant^{-1}$ (12.62 dm^2 $plant^{-1}$) as compared to control (6.82 dm^2 $plant^{-1}$) and potassium level alone (6.96 dm^2 $plant^{-1}$). However there was no significant effect of leaf area at 30 DAS where as higher leaf area $plant^{-1}$ (4.31 dm^2 $plant^{-1}$) was observed with N/P ratio of 0.70 compared to control (3.18 dm^2 $plant^{-1}$). 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 leaves of the plant are normally main organs of photosynthesis. So higher leaf area-index coupled with vigorous vegetative growth at higher fertility levels might be responsible for higher dry matter production. These findings are well supported by Lone *et al.* (2009) [9] and Begum *et al.* (2015) [10].

The available N in soil varied from 191.67 to 276.33 kg/ha indicating that the soil was low to medium in available N content. The maximum N (276.33 kg ha^{-1}) was observed in treatment T5 receiving N/P ratio of 0.70. The highest available P (35.44 kg ha^5) was found in treatment T5 receiving N/P ratio of 0.70. The lowest value of P was found in treatment T1 *i.e.* control. The higher available phosphorus in treatment may be due to the phosphate solubilizing bacteria (PSB) which increases the availability of P in the soil. Similar results were recorded by Varalakshmi *et al.* (2005) [3] and Singh *et al.* (2007) [4].

The balance after the harvest of soybean was the highest (164.23 kg ha^{-1}) in treatment T4 receiving, while the lowest (88.07 kg ha^{-1}) balance was observed in treatment T5 *i.e.*N/P ratio of 0.70. However, the apparent gain or loss in the available nitrogen was to extent of 188.26 kg ha^{-1} in treatment T5 receiving N/P ratio of 0.70,while lowest (39.04 kg ha^{-1}) apparent gain was observed in control. These results are in conformity with the findings of Ravankar *et al.* (1998) [5] who also observed that the application of nitrogen to legumes improved the fertility status of soil.

The results pertaining to the balance of available phosphorus in soil are presented in Table 3. The initial available phosphorus in soil was 28.3 kg ha^{-1}. The maximum uptake of phosphorus (27.93 kg ha^{5}) was observed in treatment T6 receiving N/P ratio of 0.70. The expected phosphorus balance after the harvest of soybean was highest (91.33 kg ha^{-1}) in treatment T3, while lowest (12.9 kg ha^{-1}) expected balance was observed in control treatment (T2). The data in respect of apparent gain or loss of phosphorus revealed that there was gain of 7.21 kg ha^{-1} phosphorus in N/P ratio of 0.70 and the apparent loss of phosphorus was highest (-0.48 kg ha^{-1}) in treatment T2 receiving potassium level alone after the harvest of soybean.

Table 1: Effect on growth parameters

Treatments	Plant height (cm)		Stem girth (mm)		No of branches plant^{-1}		No of leaves plant^{-1}		Leaf area dm^2 plant^{-1}	
	At 30 DAS	At 60 DAS	At 30 DAS	At 60 DAS	At 30 DAS	At 60 DAS	At 30 DAS	At 60 DAS	At 30 DAS	At 60 DAS
T_1	20.01 c	55.93 d	3.90 e	4.44 c	3.1 f	3.70 g	5.53 d	10.67 d	3.18	6.82 c
T_2	21.59 bc	58.63 c	3.96 de	5.0 bc	3.8 e	4.33 f	5.83cd	12.87 c	3.38	6.96 c
T_3	24.26 ab	61.05 b	4.66 bc	5.67 ab	4.6 bc	5.00 de	6.80 ab	14.13 a-c	4.48	8.58 bc
T_4	24.00 ab	62.15 b	4.85 a-c	5.83 ab	4.7 ab	5.43 b	6.93 ab	14.70 a-c	3.89	10.92 ab
T_5	25.55 a	64.67 a	5.66 a	6.40 a	5.3 a	5.87 a	7.40 a	15.73 a	4.31	12.62 a
T_6	24.67 a	62.05 b	4.49 cd	5.55 a-c	4.9 b	5.40 bc	6.30 b-d	14.93 ab	4.13	8.51 bc
T_7	23.92 ab	62.65 ab	5.14 ab	6.21 ab	4.6 bc	5.07 c-e	6.87 ab	14.60 a-c	3.88	8.86 bc
T_8	23.77 ab	61.05 b	4.88 a-c	6.00 ab	4.7 bc	5.27 b-d	6.73 ab	13.70 bc	3.79	10.45 ab
T_9	23.19 ab	61.43b	4.75 bc	5.83 ab	4.4 cd	4.93 de	6.73 a-c	13.77 bc	3.88	10.93 ab
T_{10}	23.92 ab	61.11 b	4.55 bc	5.65 ab	4.6 bc	5.00de	6.47 bc	14.67 a-c	4.15	10.19 a-c
T_{11}	22.96 ab	60.95 b	4.39 c-e	6.24 ab	4.2 d	4.80e	6.23 b-d	13.47 bc	3.72	7.67 bc
T_{12}	23.34 ab	62.45 ab	4.71 a-c	6.34 a	4.9 b	5.47b	6.30 b-d	15.10 ab	4.11	10.12 a-c
T_{13}	24.87 a	62.33 ab	4.45 bc	5.91 ab	4.6 bc	5.20 b-d	6.37 bc	13.73 bc	4.24	8.95 bc
S.Em±	0.88	0.76	0.17	0.37	0.12	0.11	0.25	0.56	0.09	0.34
LSD(p=0.05)	2.729	2.341	0.539	1.15	0.359	0.337	0.764	1.741	NS	1.045

Table 2: Effect on nitrogen balance sheet after harvest of soybean.

