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Research Article

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Effect of foliar and soil application of potassium on soybean (*Glycine max* L.)

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Summary

The experiments on farmers' field were conducted at Krishi Vigyan Kendra, Indore in nearby two villages during 2016-17 to 2017-18 to assess the impact of soil and foliar application of potassium nutrition on productivity of soybean. On farm trial comprised of three treatments *viz.*, T_1- farmer's practice (18:45:0), T_2- recommended doses of potassium on soil test basis and T_3- foliar application of potassium (1%) were taken on the ten farmers field each year. The experimental design was Randomized Block Design with the ten replications in which farmers were taken as the replication. The result indicated that soybean grain yield in the soil application of recommended dose of potassium (T_2), was significantly superior over foliar application of the potassium (1%) (T_3) and farmer practices (T_1). The increase in yield was 18.97 per cent in the treatment T_2 and 12.20 per cent in treatment T_3 over the farmers' practices (T_1). The soil application of recommended dose of potassium recorded significantly higher average pod per plant and seed index followed by the foliar application of potassium as compared to farmer practice (33.90). Similar trend were also recorded in the gross return, net return and B:C ratio.

Key words : Potassium, Soybean, Foliar spray, Soil application

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Introduction

Soybean is the second largest crop in cash sales. The area and production in 2015-16 under soybean in Madhya Pradesh is 59.06 lakh ha and 4.45 lakh tonne, respectively. The area of soybean crop in Indore district in 2015-16 is 2.23 lakh ha and production is 1.70 lakh tonne. The average productivity is around 1059 kg/ha in Indore district (Krishi, 2016). The majority of soybean crops are processed for oil and meal and soybean is the only plant food that contains complete protein that provides all essential amino acids required for human health. Soybean seed also contains carbohydrate, fatty acids and minerals (The Soybean Fact Book, 2007). Polyunsaturated fatty acids in diet have been shown to actively lower serum cholesterol levels. Soybean oil is rich in polyunsaturated fatty acids, including the two essential fatty acids, linoleic and linolenic, that are not produced in the body. Linoleic and linolenic acids help the absorption of vital nutrients required for human health (The Soybean Fact Book, 2007) and soy products have also been shown to be useful in prevention and treatment in bone resorption, inhibiting ovarian, breast and colon cancer and other chronic heart and kidney diseases

Hasler (1998); Messina (1995); Caragay (1992); Doyle *et al.* (2006) and Wu *et al.* (2008).

Potassium (K) is an essential nutrient involved in regulating water balance (Mehdi *et al.*, 2007) and enhancing water uptake. Potassium is involved in nearly all processes needed to sustain plant life, besides its role in conferring pest and disease resistance. Soybean crop takes up and removes large amounts of potassium from soil than any other nutrient (Tiwari *et al.*, 2001). Potassium application have shown to increase the number of pods as well as exerted a beneficial influence on retaining pods until harvest in soybean (Coale and Grove, 1990). Potassium fertilization can be either applied to soil or as foliar spray to plants. Soil application is the standard form of application and has its own advantages unless soil pH and other factors affect the movement and uptake from soil to the plants. Foliar application can rapidly help plants to recover from stress due to drought, high heat, pests and diseases. The conventional way (Nelson *et al.*, 2007 and Fernandez, 2012) to apply K to the soil is before planting (pre-planting) and larger quantity may improve soil fertility for subsequent crops. Previous research has focused on foliar fertilization of soybeans at late reproductive stages and produced inconsistent and insignificant results (Garcia and Hanway, 1976), However, foliar application is still attracting researchers' interest Weir (1998); Dkhil *et al.* (2011) and Hiller (1995) to evaluate effective rates and timing of application to avoid drought and heat stress at critical stages. Studies (Nelson *et al.*, 2007) have shown that both pre-plant and foliar K applications can increase soybean yields with low to medium soil K levels. Although foliar and soil application of K fertilizers have been used to maintain optimum level of nutrients (Hiller, 1995) in crop, there is limited information on the effect of foliar and soil K fertilizer on seed composition (protein, oil, fatty acids, and minerals).

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 sub- optimal 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). An average soybean crop uptake is about 101-120 kg/ha (Nambiar and Ghosh, 1984 and Aulakh *et al.*, 1985), hardly any attention has been paid to meet the crop requirement. There has been a wide gap between recommendations of K application *vis-à- vis* its uptake. Looking to this aspects a on farm trial was conducted with objective to study the impact of soil and foliar application of potash on the soybean crop.

Resource and Research Methods

On farm field trials was carried out for two consecutive years 2016 and 2017 in *Kharif* season in two villages *i.e.* Gram Baroda-doulat and Panod of Indore district by Krishi Vigyan Kendra, Indore. The experimental soil was clay loam and analyzed: pH (1:2.5) 7.88, EC (1:2.5) 0.42 dSm^{-1}, organic carbon 0.63 per cent, available nitrogen 205 kg ha^{-1}, available phosphorus (P_2O_5) 17.92 kg ha^{-1} and available potassium (K_2O) 383 kg ha^{-1}. Three treatments *viz.*, T_1-Farmer's practice (18:45:0, NPK kg /ha), T_2-Recommended doses of potassium (K 30 to 40 kg/ha on soil test basis) and T_3-Foliar application of potassium (1%) at pod development stage were taken on the ten farmers field each year. The experimental design was Randomized Block Design with the ten replications in which farmers were taken as the replication. In the treatment with farmer's practice, farmers applied the fertilizer as per their traditional practice. In case of the treatment recommended doses of potassium (RDF), entire amount of potassium were applied as basal , while in the treatment T_3 potassium were applied as 1 per cent foliar application of potassium (through potassium sulphate) at the pod formation stage. The rainfall received during 2016 and 2017 was 1110 mm and 831 mm, respectively. Average temperature range in winter minimum 4^o C and maximum is 29^0C while summer minimum is 21^0C and maximum is 43^0C. Soil samples collected before and after harvest of crop were air dried, ground, passed through a 2 mm sieve and analysed for pH, EC, organic carbon, available phosphorus and potassium contents using standard procedures. Based on the price of cash inputs used and produce obtained during the year 2016 and 2017 net return and benefit cost ratio were calculated.

