EFFECT OF DIFFERENT DOSES OF NPK ON TARGETED YIELD AND QUALITY OF SOYBEAN

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Received-14.08.2015, Revised-21.08.2015

Abstract: A field experiment was conducted during kharif season on fine montmorillonitic, Hyperthermic, family of Typic Haplustert soil at research farm of the Soil Science Department, JNKVV, Jabalpur. In order to study the effects of different doses of NPK on targeted yield and quality of soybean, based on targeted yield was laidout in randomized block design with five treatments consisted of T_1= control, T_2= GRD (20.60.20), T_3= Targeted Yield (25 qha^{-1}), T_4= Targeted Yield (30 qha^{-1}) and T_5= Targeted Yield (35 qha^{-1}). The soil of experimental field was normal in soil reaction (pH 7.72), EC (0.305 dSm^{-1}) and 0.49 % OC with low in available N, medium in P, K, and S having 124, 12, 370 and 11.45 kgha^{-1} respectively. The results indicated that different doses of fertilizers based on targeted yield affected the yield of soybean significantly over control and general recommended doses (GRD) of fertilizer for various set targeted yield. The highest yield of seed and Stover were recorded in treatment T_5 having 31.35 and 61.48 q ha^{-1} respectively. Also, the highest nutrient content of NPK were 2.78, 0.17 and 0.78 percent at 30 DAS respectively. The analyzed quality of soybean such as oil and protein content was highest in T_4 i.e. 19.45 and 42.93 per cent, respectively. It was reckoned that for set of target yield based on soil test value, use of NPK fertilizers can be best practice for nutrient buildup and assimilation of higher seed protein and oil content. The targeted yield was increased by 32.25 percent over control. The available nitrogen, phosphorous and potash were found to increase with respect to initial status.

Keywords: Fertilizer, Soybean, Seed yield, Oil, Protein content

INTRODUCTION

Soil is an important medium for plant growth supplying nutrients and moisture to crops in addition to providing mechanical anchorage. The importance of fertilizer nutrients are well recognized for enhancing crop yields. Balanced nutrition considers having all the essential nutrients available to the plant in adequate amounts. Although, the entire range of essential nutrients is involved in balanced nutrition generally the emphasis is being made on proper balance among N, P and K. The use of chemical fertilizer may be helpful in increasing crop productivity and soil health. It is essential that the nutrient demand of a crop to produce a target yield and the amount removed from soil may be replaced sooner or later. Nutritional management is one of the important constraints identified for restricting soybean yield (Bhist and Chandel 1996) and its sustainability (Abrol and Palaniappan 1998) through nutritional management has been reported apart limitations offered by major nutrients, correction of deficiency of sulphur (S) and (Zn) in soils of Madhya Pradesh is of equal importance (Tondon 1991).Targeted yield based on soil test is now being adopted by the farming community as this practices leads to balanced use of fertilizer for better crop yield and sustainable soil health.

METHOD AND MATERIAL

The present investigation entitled "Effect of different doses of NPK on targeted yield and quality of Soybean [Glycine max (L) Merill]". was carried out during (Kharif) season of 2011 at the Research Farm of Jawaharlal Nehru Krishi Vishwa Vidyalaya , Jabalpur (India). With five treatments consisting of T_1: control ; T_2: GRD (20:60:20 NPK kg ha^{-1}); T_3: (51:73:10 NPK kg ha^{-1}); T_4: (77:99:20 NPK kg ha^{-1}); and T_5: (103:125:40 NPK kg ha^{-1}).The soil of experimental field was clayey with average values of soil pH (7.72), EC 0.305 d Sm^{-1}), OC (4.90 g kg^{-1}), available N (124.44 kg ha^{-1}), P (12.00 kg ha^{-1}) and K (370.30 kg ha^{-1}), respectively. At harvest, soil and plant samples were collected, air dried then plant samples was oven dried and then both samples were processed. The chemical analysis of the plant sample was carried out by wet digesting with HNO_3:$HClO_4$ (4:1) di-acid mixture as per the procedure outlined by (Jackson, 1973) and to determine concentrations of N, P and K at harvest using procedure described by (Jackson, 1973). The seed and stover yield of soybean were collected of each plot after harvesting. The soil samples were analyzed for pH using 1:2.5 soil: water suspension, electrical conductivity by conductivity meter (Jackson, 1973), organic carbon by rapid titration method (Walkley and Black, 1934). Available N estimated by alkaline permanganate method (Subbiah and Asija, 1956), available P by Olsen's method (Olsen *et al.* 1954), available K by ammonium acetate extraction method (Jackson, 1967). The analysis of variance was carried out using the randomized block design (Gomez and Gomaz, 1984).

