Original Research Article

Influence of organic and Inorganic Nutrient sources on yield and uptake of Major Nutrients in Soybean

Abstract

A Field experiment was conducted to study the effect of different organic sources of nitrogen with inorganic fertilizers on crop yield, yield attributes and uptake of major plant nutrients in soya bean-maize cropping system. Highest soybean yield of $12.9qt^{-1}$ was obtained with the application of 75% of recommended dose of nitrogen along with 100% recommended dose of P&K through inorganic fertilizers+25% recommended dose of nitrogen through vermi-compost and lowest values of all the parameters were obtained from control treatment . Uptake of N, P&K increased with treatments that received integrated use of organic manures in combination with recommended dose of nutrients.

Key words: Soybean, Organic and inorganic fertilizers ,Yield , uptake nutrient management practices, nutrient uptake, productivity, soil fertility

Introduction

Soybean (*Glycine max*(L) Merrill) is gaining importance as a remunerative crop in different parts of India. It is one of the most important oilseed crop in the world. In crop production, nutrient availability from manure has been recognized for many centuries. Before the introduction of inorganic fertilizers, manure was the primary source of nutrients for crop production. Recently there has been a renewed interest in use of farmyard manure. This interest is attributed to necessity of maintaining sustainable agricultural production while preserving the environment. For better utilization of resources and to produce crops with less expenditure, INM is the best approach. In this approach all the possible source of plant nutrients are applied based on economic consideration and the balance required for the crop is supplemented with chemical fertilizers. The combined use of organic and inorganic sources of plant nutrient not only pushes the production and profitability of field crops, but also it helps in maintaining the permanent fertility status of the soil. It is highly desirable to make massive efforts to adopt organic sources as a source of plant nutrients as well as soil productivity in the developing countries. In India, there is sufficient availability of organic

manures like animal dung manure (791.6 mt), crop residues (603.5 mt), green manure (4.50 m ha), rural compost (148.3 mt), city compost (12.2 mt) and biofertilizer (0.41 mt) (Bhattacharya and Chakraborthy 2005) and these may become a good substitute of chemical fertilizers to maintain the soil physico-chemical and biological properties. The incorporation of organic manures improves the nutrient content and uptake. Although organic manures contain plant nutrients in small quantities as compared to the fertilizer, the presence of growth promoting principles like enzyme and hormones besides plant materials make them essential for improvement of soil fertility and productivity. Integrated use of organic and inorganics through FYM, VC and PM improved the organic carbon and cation exchange capacity. Available N, P_2O5 , K_2O and S status of soil increased significantly with organic sources of nutrients over their initial (Sharma et al. 2001). Pandey et al. (2006) reported that application of manures, irrespective of sources and rates recorded significantly higher soil organic carbon, N, P_2O_5 and K_2O compared to control. Kadam et al. (2010) reported that at harvest of soybean, the soil nutrient status was influenced by the application of organic nitrogen sources along with fulvic acid sprays. This is ascribed to presence of soybean crop which enhances the available N status of soil by nodulation. The soil available N, P_2O_5 and K_2O buildup was higher in all the treatments over initial. Therefore, the study was conducted to find out the suitable combination of organic and inorganic fertilizers in order to obtain better yield and its influence on nutrient uptake in soybean.

Materials and methods

Location and existing soil Nutrient status

The experiment was carried out at crop research form of AAIDU Allahabad. The soil was sandy loam in texture, medium in available N,(165.82 Kg/ha), high in available P_2O_5 (48.06 Kg/ha), fairly rich in available in K (242.20 Kg/ha), with neutral soil reaction (pH 7.38) and was non saline (EC = 0.101 dsm^{-1}).

Experiment Details

The experiment was laid out in completely randomized block design (RCBD), comprising of eight treatments and three replications. As Presented in table 1.