Research Findings and Discussion

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Yield and yield attributes:

The data presented in the Table 1 show that in the year 2016 and 2017, soybean grain yield in treatment the soil application of recommended dose of potassium (T_2), was significantly superior over foliar application of the potassium (1%) (T_3) and famer practices (T_1). The soybean grain yield of foliar application of the potassium sulphate (1%) (T_2) was also found significantly superior over farmers' practices (T_1). In the 2016, Treatment T_2 recorded the highest soybean grain yield 16.87 q /ha followed by T_2 15.91 q /ha in foliar application of potash as compared the farmers' practices. The increase in yield was 18.97 per cent in the treatment-T_1 and 12.20 per cent in treatment-T_2 over the farmers' practices. While in the year 2017, treatment-T_2 recorded the highest soybean grain yield 14.22 kg /ha followed by T_3 13.09 kg/ha in foliar application of potash as compared the farmers' practices. The increase in yield is 20.71 per cent in the treatment-T_1 and 11.12 per cent in treatment-T_2 over the farmers' practices. The pooled mean of the both year also showed similar trends in soybean grain yield. The results are in conformity with the findings reported by Vedprakash Kundu *et al.* (2001).

The result indicated that treatments have significant effect on the number of pods per plant. The soil application of recommended dose of potash recorded significantly higher average pod per plant (33.90) followed by the foliar application of potassium (30.10) as compared to farmer practice. Similarly the seed index of the soybean also showed the significant higher average seed index (12.21) in the treatment soil application of recommended dose of potassium (T_2) followed by the treatment foliar application of the potassium (1%) (T_3) as compared to treatment farmers'practices (T_1).

Economics :

The data depicted in the Table 2 indicated that the cost of cultivation in treatment T_2 the soil application of the recommended dose of potassium comparatively higher (Rs.24,209) as compared to farmer's practice (Rs. 23,324) on account of additional input provided in the demonstration. Higher average gross returns (Rs. 50,100) and net returns (Rs. 25,891) were obtained from in treatment- T_2 the soil application of potash as compared to farmers' practices T_3 (Rs. 41,837 and Rs. 23,125), respectively. The average net returns obtained from soil application of potash were 38.3 per cent higher over farmer practice. The B: C ratio in soil application of potash (2.07) followed by T_3- foliar application of potassium (2.01) were higher as compared to farmer practices (1.81). The result suggests economic viability of the treatment applied.

Conclusion:

It is concluded from the study that there was positive response of potassium application from soil as well as

Table 1: Yield and yield attributes of soybean as affected by the different treatments

Sr. No.	Treatments	Soybean yield (q/ha)			No. of pods/ plant			Seed index (g)		
		2016	2017	Pooled mean	2016	2017	Pooled mean	2016	2017	Pooled mean
1.	T_1- Farmer practice	14.18	11.78	12.98	26.2	27.5	26.85	11.79	9.86	10.83
2.	T_2- K soil test basis	16.87	14.22	15.54	32.7	35.1	33.90	13.27	11.14	12.21
3.	T_3- Foliar spray of potassium (1%) at the pod formation	15.91	13.09	14.05	29.6	30.6	30.10	12.91	10.47	11.69
	C.D. (P=0.05)	0.71	0.58	0.36	2.85	4.18	2.57	0.35	0.87	0.51

Table 2 : Economics of soybean as affected by the different treatments

Sr. No.	Treatments	Gross income (Rs.)			Cost of cultivation (Rs.)			Net income (Rs.)			B:C ratio		
		2016-17	2017	Pooled Mean	2016	2017	Pooled Mean	2016	2017	Pooled mean	2016	2017	Pooled mean
1.	T_1-Farmer practice	45,382	38,292	41,837	23,122	23,128	23,125	22,260	15,164	18,712	1.96	1.66	1.81
2.	T_2 - K soil test basis	53,974	46,225	50,100	24,116	24,302	24,209	29,858	21,923	25,891	2.24	1.9	2.07
3.	T_3- Foliar spray of potassium (1%) at the pod formation	50,909	42,556	46,733	23,332	23,316	23,324	27,577	19,240	23,409	2.18	1.84	2.01
	C.D. (P=0.05	2287	1899	1147	NS	NS	NS	2288	2241	1190	0.10	0.13	0.06

NS= Non-significant

foliar application. The soil application and foliar of K fertilizer increased the soybean seed yield significantly over farmer s practice. It is evident from the study that in absence of soil application of potassium K fertilizer by the farmer, foliar application also have the beneficial effect in increasing the yield of soybean crop significantly.

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