Journal of Crop and Weed, 13(3): 20-23 (2017)

Assessment of potassium on balanced fertilization of soybean-wheat cropping system in Bundelkhand of Uttar Pradesh

A. K. SINGH

Deendayal Research Institute, Krishi Vigyan Kendra, Chitrakoot, U.P.

Received : 29-03-2017 ; Revised : 15-08-2017 ; Accepted : 20-08-2017

ABSTRACT

The experiments on research farm field were conducted at KVK during 2013-14 to 2015-16 to assess the impact of balanced fertilization particularly of potassium nutrition on productivity of soybean as well as soybean-wheat cropping system. Potassium application had significant positive effect on growth and nodulation in soybean. It favourably influenced the quality parameters of soybean as well. There was significant reduction in insect-pests infestation and disease incidence in soybean receiving potassium dressings. Application of 20 kg basal + 20 kg K_2O ha^{-1} at flowering (R2 stage) gave maximum productivity of soybean-wheat cropping system while application of 20 kg K_2O ha^{-1} as basal was most economical in terms of IBCR indicating the utility of K applications for resource poor farmers. The negative balance of K in all the treatments, except with the application of 40kg K_2O ha^{-1} as basal to both the crops of the system, brought out the need for reorienting the present recommended levels of K to meet the system need and enhance system efficiency in sustainable way.

Keywords : Balance fertilization, crop, cropping system, economic effect, potassium

Soybean is the premier oilseed crop in India. Although the crop has history of only three and a half decade's of commercial cultivation, but it has exhibited phenomenal growth and provided resilience to oilseed and edible oil production in the country. The productivity of soybean crop has shown gradual build up from the time of its initiation of commercial cultivation, but it is hovering around 1 t ha^{-1} for more or less last one decade, mainly in view of deficit and erratic distribution of rainfall and uncertainty in onset of monsoon being experienced on account of global climatic change. Being rainfed the productivity of oilseeds in general and soybean in particular has been far below the potential yield achievable. Constraint analyses have indicated that unbalanced nutrition is one of the important reasons for restricted growth in productivity (Sharma *et al*., 1996 and Tiwari, 2001). It is a general practice among farmers of major soybean growing regions to apply some N and/ or P mostly through di-ammonium phosphate or single superphosphate (SSP) and that too in suboptimal levels. By and large, K applications are dispensed with in view of conceived high status of the element in the soil, particularly in Vertisols. As a matter of fact, even the level of K, which is under recommendation, is insufficient to meet the requirement of the soybean crop as well as that of soybean based cropping system (Joshi, 2004). Though, sulphur is also not included in the fertilizer schedule, gets incidentally included wherever the SSP is applied (Bhatnagar and Joshi, 1999). In spite of the fact that the uptake of K by an average soybean crop is about 101-120 kg ha^{-1} (Nambiar and Ghosh, 1984 and Aulakh *et al*., 1985), hardly any attention has been paid to meet the crop requirement. Ved prakash *et al*. (2001) found that values of net depletion of K (sum total of available and non exchangeable K) from soil profile after 27 cropping cycles of soybean-wheat were quantitatively much higher than the expected K depletion values suggesting considerable depletion of K from soil. There has been a wide gap between recommendations of K application vis-à-vis its uptake. This status of nutrition management in soybean make it unbalanced. Now, it has become imperative to optimize K nutrition for soybean-wheat cropping system so as to optimize the productivity from the system by way of making the fertilization balanced. Besides, K being a quality element, has been found to play an important role in providing drought tolerance to crop plants by regulation of stomata opening and building up resistance against insect-pests and diseases. In view of this, "Assessment in Balanced Fertilization of Soybean-Wheat Cropping System in Bundelkhand of Uttar Pradesh" was initiated in 2013-14 and concluded in 2015-16 with the twin objectives: -

- To assess the impact of balanced fertilization particularly potassium nutrition on productivity of soybean wheat cropping system.
- To study the role of potassium nutrition in providing resistance against insect pests and diseases of soybean.