In case of RDF, Nitrogen was applied in two splits in the form of Urea while entire doses of P and K where applied as basal in the form of single supper phosphate and murate of potash, respectively. Soil samples were collected before sowing and after harvesting of crop. After harvesting of soybean crop seed samples were analyised for oil content and NPK uptake with standard procedures (Jackson, 1973). In organic nutrient management practices

- 100% RDN given through 1/3rd FYM, 1/3rd VC and 1/3rd PM, in integrated nutrient management practices -50% RDN given through fertilizers and 50% RDN through 1/3rd FYM, 1/3rd VC and 1/3rd PM and in chemical nutrient management practices -100% recommended chemical fertilizers only were added. These manures were applied based on the nitrogen equivalent basis and nutrient requirement of each crop. Phosphorus requirement of the plants was supplemented through rock phosphate in organic nutrient management practices. The nutrient composition of FYM, Vermi-compost and Poultry manure were 0.5-0.18 -0.53, 1.2-0.70-0.94 and 1.9-0.85-1.02 % N, P and K, respectively. The organic manures according to the treatment details were applied two weeks before sowing of crops for both organic and integrated nutrient management plots. The collected samples were analysed for physical and chemical properties following standard procedures. The data collected from the experimental field and laboratory analysis were subjected to statistical analysis. Standard statistical methods were used (Gomez and Gomez., 1984).

Results

Effect of treatments on Growth and yield Parameters of Soyabean

The number of pods per plant is an important parameter which governs the yield of crop. The number of pods per plant was recorded at 60 DAS. The highest number (72 pods/plant) was recorded in T_7 (75%RDFN through inorganic fertilizers+25%RDFN through VC (4.74kg/ha) treatment at 60 DAS (Table 2 and Fig.1). Increased number of pods [per plant were noticed with the application of vermicompost @ 4.74 q/ha to supply 25% RDFN. Seed weight is an important attribute, which has a direct influence on the yield. The highest thousand seed weight was found in T_7 treatment (Table 2 and Fig 1). The seed yield for different treatments ranged between 8.22 to 12.9 q/ha.T_7 recorded highest seed yield per hectare at 12.9q/ha. It was 56.93% higher than the control. The next best treatment was T_8, i.e., 75% RDFN through inorganic fertilizers + 25% RDFN through PM (244 Kg/ha) (Table 2, Fig 1).

Effect of Treatments on Nutrient Uptake in Soyabean

N uptake by crop was significantly influenced by different treatments. Uptake of crop increased with crop growth and was highest at 75 DAS. The highest N uptake (4.99 Kg/ha) was recorded in T_7 treatment and was followed by T_8 Treatment at 25 DAS. The control recorded lowest uptake of N. the highest N uptake (22.2 Kg/ha) was recorded in T_7 treatment and was followed by T_8 treatment at 50 DAS. The highest N uptake (51.5 Kg/ha) was recorded in T_7 treatment and was followed by (44.8 kg/ha) T_8 treatment at 75DAS (Table 3 and Fig 2).. The highest

P uptake (0.91kg/ha) was recorded in T_7 treatment followed by (0.90kg/ha) T_8 treatment at 25 DAS. The highest P uptake (9.60kg/ha) was recorded in treatment T_7 at 50 DAS. Highest P uptake (16.30kg/ha) recorded in T_7 treatment followed by T_8 treatment (11.70kg/ha) at 75 DAS. The control recorded lowest at all stages (Table 4 and Fig.3. K uptake was estimated at 25DAS, 50DAS and 75 DAS. The highest K uptake (3.65kg/ha) was recorded in T_7 at 25DAS. The highest K uptake of 21.3kg/ha and 45.6kg/ha recorded in T_7 treatment at 50DAS and 75 DAS respectively. Lowest uptake of K at all the stages was recorded in the control treatment. (Table 5 and Fig 4.)

Discussion

Number of pods per plant height of soybean varied significantly with different treatment combinations of inorganic and organic fertilizer (Table 2). The highest number of pods were recorded with the treatment comprising of RDFN and Vermi-Compost . On the other hand, combination of fertilizers applied plots increased 1000 seed weight and over control. These findings are in accordance with the results of Patil and Udmale (2016).Different combinations of inorganic and organic fertilizers showed significant variation for seed yield (Table 2). Result revealed that seed yield increased significantly with inorganic and organic fertilizers combination treatment over control. Among the combinations Treatment T7 showed maximum seed yield followed by T8 than other combinations .This might be due to optimum and continuous supply and availability of nutrients through organic source which help in better uptake of nutrient that ultimately enhancing cell division and thereby increased all the growth attributes. These findings are in accordance with the results of Prasad et al. (2010). . The result revealed that treatment T7, T6 and T4 produced 56.93%, 16.54% and 11.19% higher yield over control (T0). The maximum grain yield might be attributed to maximum dry matter weight per plant , number of pods per plant , seeds per plant and 1000- seed weight. This might be due to adequate supply of nutrient elements at the right time from organic and inorganic sources, which helped in optimum dry matter partitioning from the source to sink during the reproductive stage of Soybean crop consequently increase the seed yield of soybean.Increased nutrient uptake and assimilation by crop plants at the reproductive stage enhanced the thousand seed weight. Similar findings were reported by Maheshbabu et al. (2008). The result corroborates with the findings of Patwary (2003) and Yamika et al. (2012).The uptake of N, P and K by the soybean was influenced by the different integrated nutrient management treatments . The plant height and crop dry matter production might have resulted in higher uptake of nitrogen). Better crop growth conditions favoured the uptake of P. This finding is also supported by Babhulkar et al. (2000) Increased uptake of potassium might be due to better crop dry matter production and crop growth. The present report is