Fertilizer adjustment equation (FAEs)

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Soybean

FN = 5.19 T - 0.48 SN

FP_2O_5 = 5.20 T - 4.10 SP

FK_2O = 3.90 T - 0.22 SK

RESULT AND DISCUSSION

Seed and stover yields

The data on seed and Stover yields of soybean are presented in Table 1 indicated that seed and Stover yields of soybean under various treatments were found significantly higher over control. Higher targeted yield of 35 q ha^{-1} by T_5 could not be achieved and deviated by ±10.43 % negatively, whereas, the target of 25 q ha^{-1} was obtained comfortably. The treatment T_5 target could not be achieved. However; it resulted significantly superior over rest of the treatments. The yield increased over control by 32.25 percent and over GRD by 15.79 percent, respectively. The effect of treatments on Stover yield also followed the similar trend as that of seed yield. It was attributed in the target yield with balanced fertilization augmented high yield. These result confirms with the results reported by Mishra and Vyas (1992); Warade *et.al.* (1992); Bhosle *et al.*, (1995) and Pandya *et al.* (2005). The overall increase in yield due to treatments either GRD or soil test based fertilizer alone have markedly augmented yield of soybean attributed to optimum available of nutrient for plant growth.

Table 1. Effects of different treatments on seed and Stover yields of soybean.

Treatment	Soybean yield (q ha^{-1})	
	Seed yield (q ha^{-1})	Stover yield (q ha^{-1})
T1: Control (No fertilizer)	21.24	37.64
T2: GRD(20-60-20 NPK Kgha-1)	26.40	48.39
T3: TY 25qha-1 (51-73-10 NPK Kgha-1)	27.90	52.23
T4:TY 30qha-1 (77-99-20NPK, Kgha-1)	29.75	57.21
T5:TY35qha-1 (103-125-40 NPK Kgha-1)	31.35	61.48
S Em ±	**1.05**	**2.14**
CD *(p = 0.05)*	**3.22**	**6.58**

Effect of treatments on primary available nutrients (N, P and K) in soil.

Data on primary available nutrients as affected by different treatment at different stages are presented in Table 2. The data indicated that various treatments varied significantly with nutrient content. The nitrogen content increased with increasing levels of N at 30 DAS and gained at 45 DAS being increased to 213 Kgha-1but decreased at higher dose of NPK with higher targeted, but at 60 DAS and at harvest it depleted.

The nitrogen content was recorded significantly superior over control having 263.42 and 250.88 $kgha^{-1}$ under treatment T_5 (T.Y. 35 q ha^{-1}) at 30 and 45 DAS whereas 188.16 and 175 $kgha^{-1}$ in T_2 at 60 DAS and at harvest was recorded. However, there was decrease in the content which may be attributed the demand of nitrogen was more for grain setting.

The phosphorous concentration also followed the similar trend as that of nitrogen. Comparatively P was higher at 30 DAS at higher dose and decreased with advancement in growth up to harvest. The variation in the P content differed significantly with respect to treatments but there was no much difference noticed with growth stages but was very meager decrease was recorded by 1Kg from 30 days to the harvest stage. The decrease was observed at higher doses of fertilizer up to 7 $Kgha^{-1}$ which can be attributed to the fact that P was mostly required for seed development.

Data on potassium content as affected by different treatments at different stages (30, 45, 60 DAS at harvest) are presented in Table 2.The data revealed that potassium content was comparatively higher having 435 $Kgha^{-1}$ with higher target T_5 at 30 DAS as compared to 45 and 60 DAS and harvest. The potassium content was recorded significantly superior as compared to control at all the growth stages. Similar results have been reported by Dubey and Shrivastava (1991). Tiwari *et al (*2002) Sharma and Vikas (2007). Similarly Singh at el. (2012) and Swarup and Rao (1999) also reported that the available N status could only be maintained through integration of fertilizer and manure for increasing the nutrients use efficiency of N over imbalance fertilizer use. On the other hand appreciable, build up was recorded when fertilizer addition raised from optimal to super optimal dose. Similarly, a considerable higher amount of available P was accumulated when NPK fertilizer was applied with FYM. The findings reported by Swarup and Yaduvanshi (2000) and Dwivedi et al. (2007) are also in agreement with the present investigation. These results are agreement with the findings of Bharadwaj et al.

(1984) and Mandal et al., (1991) who have also observed similar effects on available K status of soil arising out of application of either NP or N alone.

