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Effect of Sulphur on Productivity of Soybean in Front Line Demonstrations in the Indore District of Madhya Pradesh, India

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A B S T R A C T

The soybean is the important crop of Madhya Pradesh. The unbalanced uses of fertilizer have deteriorated the productivity of soybean in the region. The poor productivity of soybean is mainly due to imbalanced application of nutrients and use of traditional varieties. Sulphur is an essential plant nutrient for crop production. For oil crop producers, S fertilization is especially important because oil crops require more S than cereal crops. In view of this, twenty front line demonstrations (FLD) on soybean conducted by Krishi Vigyan Kendra, Indore during 2016-17 and 2017-18 to know the yield gaps between FLD's and farmer's field, extent of technology adoption. Results indicated under the improved practice soybean seed yield recorded was in range of 17.57 to 13.14 q/ha (average 15.98 q/ha) by improved package of practices over existing farmers practices. On average basis the technology gap of all the twenty demonstration was recorded of 6.32 q/ha. An extension gap ranging from 2.14 to 2.47 q/ha was found between FLDs demonstration and farmers practices. The average technology index was 31.60% for both the year. The result of economic analysis of soybean production revealed that front line demonstration recorded higher gross return Rs. 51,523 and net return Rs.27 421 with higher benefit cost ratio of 2.14.

Introduction

Soybean [*Glycine max* (L.) Merrill], being an oil yielding leguminous crop, richest source of high quality protein, oil, calcium, iron and in amino acid like glycine, has established its potential as an industrially and economically viable oilseed crop in the world by virtue of its high nutritional value and myriad uses. In India, soybean has emerged as an important oilseed crop. 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 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). One of the major constraints for low soybean productivity is provision of imbalanced nutrition (Joshi and Bhatia, 2003). Unless soybean is provided with required nutrient input to produce sufficient biomass, it may not yield high (Singh *et al.*, 2003). The fertilizer plays a major role in enhancement crop production and productivity along with high yielding varieties. Fertilizer use has become more and more important to increase crop yields and their quality.

The poor productivity of soybean is mainly due to imbalanced application of nutrients and use of traditional varieties. Under such situations, use of soil test base nutrient management and biofertilizer seed treatment had shown advantage in enhancing soybean productivity. Macro nutrients such as nitrogen, phosphorus and potassium play a crucial role in plant growth and yield. Sulphur is an essential plant nutrient for crop production. For oil crop producers, S fertilization is especially important because oil crops require more S than cereal crops. For example, the amount of S required to produce one ton of seed is about 3-4 kg S for cereals (range 1-6); 8 kg S for legumes (range 5-13); and 12 kg S for oil crops (range 5-20) (Jamal *et al.,* 2010). In general, oil crops require about the same amount of S as, or more than, phosphorus for high yield and product quality. The role of sulphur in soybean production has been reported by Shrivastava *et al.,* (2000).

The yield response with optimum S application differed among the plant species and it has been suggested that legumes differ in their S demand (Scherer and Lange, 1996). Application of sulphur improved nitrogenase activity, nitrogen fixation, plant dry matter and quality of soybean grain in sulphur deficient soil (Kandpal and Chandel, 1993). Sulphur application @ 20 to 40 kg per ha in soybean produced maximum yield in various soils (Billore and Vyas, 2012).

In view of this, the scientist of Krishi Vigyan Kendra, Indore conducted the front line demonstrations (FLD) on soybean crop to know the yield gaps between FLD's and farmer's field, extent of technology adoption. The main aims of organizing these FLDs in farmer's field to bridge wide gap between demonstration field yield and farmer field yield and creating awareness about balance dose of fertilizer soybean in Indore district.

Materials and Methods

Utilizing the information generated during Participatory Rural Appraisal (PRA) and soil test, the Krishi Vigyan Kendra, Indore, organized 20 front line demonstration (0.4 ha area each) during 2016-2017 and 2017-2018 on soil test based nutrient management (macro and micro nutrients) on farmers' fields in adopted villages viz., in Baroda doulat and Karwasa of Indore district of Madhya Pradesh. In the study area monsoon starts from the month of June and ends in September. In the remaining period the weather is very dry. 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^{0}C while summer minimum is 21^{0}C and maximum is 43^{0}C. Soil samples collected before and after harvest of crop were air dried grinded, passed through a 2 mm sieve and analysed for pH, EC, organic carbon, available phosphorus, potassium and sulphur and micronutrients content using standard procedures. The average nutrient status of soil of adopted villages is pH 7.46, EC 0.42 dSm^{-1}, Organic carbon 0.63%, available nitrogen 233 kg/ha, available phosphorus 15.42 kg/ha, available potassium 348 kg/ha and sulphur 7.81 kg/ha and sufficient in all other micronutrient. The packaged of improved practices demonstrated encompassed variety JS-95-60, integrated nutrient management (soil test based) viz., 20:60:40 + 20 kg/ha Sulphur + Rhizobium + PSB @ 5ml /kg seed over existing farmers practices of (18:46:00:00 NPKS kg/ha).

Before conducting the demonstrations, training to the farmers of respective villages was imparted with respect to envisaged technological interventions. Site selection, farmers' selection, layout of demonstration and farmers participation was considered as suggested by Choudhury (1999). The demonstrations on farmers fields were monitored by KVK scientists in performing field operations like sowing, spraying, weeding, harvesting etc., during the course of training and visits. The observation of yield and economic performance of front line demonstration, the data on output were collected from FLDs as well as local plots from all selected farmers and finally the grain yield, cost of cultivation, net returns of different farmers was analyzed by the formula. For the study, technology gap, extension gap and technology index were calculated as suggested by Samui *et al.,* (2000).