MATERIALS AND METHODS

A field experiment was laid out at the Research Farm of Krishi Vigyan Kendra, Chitrakoot during 2013-14 to 2015-16 with 7 treatments (Table 1) and four replications under Split Plot Design. Soybean (cv. NRC 7) – wheat (cv. HD 2967) sequence was taken on fixed plot (5 x 3.6 ft.) basis concurrently, with three treatments namely 100, 75 and 50 per cent (basal) K_2Oha^{-1}, however recommended dose of Soybean crop is 20, 60 and 40 kg

Email: adityakumarsinghupc@gmail.com

Table 1: Effect of potassium nutrition on soybean seed and wheat grain yield and SEY of soybean- wheat cropping system (pooled 3 years' data)

Level of K_2O (kg ha^{-1})	Soybean seed yield (kg ha^{-1})	Wheat seed yield (kg ha^{-1})	SEY (kg ha^{-1})
0	1746	3714	4064
50% (basal)	2109	4560	4962
75% (basal)	2295	4764	5278
100% (basal)	2250	4689	4182
10kg (basal) +10kg (at flowering)	2108	4836	5136
20kg (basal) + 20kg (at flowering)	2447	5107	5647
30kg (basal) + 30kg (at flowering)	2274	4796	5266
LSD (0.05)	**116.1**	**364.6**	**1037.0**

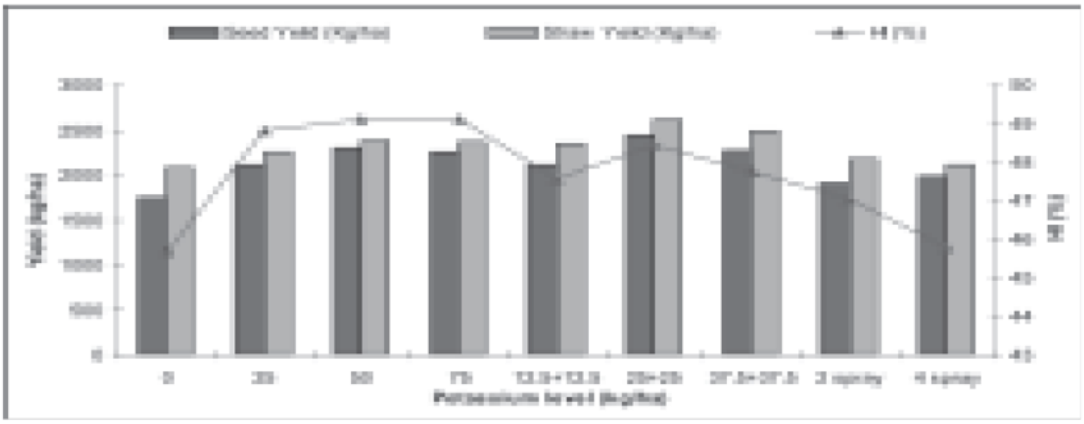

Fig. 1 : Effect of potassium nutrition on seed and straw yield of soybean and harvest index (pooled 3 years data)