Treatments	Initial fertility status (kg/ha) A	N added B	Nutrient uptake kg/ha C	Expected balance kg/ha D=(A+B)-C	Actual fertility after harvest kg/ha E	Apparent gain or loss kg/ha F= E-D	Actual gain or loss kg/ha G= E-A
T_1	301.46	0	148.83	152.53	191.67	39.04	-262.42
T_2	301.46	0	166.65	134.81	204.77	69.96	-231.5
T_3	301.46	40	177.23	164.23	235.93	71.7	-229.76
T_4	301.46	40	210.14	131.32	248.77	117.15	-184.31
T_5	301.46	32	245.39	88.07	276.33	188.26	-113.2
T_6	301.46	32	228.51	105.25	248.27	143.02	-158.44
T_7	301.46	32	218.34	115.12	238.39	123.81	-177.65
T_8	301.46	40	203.26	138.2	266.93	128.73	-172.73
T_9	301.46	40	209.38	132.08	253.87	121.79	-179.67
T_{10}	301.46	40	221.61	119.85	245.47	125.62	-175.84
T_{11}	301.46	54	195.68	159.78	250.27	90.49	-210.97
T_{12}	301.46	54	238.16	117.3	258	140.7	-160.76
T_{13}	301.46	54	231.43	124.03	246.93	122.7	-178.56

Table 3: Effect on nitrogen balance sheet after harvest of soybean.

Treatments	Initial fertility status (kg/ha) A	P added B	Nutrient uptake kg/ha C	Expected balance kg/ha D=(A+B)-C	Actual fertility after harvest kg/ha E	Apparent gain or loss kg/ha F= E-D	Actual gain or loss kg/ha G= E-A
T_1	28.23	0	12.93	15.3	27.84	12.54	-0.39
T_2	28.23	0	15.33	12.9	27.75	14.85	-0.48
T_3	28.23	80	16.34	91.89	35.24	-56.65	7.01
T_4	28.23	80	19.74	88.49	33.95	-54.54	5.72
T_5	28.23	46	27.93	46.3	35.44	-10.86	7.21
T_6	28.23	69	24.78	72.45	35.25	-37.2	7.02
T_7	28.23	80	23.16	85.07	34.48	-50.59	6.25
T_8	28.23	46	23.46	50.77	32.08	-18.68	3.86
T_9	28.23	69	23.84	73.39	29.19	-44.2	0.96
T_{10}	28.23	80	24.54	83.69	32.98	-50.71	4.75
T_{11}	28.23	46	21.39	52.84	32.61	-20.23	4.38
T_{12}	28.23	69	26.2	71.03	31.83	-39.2	3.6
T_{13}	28.23	80	25.52	82.71	31.35	-51.36	3.12

References

1. Carsky RJ, Singh BB, Oyewole R. Contribution of early–season cowpea to late season maize the savanna zone of West Africa. Biol. Agric. Hort. 2001; 18:303-315.
2. Chaturvedi S, Chandel AS, Dhyani AS, Singh AP. Productivity, profitability and quality of soybean

(*Glycine max*) and residual soil fertility as influenced by integrated nutrient management. Indian J. Agron. 2010; 55(2): 133-7.
3. Varalakshmi LR, Srinivasamurthy CA, Bhaskar S. Effect of integrated use of organic manures and inorganic fertilizers on organic carbon, available N, P and K in sustaining productivity of groundnut-fingermillet cropping system. J. Indian Soc. Soil Sci. 2005; 53(3):315-318.
4. Singh SR, Nasar GR, Singh U. Productivity and nutrient uptake of soybean (*Glycine max.*) as influenced by bioinoculant and farm yard manure under rainfed condition. Indian J. Agron. 2007; 52(4):325-329.
5. Ravankar HN, Puranik RB, Deshmukh PW. Soil fertility management with legume-wheat sequence. PKV Res. J. 1998; 22(1):15-18.
6. Yan CJ, Song SH, Wang WB, Miao SJ, Cao YQ, Wang CL *et al*. Impacts of fertilization on photosynthesis, growth and yield of two soybean cultivars (*Glycine max*) in Northeast China. Legume Res. 2015; 38(1):77-84.
7. Vivekanandan AS, Gunasena HPM, Sivanayagam T. Statistical evaluation of the accuracy of three techniques used in the estimation of leaf area of crop plants. Indian J. Agric. Sci. 1972; 42:857-860.
8. Shinde RN, Karanjikar PN, Gokhale DN. Effect of different levels fertilizer and micronutrients on growth, yield and quality of soybean. J. Crop Weed. 2015; 11(1):213-215.
9. Lone BA, Hasan B, Ansar S, Khanday BA. 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. 2009; 4(3):7-10.
10. Begum A, Islam A, Ahmed QM, Islam MA, Rahman MM. Effect of nitrogen and phosphorus on the growth and yield performance of soybean. *Res*. Agric. Livest. Fish. 2015; 2(1):35-42.