consistent with the findings of Kadam et al. (2010). The higher uptake of N, P and K is attributed to continuous and steady supply of available nutrient throughout crop growth period because application of organic and inorganic inputs.

Conclusion

Due to imminent concerns regarding the affects of inorganic fertilizers and off course the slow returns from organic nutrients amidst a galloping population and retreating land holdings, the combination of organic and inorganic fertilizers is the most sensible agri-input approach. But studies are required in different scenarios at micro levels to determine optimal combination setups of chemical and organic sources in different crops. We cannot have a same yardstick for a crop in all regions. Therefore, this study was taken in Kashmir Valley in Shalimar Soyabean-1 variety to study optimal fertilizer combinations. It was observed that if we replace 25% of recommended dose of chemical fertilizers by 474kg/ha vermi-compost, there is a gain of approximately 39% in grain yield over recommended chemical fertilizer dose in soybean crop.

References

Babhulkar, P.S., Badole, W.P., Balapnde, S.S and Kar, D. 2000. Effect of sulphur and zinc on yield, quality and nutrient uptake by safflower in versitol. *J. Indian Soc. Soil Sci.* 48(3): 541-543.

Bhatacharya, L. S. and Chakraborthy, K. H., 2005, Current status of organic farming. Indian J. Fert., 1(9) : 111-123.

Dikshit, P.R. and Khatik, S.K. 2008. Influence of organic manures in combination with chemical fertilizers on seed yield. *LegumeRes.* 25(1): 53-56.

Das, A., Patel, D. P., Munda, G. C. and Ghosh, D. K., 2010, Effect of organic and inorganic sources of nutrients on yield, nutrient uptake and soil fertility of maize (Zea mays)-mustard (Brassica campestris) cropping systems. Indian J. Agric. Sci., 80(1) : 85-88

Falodun, E.J. and Osaigbovo, A.U. 2010. The effect of packaged organic and inorganic fertilizers on the growth and yield ofsoyabean (*Glycine max*). *African J. Agric*. 25(1): 34-37JACKSON.M.L(2007) Soil Chemical Analysis. Prentice Hall of India, New Delhi.

Kadam, S. R., Amrustsagar, V. M. and Deshpande, A. W., 2010, Influence of organic nitrogen sources with fulvic acid spray on yield and nutrient uptake of soybean on Inceptisol. J. Soils Crops, 20 (1): 58-63.

Maheshbabu, H.M., Hunje, R. and Patil, N.K. 2008. Effect of organic manures on plant growth, seed yield and quality of soybean.*Karnataka J. Agric. Sci.* 21 (2): 219-221.

Prasad, J., Kadamkar, S., Kumar, R. and Mishra, B., 2010, Influence of integrated nutrient management on yield and soil properties in maize-wheat cropping systems in an Alfisol of Jharkhand. J. Indian Soc. Soil Sci., 58 (2) 200-204.

Pandey, A. K., Gopinath, K. A., Bhattacharya, P., Hooda, K. S., Sushil, S. N., Kundu, S., Selvakumar, G. and Gupta, H. S., 2006, Effect of source and rate of organic manures on yield attributes, pod yield and economics of organic garden pea (Pisum sativum) in Northwestern Himalaya. Indian J. Agric. Sci., 76(4) : 230-234.

Patwary, M.O.F. 2003. Effect of sulphur and phosphorus on the yield, yield attributes and quality of soybean cv. Shohag (PB-1).M.S. Thesis. Dept of Agric. Chemistry. Bangladesh Agricultural University, Bangladesh.