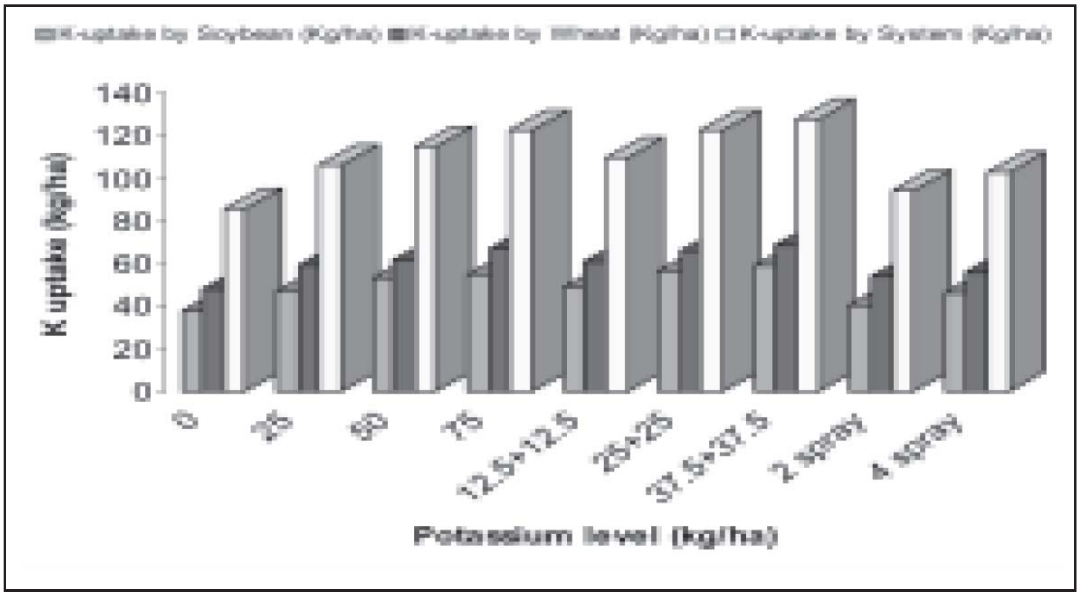

Fig. 2 : Effect of potassium nutrition on K uptake by soybean, wheat and cropping system (pooled 3 years data)

ha^{-1} N, P and K respectively. Soybean and wheat varieties grown were NRC-7 and HD-2967, respectively. The physico-chemical characteristics of soils of the experimental sites are as follows : pH-7.9 EC ($dS.m^{-1}$)- 0.26

Organic carbon (%) 0.50, available N (kg ha^{-1}) 198.0, available P (kg ha^{-1}) 16.8, available K (kg ha^{-1}) 257.0 available S (ppm) 22.5, available Zn (ppm) 0.98, available Fe (ppm) 9.0, available Cu (ppm) 0.68. Soybean received the recommended levels of N and P (20 kg N and 60 kg P_2O_5 ha^{-1}) as basal. Subsequent wheat crop was supplemented with 120 kg N and 60 kg P_2O_5 ha^{-1}. The potassium was applied as per treatments to both the crops through basal placement and side dressing in standing crop at flowering (R2 stage). The carriers used for supplementing N and P were urea and Di - ammonium phosphate, respectively. The recommended package of practices was followed for both the crops. The data accumulated over three years were pooled and results were concluded.

RESULTS AND DISCUSSION

Significant positive effect of potassium application on growth and nodulation of soybean was noticed. Dry weight (g $plant^{-1}$) of plants at flowering and plant height at harvest were significantly highest with split applications of K, either 20 kg (basal) + 20 kg K_2O ha^{-1} (at flowering). Nodule number and their dry weight were maximum with 40 kg K_2O ha^{-1}. All the treatments involving basal and split applications of K significantly enhanced branches $plant^{-1}$, pods/plant and seed index over control. The maximum branches $plant^{-1}$ were observed with 40 kg K_2O ha^{-1} (basal), while pods $plant^{-1}$ and seed index were maximum with split application of 20 kg (basal) + 20 kg $K_2O ha^{-1}$ (at flowering). Potassium application significantly improved the seed yield of soybean (Table 2 and Fig. 1). The split application of Potassium had an edge over basal application and maximum seed yield was recorded with 20 kg (basal) + 20 kg K_2O ha^{-1} (at flowering), which was significantly superior over control. Potassium nutrition had significant positive influence on harvest index of soybean and varied in proportion to K applied to the crop (Fig. 1).

K uptake by plant

Maximum total K uptake by soybean, wheat and the system were observed with 30 kg basal + 30 kg K_2O ha^{-1} at flowering followed by 20.0 kg basal +20.0 kg K_2O ha^{-1} at flowering (Fig.2).