Technological gap= Potential yield - Demonstration yield

Extension gap =Demonstration – farmers yield

Technological Index= (Potential yield – demonstration yield)/ Potential yield

Results and Discussion

Seed yield

A comparison of productivity levels between demonstration and framers practices is shown in table 3. It is evident from results that under the improved practice (demonstrated plots), performance of soybean yield was occurring higher than in the farmer practice. Seed yield of Soybean recorded was in range of 17.57 to 13.14 q/ha (average 15.98 q/ha) by adoption of improved package of practices (balance fertilizer (soil test based) viz., 20:60:40 + 20 Kg Sulphur kg/ha) over existing farmers practices (local check18:46:00:00 NPKS kg/ha), an increase of 16.78 to 16.90 per cent (average 16.84 %) in seed yield was recorded during the study period because improved package of practices. These results are in agreement with findings of Tiwari *et al.*, (2013). It was also observed that the seed yield during Kharif 2017-18 was recorded lower than that of Kharif 2016-17 due to erratic rains during the crop growing season.

From these results it is evident that the performance of the technology demonstrated was found to be better than the farmers' practice under the same environment conditions. The farmers get inspired by seeing the results in term of productivity and they are interested in adopting the technologies.

Technology gap

The technology gap were observed during these years and it was lowest 5.39 q/ha during the 2016-17 and highest 7.25 q/ha in 2017-18. On average basis the technology gap of all the twenty demonstration was recorded as of 6.32 q/ha.

Extension gap

An extension gap ranging from 2.14 to 2.47 q/ha was found between FLDs demonstration and farmers practices during the different time line and on average basis the extension gap was found to be 2.30 q/ha (Table 3). The extension gap was lowest 2.14 q/ha in the year 2016-17 and was highest 2.47 q/ha in the year 2017-18.

Such gap might be attributed to adoption of improved technology in demonstrations which resulted in higher grain yield than that in the farmers' practices.

Technology index

The technology index shows the feasibility of the demonstrated technology at the farmers' fields. The technology index varied from 26.95 to 36.50 % (Table 3). The average technology index was 31.60% for both the year.

Table.1 Comparison between demonstration practices and farmers practices in soybean crop

SN	Particular	Demonstration	Farmers practices
1	Farming situation	Rainfed	Rainfed
2	Variety	JS-95-60	Js-95-60
3	Time of sowing	June	June
4	seed treatment	Thiram+bavistin @3g/kg	No seed treatment
5	Method of sowing	Line	Line
6	seed rate	80 kg/ha	120kg/ha
8	Fertilizer dose	NPKS (20:60:40:20 kg/ha)	NPK(18:46:00:00 kg/ha)
9	Plant protection	Integrated Pest Management	Indiscriminate use of pesticide
10	Weed management	Imazethpyer @1.5 l/ha as post emergence	Imazethpyer @1.5 l/ha as post emergence

Table.2 Gross return, cost of cultivation, net return and B: C ratio as affected by improved technology under FLDs on farmers' fields

Year	No. of farmers	Gross expenditure (Rs./ha)		Grass returns (Rs./ha)		Net returns (Rs./ha)		Additional net returns (Rs./ha)	B:C Ratio	
		FP	RP	FP	RP	FP	RP		FP	RP
2016-17	10	23,122	23,816	46,755	54,656	23,633	30,840	7,207	2.02	2.30
2017-18	10	23,243	24,388	41,444	48,389	18,201	24,001	5,800	1.78	1.98
	20	**23,183**	**24,102**	**44,100**	**51,523**	**20,917**	**27,421**	6,503	**1.90**	**2.14**

Table.3 Productivity, technology gap, extension gap and technology index of soybean under Front Line Demonstrations on Farmers fields

Year	Area (ha)	No of farmers	Potential Yield (q/ha)	Recommended Practice (q/ha)			Farmer Practice (q/ha)	Per cent increase over FP	Technology gap (q/ha)	Extension gap (q/ha)	Technology index (%)
				Highest	Lowest	Average	Average				
2016-17	4	10	20	18.20	15.60	17.08	14.61	16.90	5.39	2.47	26.95
2017-18	4	10	20	16.94	10.68	14.89	12.75	16.78	7.25	2.14	36.25
	8	**20**	**20**	**17.57**	**13.14**	**15.985**	**13.68**	**16.84**	**6.32**	**2.30**	**31.60**

Economics

Economics of soybean production under front line demonstrations was calculated and the results of the study have been presented in table 2. The result of economic analysis of soybean production revealed that front line demonstration recorded higher gross return range from Rs. 48,389 to 54,656 Rs. (average Rs.51,523) and net return of Rs. 24,001 to 30,840 (average Rs.27,421) with higher benefit cost ratio range from 1.98 to 2.30 (average 2.14) due to use of soil test basis balance nutrient management viz., 20:60:40 + 20 kg sulphur kg/ha) as compared to farmer practices (18:46:00:00 NPKS kg/ha) were applied. These results are in accordance with findings of Dhaka *et al.*, (2015) and Hiremath and Nagaraju (2009), further, reduce the cost of cultivation per hector area. The demonstration has increased additional net return Rs. 6,503 averagely per ha. Similar results were also reported by Hiremath and Nagaraju (2010) and Bhowate and Olambe (2017).

The Front line demonstration gives significant positive results and provided the scientist an opportunity to demonstrate the productivity potential and profitability of the use of balance fertilizers (intervention) under real farming situation, which they are suggesting farmers from long time. This will be beneficial in overcoming the some of the constraints in the existing transfer of technology system in the district, Indore of Madhya Pradesh. The productivity gain under FLDs over existing practices of soybean cultivation created greater awareness and motivated the other farmers to adopt balance nutrients management (soil test base application) to increase the nutrient availability and improve productivity.

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