Patel, C. K., Chaudhari, P. P., Patel, R. W. and Patel, N. H., 2010, Integrated nutrients management in potato based cropping systems in North Gujarath. Potato J., 37(1-2) : 68-70.

Ramesh, P., Panwar, N. R., Singh, A. B. and Ramana, S., 2008, Effect of organic manures and productivity, nutrient uptake and soil fertility of maize (Zea mays)-linseed (Linum usitatissimum) cropping system. Indian J. Agric. Sci., 78(4) : 35-354.

Sharma, M. P., Balf, S. V. and Gupta, D. K., 2001, Soil fertility and productivity of rice-wheat cropping system in an Inceptisol as influenced by integrated nutrient management. Indian J. Agril. Sci., 71 (2) : 82-86.

Singh A. B., Saha, J. K. and Gosh, P. K., 2008, Effect of nutrient management practices on soybean (Glycine max)-chickpea (Cicer arietinum) cropping systems for improving seed yield, quality and soil biological health under rainfed condition. Indian J. Agric. Sci., 78(6) : 485-489.

Yamika, W.S.D. and Ikawati, K.R. 2012. Combination inorganic and organic fertilizer increased yield production of soybean.*American-Eurasian J. Sustainable Agric.* 6(1): 14-17.

Patil, H.M. and K.B. Udmale. 2016. Response of different organic inputs on growth and yield of Soybean on Inceptisol. Scholarly J. Agril. Sci.6(5): 139-144.

Anonymous, 2016. Ministry of Agriculture Govt. of India. The Soybean Processor Association of India (SOPA).

Falodun, E.J., J.O. Ehigiator. and S.A. Ogedegbe. 2015. Growth and Yield Response of Soyabean (Glycine max Merr.) to Organic and Inorganic Fertilizer in Edo Rainforest of Nigeria. American J. Plant Sci. 6: 3293-3297.

FAO STAT. 2014. Available at http://faostat.fao.org/.

Javed, S. and A. Panwar. 2013. Effect of biofertilizer, vermicompost and chemical fertilizer on different biochemical parameters of Glycine max and Vigna mungo. Recent Res. Sci. Technol.5: 40-44.

Sunilkumar, K., Gowda, A., Nagaraj, R., Veeranagappa, P. Jayaprakash, R. and Patil, S. 2013. Influence of integrated nutrient management on growth, yield, nutrient uptake and economics of vegetable soybean. Intern. J. For. Crop Impro., 4(1): 24-27.

Khaim, S., M.A.H. Chowdhury. and B.K. Saha. 2013. Organic and inorganic fertilization on the yield and quality of soybean. J. Bangladesh Agril. Univ. 11(1): 23-28.

Devi, K. N., Singh, T. B., Athokpam, H. S., Singh, N. B. and Shamurailatpam, D. 2013. Influence of inorganic, biological and organic manures on nodulation and yield of soybean (Glycine max Merril L.) and soil properties. Austra. J. Crop Sci., 7(9):1407-1415.

Sunilkumar, K., Gowda, A., Nagaraj, R., Veeranagappa, P. Jayaprakash, R. and Patil, S. 2013. Influence of integrated nutrient management on growth, yield, nutrient uptake and economics of vegetable soybean. Intern. J. For. Crop Impro., 4(1): 24-27.

Kumawat, N. 2011. Effect ofpigeonpea + blackgram intercropping and integrated nutrition on growth, yield and quality of rainfed pigeonpea [Cajanus cajan (L.) Millsp.]. PhD. Thesis, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi (UP).

Kumawat, N., Sharma, O. P., Kumar, R. and Kumari. A. 2010. Yield and yield attributes of mungbean [Vigna radiata (L.) Wilczek] as affected by organic manures, PSB and phosphorus fertilization. Environ Ecol., 28(1A): 332-335

Thenua, O. V. S., Singh, K. and Shivakumar, B. G. 2010. Studies on Rhizobium inoculation and potassium levels on the performance of soybean (Glycine max L.). Ann. Agric. Res., 31(1):1-4.