Oil content was recorded with the application of 20 Kg K_2O ha^{-1} as basal, which was significantly higher than control. Soybean crop responded significantly to K application in terms of kg seed kg^{-1} K_2O applied. The maximum response was observed with basal application followed by 20 kg (basal) + 20 kg K_2O ha^{-1} (at flowering). However, the Incremental Benefit Cost Ratio (IBCR) was highest with 20 kg K_2O ha^{-1} as basal. Basal and split application of all the levels of K significantly reduced the infestation of blue beetle at 20 DAS while, all the levels and methods of K application *i.e.* basal and split significantly reduced the infestation of defoliators, girdle beetle and stem fly in soybean. Similarly, application of K in any form brought significant reduction in collar rot mortality and Myrothecium leaf spot.

The inclusion of potassium in the fertilizer schedule irrespective mode of application in general, enhanced the yield of wheat to the extent of 38 per cent (Table 2) with 20 kg (basal) + 20 kg K_2O ha^{-1} (at flowering) over control. Application of K in equal splits (basal and at flowering) had an edge over basal applications. The maximum response was observed with basal application followed by 20 kg K_2O ha^{-1} as basal and 10 kg (basal) + 10 kg K_2O ha^{-1} (at flowering). In general, the IBCR decreased with the increasing levels of potassium.

The system efficiency was evaluated in terms of soybean equivalent yield (SEY). The inclusion of potassium in the fertilizer schedule irrespective of mode of application in general, enhanced the productivity of the system to the extent of 9.3 to 39.0 per cent (Table 1). The basal applications of potassium were found superior. The maximum soybean equivalent yield was recorded with the split application of 40 kg K_2O ha^{-1} (20 kg basal + 20 kg at flowering), which was significantly superior over all treatments and control. However, the IBCR was highest with 20 kg K_2O ha^{-1} as basal. In general, the IBCR decreased with the increasing levels of potassium. There was definite effect of K nutrition on productivity of soybean-wheat cropping system in terms of soybean equivalent yield. The response per kg K_2O applied and IBCR were maximum with the application of 20 and 40 kg K_2O ha^{-1} as basal, respectively.

K status and balance in soil

The maximum ammonium acetate- K, $CaCl_2$-K and HNO_3-K content after wheat harvest *i.e.* at the completion of the cropping system was observed with the application of 30 Kg (basal) + 30 kg K_2O ha^{-1} (at flowering) followed by 40 kg K_2O ha^{-1} as basal. Except application of 40 kg K_2O ha^{-1} as basal to both the crops of the system, there was negative balance of K in the soil after completion of the cropping system at all the levels.

REFERENCES

Sekhon, G.S., Brar, M.S. and Subba Rao, A. 1992. *Potassium in Some Benchmark Soils of India*. Potash Research Institute of India, Gurgaon, Haryana, India. pp. 1-82.

Sharma, N., Srivastava, B., Mishra, B. and Srivastava, N.C. 1998. Change in some physicochemical properties of an acid soil as affected by long term use of fertilizer and amendments. *J. Indian Soc.Soil Sci*. **36**:688-92.

Subba Rao, A., Sesha Sai, M.V.R.and Pal, S.K. 1993. Nonexchangeable potassium reserves and their characterization in some soils of India. *J. Indian Soc. Soil Sci.* **41 (4**); 667-73.

Tiwari, K.N. 1985. Changes in potassium status of alluvial soils under intensive cropping. *Fert. News* **30** (9): 17-24.

Aulakh, M. S., Sidhu, B.S., Arora, B.R. and Singh, B. 1985. Contents and uptake of nutrients by pulses and oil seed crops. *Indian J. Ecol.* **12(2)**: 238-42.

Bhatnagar, P.S. and Joshi, O.P. 1999. Soybean in cropping systems in India. FAO *Series on Integrated Crop Management*, Rome, Italy, pp.39.

Joshi, O.P. 2004. Soil Fertility Management in India. In*: Proc. of VII World Soybean Res. Conf.*, Brazil (Eds. Moscardi et al.), pp. 400-406.