Table 2. Effect of treatments on the available nutrient content in soil

Treatments	Available Primary Nutrients (kg ha^{-1})											
	30 DAS			45 DAS			60 DAS			At harvest		
	N	P	K	N	P	K	N	P	K	N	P	K
T1:Control (No fertilizer)	137.98	10.75	370.45	213.25	9.88	358.32	188.16	9.15	351.87	175.62	8.15	337.48
T2:GRD(20-60-20 NPK Kgha-1)	175.62	12.27	383.15	238.34	10.7	374.1	213.25	10.1	364.73	188.16	8.65	345.52
T3: TY 25qha-1 (51-73-10 NPK Kgha-1)	200.7	12.68	398.2	225.79	11.21	381.96	200.7	10.55	350.41	175.62	7.8	320.27
T4:TY 30qha-1 (77-99-20NPK, Kgha-1)	238.34	13.36	421.53	238.34	11.78	398.4	188.16	10.9	331.67	150.53	7.1	301.78
T5:TY35qha-1 (103-125-40 NPK Kgha-1)	263.42	13.78	435.4	250.88	12.16	409.33	175.62	11.17	314.55	125.44	6.3	288.56
S Em ±	3.17	0.2	6.65	3.56	0.174	6.12	3.01	0.162	5.34	2.44	0.114	4.86
CD *(p = 0.05)*	9.75	0.616	20.49	10.97	0.535	18.84	9.27	0.498	16.45	7.5	0.35	14.98

Oil and protein content in seed

Data presented in Table 3 indicated that oil content of soybean was higher in T4 (T.Y. 30 $qha^{-1)}$ there after it declined at higher dose of inorganic fertilizers. Various treatments showed significant influence on oil content of soybean. Maximum oil content in seed (19.45 %) was obtained in treatment T_4, having targeted yield of 30 qha^{-1} which was significantly superior over rest of the treatments except T_5 (T.Y. 35 qha^{-1}) and T_3(T.Y. 25 qha^{-1}).

Data on protein content of grain as affected by different treatment are presented in Table 3.The protein content was comparatively higher in T_4 (T.Y. 30qha^{-1})as compared to rest of the treatments.The different treatment enhanced the protein content significantly. Data on protein content was obtained significantly superior (42.93%) in T_4 (T.Y. 30qha^{-1}) as compared to T_5 (T.Y. 35 q ha^{-1}), that was statistically at par with rest of the treatments. The protein content was observed to increased over T1 (control) by T5, having higher targeted yield of 35 qha^{-1} supplemented with higher dose of fertilizer. Oil and protein (19.45 and 42.93 %) was higher recorded under in T4 (T.Y. 30qha^{-1}). Protein and oil is the major constituent contributing to the quality of any crop. The supply of balance nutrient to the growing plant influenced the protein and oil metabolism .As the supply of nutrient decreases the reduction of the plant-synthesis exhibited under such condition. Protein and oil synthesis initially checked has been estimated by El-Essawai and Abadi (1990), who indicated that seed oil and protein yield of soybean increased with balance application of NPK.

Table 3. Effect of treatments on oil and protein content in soybean Seed

Treatment	Soybean oil and protein	
	Oil	Protein
T_1: Control (No fertilizer)	17.83	40.56
T_2: GRD (20-60-20 NPK $^{Kgha-1}$)	18.10	41.18
T_3: TY 25qha^{-1} (51-73-10 NPK Kgha-1)	18.60	41.43
T_4:TY 30qha^{-1} (77-99-20NPK, Kgha-1)	19.45	42.93
T_5:TY35qha^{-1} (103-125-40 NPK Kgha-1)	18.78	41.68
S Em ±	**0.289**	**0.632**
CD *(p = 0.05)*	**0.890**	**1.95**

Table 4. Manurial scheduling for Soybean

Treatments	Nutrient applied (kg ha^{-1})		
	N	P_2O_5	K_2O
Control	0	0	0
GRD	20	60	20
T.Y. 25 q ha^{-1}	51	73	10
T.Y. 30 q ha^{-1}	77	99	20
T.Y. 35q ha^{-1}	103	125	40

REFERENCES

Abrol, I.P. and Palaniappan, S.P.(1998). Green manure crops in irrigated and rainfed low land rice based cropping system in south Asia (In) Green manure in rice farming, International Rice Research institute Philippines pp. 71-82.