Thenua, O. V. S., Singh, K. and Shivakumar, B. G. 2010. Studies on Rhizobium inoculation and potassium levels on the performance of soybean (Glycine max L.). Ann. Agric. Res., 31(1):1-4

Table 1. Experiment details

Treatments	Growth and yield Parameters to be recorded	Nutrient Parameters to be recorded (Kg/ha)
T_1 Control (0:0:0)	Pods/Plant 60DAS, 1000 seed weight (g), Seed yield (q/ha), % yield increase over control	Nitrogen uptake at 25, 50 and 75 Days after Sowing (DAS) each
T_2 RDF(40:50:40)kg/ha		
T_3 50%RDFN through inorganic fertilizers +50%RDFN through FYM[1] (4878kg/ha)		
T_4 50%RDFN through inorganic fertilizers +50%RDFN through VC[2] (948kg/ha)		Phosphorus uptake at 25, 50 and 75 Days after Sowing (DAS) each
T_5 50%RDFN through inorganic fertilizers +50%RDFN through PM[3] (948kg/ha)		Phosphorus uptake at 25, 50 and 75 Days after Sowing (DAS) each
T_6 75%RDFN through inorganic fertilizers +25%RDFN through FYM (2439kg/ha)		
T_7 75%RDFN through inorganic fertilizers +25%RDFN through VC (474kg/ha)		
T_8 75%RDFN through inorganic fertilizers +25%RDFN through PM (244kg/ha)		

Table 2. Effect of treatments on yield, yield attributes of Soybean-Maize cropping system.

Treatments	Pods/Plant 60DAS	1000 seed weight (g)	Seed yield (q/ha)	% increase over control
T_1 Control (0:0:0)	52	124.65	8.22	
T_2 RDF(40:50:40)kg/ha	60	138.28	**9.22**	12.16
T_3 50%RDFN through inorganic fertilizers +50%RDFN through FYM[1] (4878kg/ha)	64	140.86	8.78	6.81
T_4 50%RDFN through inorganic fertilizers +50%RDFN through VC[2] (948kg/ha)	68	143.56	9.14	11.19
T_5 50%RDFN through inorganic fertilizers +50%RDFN through PM[3] (948kg/ha)	66	141.96	8.97	9.12
T_6 75%RDFN through inorganic fertilizers +25%RDFN through FYM (2439kg/ha)	68	148.56	9.58	16.54
T_7 75%RDFN through inorganic fertilizers +25%RDFN through VC (474kg/ha)	72	155.39	**12.9**	56.93
T_8 75%RDFN through inorganic fertilizers +25%RDFN through PM (244kg/ha)	68	152.53	9.68	7.76
CD(p=0.05)	NS	3.78	1.91	

RDFN= Recommended dose of fertilizer nitrogen

Table 3. Effect of treatments on N uptake (kg/ha) by soybean in Soybean-Maize cropping system.

Treatments	25 DAS*	50DAS*	75DAS*
T_1 Control (0:0:0)	4.13	15.6	28.0

T_2 RDF(40:50:40)kg/ha	4.22	16.5	27.2
T 50%RDFN through inorganic fertilizers +50%RDFN through FYM[1] (4878kg/ha)	4.38	16.9	29.2
T_4 50%RDFN through inorganic fertilizers +50%RDFN through VC[2] (948kg/ha)	4.77	18.4	38.3
T_5 50%RDFN through inorganic fertilizers +50%RDFN through PM[3] (948kg/ha)	4.67	17.2	37.4
T_6 75%RDFN through inorganic fertilizers +25%RDFN through FYM (2439kg/ha)	4.75	18.8	41.2
T_7 75%RDFN through inorganic fertilizers +25%RDFN through VC (474kg/ha)	4.99	22.2	51.5
T_8 75%RDFN through inorganic fertilizers +25%RDFN through PM (244kg/ha)	4.89	21.7	44.8
CD(p=0.05)	0.66	0.34	1.89

Table 4. Effect of treatments on P uptake (kg/ha) by soybean in Soybean-Maize cropping system.

Treatments		25 DAS*	50DAS*	75DAS*
Control (0:0:0)	T_1	0.50	3.30	5.96
RDF(40:50:40)kg/ha	T_2	0.51	3.12	6.20

50%RDFN through inorganic fertilizers +50%RDFN through FYM[1] (4878kg/ha) T_3	0.52	5.26	8.06
50%RDFN through inorganic fertilizers +50%RDFN through VC[2] (948kg/ha) T_4	0.55	5.31	10.60
50%RDFN through inorganic fertilizers +50%RDFN through PM[3] (948kg/ha) T_5	0.55	5.30	8.18
75%RDFN through inorganic fertilizers +25%RDFN through FYM (2439kg/ha) T_6	0.57	5.50	11.20
75%RDFN through inorganic fertilizers +25%RDFN through VC (474kg/ha) T_7	0.91	9.60	16.30
75%RDFN through inorganic fertilizers +25%RDFN through PM (244kg/ha) T_8	0.90	7.73	11.70
CD(p=0.05)	0.01	0.11	0.23

Table 5. Effect of treatments on K uptake (kg/ha) by soybean in Soybean-Maize cropping system.