Nambiar, K. K. M. and Ghosh, A.B. 1984. Highlights of research of a Long-term Fertilizer Experiment in India (1971-1982). *Technical Bulletin* 1. Long-term Fertilizer Experiment Projects, IARI. pp.100.

Sharma, H., Nahatkar, S. and Patel, M.M. 1996. Constraints of soybean production in Madhya Pradesh: An analysis. *Bhartiya Krishi Anusandhan Patrika* **11**(2): 79-84.

Tiwari, S.P. 2001. Shattering the production constraints in soybean-based cropping systems. *JNKVV Res. J.* **35**(182): 1-10.

Kundu, V., Ghosh S., Singh B. N., R.D. and Gupta, H.S. 2001. Yield response patterns of soybean and wheat to K application and changes in K status in soil profile after 27 years of cropping in mid-hills of northwestern Himalayas. In: *Proc. Int. Symp. Importance of Potassium in Nutrient Management for Sustainable Crop Production in* India Vol.1 Potash Research Institute of India, Gurgaon pp. 362-65.

Bansal, K.N. and Jain, S.C. 1988. Forms of potassium in a Vertisol as influenced by long-term intensive cropping and fertilizer use. *J. Potassium Res.* **4**: 104-09.

Katyal, J.C. 2001. Fertilizer use situation in India. *J. Indian Soc. Soil Sci* **49**: 570-92.

Ladha, J.K., Dawe, D., Pathak, H., Padre, A.T., Yadav, R.L., Singh, B., Singh, Y. Singh, Y., Kundu, A.L., Sakal, R., Ram, N., Regmi, A.P., Gami, S.K., Bhandari, A.L., Amin, R., Yadav, C.R., Bhattarai, E.M., Das, S., Aggarwal, H.P., Gupta, R.K. and Hobbs, R.R. 2003. How extensive are yield declines in long-term rice-wheat experiments in Asia? *Field Crops Res.* **81**: 159-80.

Mengel, K. 1985. Dynamics and availability of major nutrients in soil. *Adv. Soil Sc*i. **2**: 65 133.

Mukhopadhyay, S.S., Sidhu, P.S., Bishnoi, S.R. and Brar, S.P.S. 1992. Changes of quantity intensity parameters on cropping. *J. Potassium Res*. **8**: 21-34.

Rupa, T.R., Srivastava, S., Swaruup, A., Sahoo, D. and Tembhare, B.R. 2003. The availability of potassium in Aeric Haplaquept and Typic Haplustert as affected by long-term cropping, fertilization and manuring. *Nutrient Cycling in Agroeco.* **65** : 1-11.

Santhi, P., Sankar, S.J., Muthuvel, P. and Selvi, D. 1998. Long-term fertilizer experimentsstatus of N, P and K fractions in soil. *J. Indian Soc. Soil Sci* **46** (3): 395- 98.

Sekhon, G.S. 1999. Potassium in Indian soils and crops.In: *Proc. Indian Nat. Sci. Acad.* B65 : 83-108.

Wanjari, R.H., Singh, M.V. and Ghosh, P.K. 2004. Sustainable yield index: an approach to evaluate the sustainability of long-term intensive cropping systems in India. *J.Sustainable Agric.* **24** (4): 39-56.

Singh, M., Singh, V.P., Reddy, Damodar, D. 2002. Potassium balance and release kinetics under continuous ricewheat cropping system in Vertisol. *Field Crops Res.* **77**: 81-91.

Srinivasa Rao, Ch., Subba Rao, A., Swarup, A., Bansal, S.K. and Rajagopal, V. 2000. Monitoring the changes in soil potassium by extraction procedure electroultrafiltration (EUF) in a Tropaquept under twenty years of rice-rice cropping. *Nutrient Cycling in Agroeco.* **56**: 277-82.

Subba Rao, A. and Srivastava, S. 2001. Soil Test based Fertilizer Recommendations for Targeted Yields of Crops. Indian Institute of Soil Science, Bhopal, India. pp. 1-326.