Bhardwaj, V. P.K, Omanwar, R.A. and Singh, V.N.(1984). Effect of intensive and continuous cropping and fertilization on the crop yields and nutrients uptake (Abstract). Proc. seminar on soil P resources and productivity management held at IARI, New Delhi from 7-10 December during 49th Annual convention of Indian Society of Soil Science

Bhosle, J.K, Joshi, T.R. and Chandel, A.S.(1995). Effect of integrated fertilizer management on yield and quality of soybean [*Glycine max* (L) Merill] biomass. *Annals Agric. Res.,* Vol.17 (4): 425-428

Bisht, J.K. and Chandel, A.S.(1996). Effect of integrated nutrient management on yield attributes, yield and quality of soybean. *Annals Agric. Res.* 17(4):360-365

Dubey, S.K. and Shrivastava, S.K. (1991). Response of soybean of microbial inoculants. Bhartiya Krishi Anusandhan Patrika. 6(4): 202-206

Dwivedi, A.K, Singh, M. Kauraw,D.L, Wanjari, R.H. and Chauhan, S.S.(2007). Research bulletin on impact of fertilizer and manure use for three decades on crop productivity and sustainability and soil quality under Soybean-Wheat system on a Vertisol in Central India. *IISS (*ICAR), Bhopal pp. 224-235

ELEssawai ,T.M. and Abadi, D.(1990). Quality and yield of soybean seeds as affected of inoculation,NPK fertilization and soil fertility. Arid Soil Res. Rehabilitation. 4:43-51

Gomez, K. A. and Gomez, A. A. (1984). Statistical procedure for agricultural research IInd edition. J. Wiley and sons, New York. Inc. p. 680

Jackson, M. L. (1967). Soil Chemical Analysis, Prentice Hall of India Pvt. Ltd, New Delhi

Jackson, M. L. (1973). Soil chemical analysis Prentice Hall of India Ltd. New Delhi. pp. 219-221.

Mandal ,B.C, Saha, M.N. and Adhikari ,M.(1991). Yield of rice and nutrient status of soil due to continuous cropping and manuring in a Jute- Rice-Wheat sequence on Indo- Gangetic Alluvial Soil. J Indian Soc. Soil Sci. 39(4): 689-692

Mishra, C.M. and Vyas, M.D. (1992). Response of Soybean [Glycine max (L) Merill] varieties to fertilizer application in tribal area of Madhya Pradesh. *Indian J. Agron*.37(2): 368-370.

Olsen, S.R, Cole, C.V, Watanabe, F.S. and Dean, L.A. (1954). Estimation of available P in soil by extraction with $NaHCO_3$.USDA, Cir.939

Pandya, N, Chouhan, G.S. and. Nepalia, V. (2005). Effect of varieties crop geometric and weed management on nutrient uptake by soybean [Glycine max (L) Merill] and associated weeds. *Indian J. Agron*.Vol. 50(3): 218-220

Sharma,V. and Vikas, A.(2007). Effect of phosphorous and zinc application on yield and uptake of P and Zn by chickpea under rainfed conditions. *Journal of food legumes*, 20(1): 49-51

Singh Muneshwar, Wanjari ,R.H, Anil Dwivedi and Dalal Ram.(2012). Yield Response to Applied Nutrients and Estimates of N_2 Fixation in 33 Year Old Soybean–Wheat Experiment on a Vertisol. Expl Agric. 48 (3): 311–325

Subbiah, B.V. and Asiija, E. C. (1956) . A rapid procedure for estimation of available nitrogen in soil. Current Science 25(8): 259-260.

Swarup, A. and Rao ,C.S ,(1999) .Current status of crop sponsored to fertilizersin different agro climatic zones. Experience of AICRP on long-term fertilizer experiments. Special issue on current status of crop response ot fertilizers in different agro-climatic zonal. Ferti. News. 44:27-30.

Swarup, A. and Yaduvanshi ,N.P.S.(2000) .Effect of Integrated Nutrient Management on soil properties and yield of rice in alkali soil. J. Indian Soc. Soil Sci. 48:279-282.

Tandon, HLS.(1991). Secondary and micronutrients in agriculture, pp25, Fertilizer development and consultation organization, New Delhi

Tiwari, K.N. (2002). Nutrient management for sustainable agriculture. *Journal of the Indian Society of Soil Science* Vol. 50: 374-397.

Vyas A.K, Billore, S.D, Joshi, O.P and Pachlania, N.K.. (2007). Influence of balanced nutrition on productivity of soybean. Soybean Res., Vol. 5: 21-25.

Walkley, A. and Black, I .A. (1934). Estimation of soil organic carbon by the chromic acid titration method. *Soil Science*. 47: 29-38

Warade, L.K., Solanki, B.O., Patil ,M.N. and Khot M.A. (1992). Effect of Nitrogen and Phosphorous on yield and protein of soybean. *J. Soils. Crops***,** Vol.2 (1): 26-28.