Treatments	25 DAS*	50DAS*	75DAS*
T_1 Control (0:0:0)	2.02	15.0	23.7
T_2 RDF(40:50:40)kg/ha	2.11	15.3	24.8
T_3 50%RDFN through inorganic fertilizers +50%RDFN through FYM[1] (4878kg/ha)	2.24	16.9	25.9
T_4 50%RDFN through inorganic fertilizers +50%RDFN through VC[2] (948kg/ha)	2.74	17.7	33.6

T_5 50%RDFN through inorganic fertilizers +50%RDFN through PM[3] (948kg/ha)	2.52	17.5	26.5
T_6 75%RDFN through inorganic fertilizers +25%RDFN through FYM (2439kg/ha)	3.04	18.7	35.5
T_7 75%RDFN through inorganic fertilizers +25%RDFN through VC (474kg/ha)	3.65	21.3	45.6
T_8 75%RDFN through inorganic fertilizers +25%RDFN through PM (244kg/ha)	3.21	21.0	45.2
CD(p=0.05)	0.05	0.61	0.90

Fig. 1. Graphical representation of effect of treatments on yield, yield attributes of Soybean-Maize cropping system.

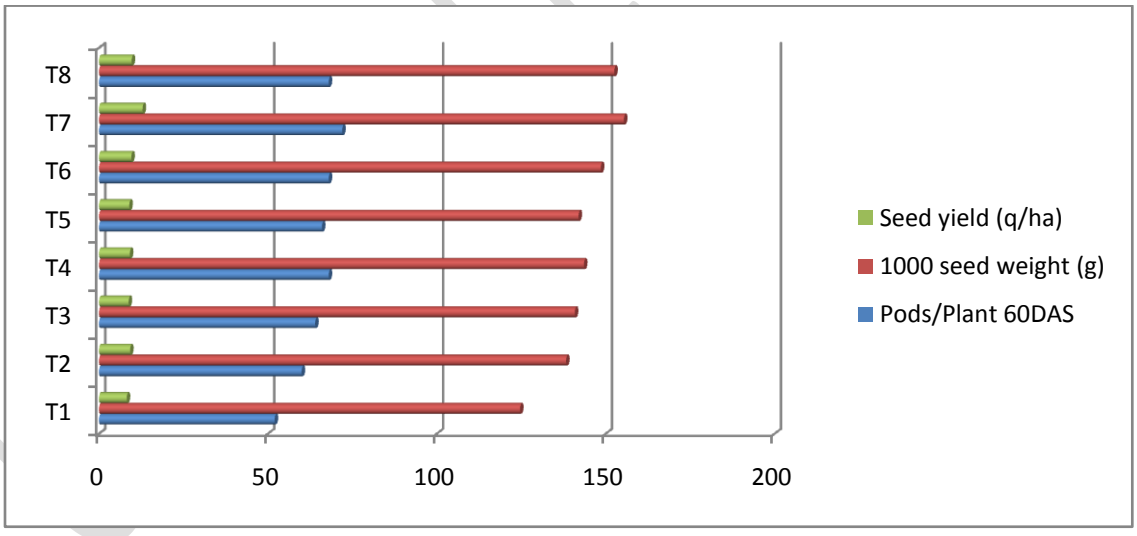

Fig 2. Graphical representation of effect of treatments on N uptake (kg/ha) by soybean in Soybean-Maize cropping system.

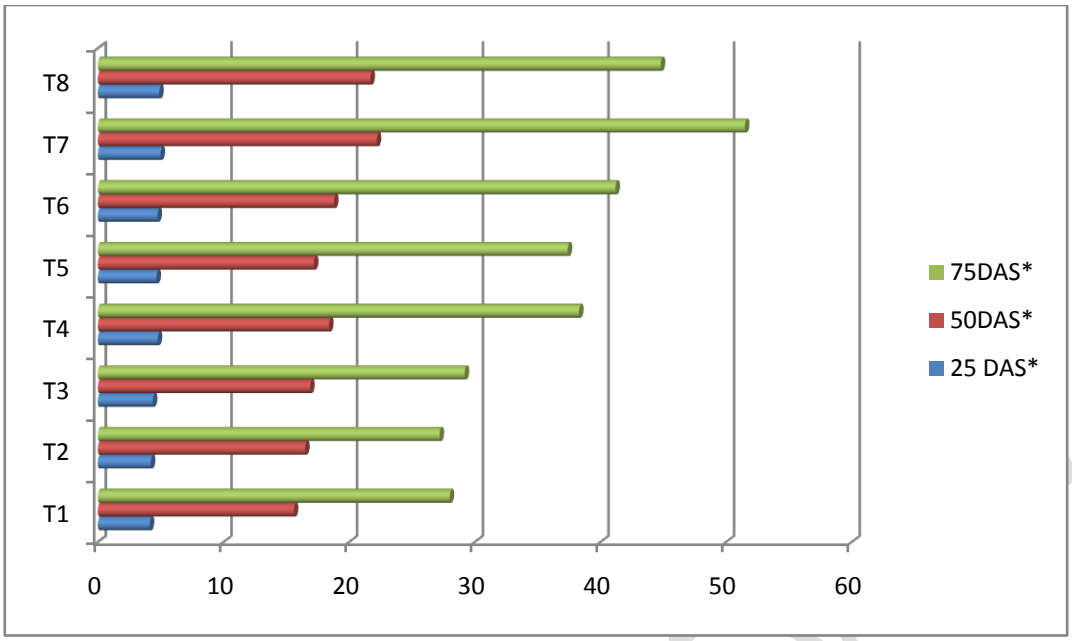

Fig 3. Graphical representation of effect of treatments on P uptake (kg/ha) by soybean in Soybean-Maize cropping system.

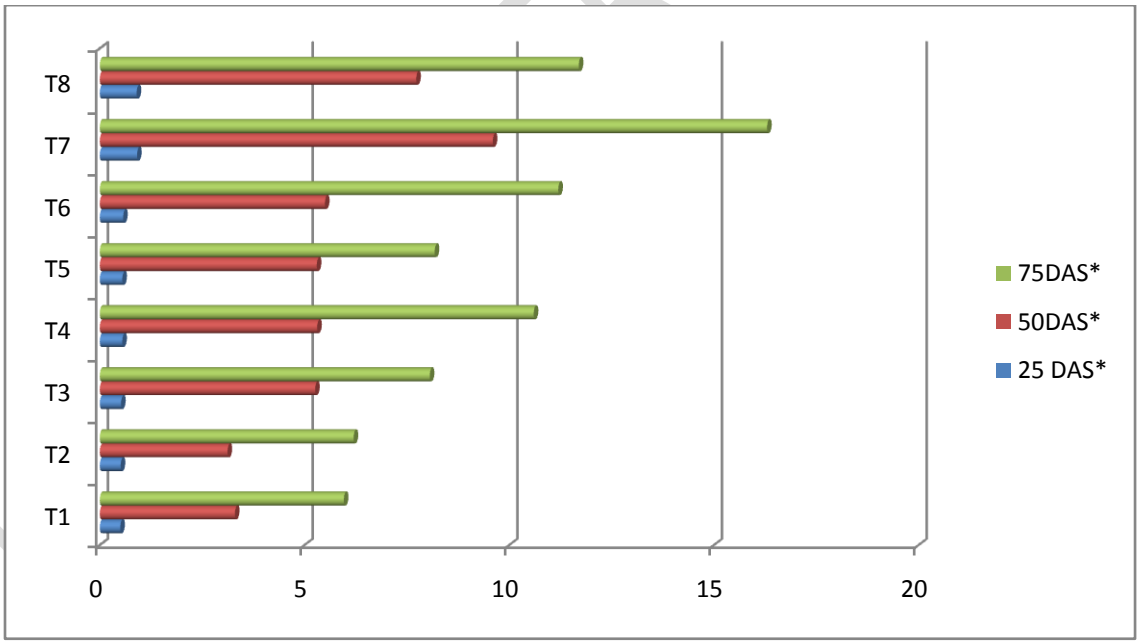

Fig. 4. Graphical representation of effect of treatments on K uptake (kg/ha) by soybean in Soybean-Maize cropping system.