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Economically Viable STCR Based Nutrient Management on Soybean (*Glycine max*)

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ABSTRACT

Soybean is the principle oil seed crop in India. Blanket recommendation of fertilizers for soybean over large area irrespective of soil type has lead to indiscriminate use of costly inputs. This has also resulted in imbalanced use of fertilizers and environment related problems. Hence to economize the fertilizer use soil testing should play important role. Therefore, a study on the soil test for improving soybean productivity was performed as a part of mandatory program of Agriculture Science Center, Rewa in Madhya Pradesh (MP) of India. Soils of study area had pH 6.8 to 7.4, EC 0.17 to 0.23 dSm^{-1}, organic carbon 0.33 to 0.71%, available nitrogen 105 to 214 kg /ha, phosphorus 7.30 to 16.80 kg/ha and potassium 173 to 325 kg/ha. Experiment were conducted in rainy season of 2009-10 with two treatments, farmers practice -T_1 (50 kg DAP/ha only) and application of fertilizer on the basis of soil test value -T_2. Higher grain yield was observed in T_2 (1830 kg/ha) than T1 (1180 kg/ha). The maximum increase in soybean yield was noted due to applied fertilizers on the basis of soil test values in T_2. The highest Benefit Cost ratio (B:C ratio) 4.05 was registered in T_2.

Keywords: Soybean, soil testing, yield, uptake, economics.

Madhya Pradesh is known as the 'Soybean state of India. However, it occupies an area of about 3.95 million hectares with production of 2.57 million tonnes in Madhya Pradesh. The productivity of soybean is very low (1130 kg/ha) in Madhya Pradesh as compared to the global average (2206 kg/ha) of this crop (Chandrakar *et al*. 2012 and Reddy *et al.* 2007)

Soil is our greatest natural resource. It is the chief wealth of an agricultural country in as much as it produces the crops that support the people and the nation. Increase in food grain production to feed the burgeoning population is technically achievable. The question remains whether targets can be achieved with economically viable, environmentally sustainable system, without causing degradation and pollution of soil, air and water.

Soil testing is to the art of crop production what the thermometer is to the medical profession. Soil testing is really 'soil science testing' as it practically applies the knowledge of soil science to crop production. Soil testing may, therefore, be defined as a tool for rapid soil chemical analysis to assess the available nutrient status of a soil, interpretation of the test results and making fertilizer recommendations based on crop responses and economic considerations. Blanket recommendation of fertilizers for soybean over large area irrespective of soil type has lead to indiscriminate use of costly inputs. This has also resulted in imbalanced use of fertilizers and environment related problems. Hence to economize the fertilizer use soil testing should play important role. The awareness of the farmers about the benefits of soil testing is helpful in determining the status of nutrients in the soil, while fertilizer recommendations is useful in determining appropriate amount of fertilizers that requires a participatory field demonstration to improve yield sustainability of soybean. Based on that, this study was performed.

Table 1. Information regarding experiment

S. No.	Parameters	Details
1	Problems diagnose	Low yield of soybean due to imbalance nutrition
2	Technology selected for assessment	
	T1- Nutrition without soil test	50 kg DAP (18N, 46 P_2O_5)
	T2- Nutrition with soil test (for target yield 15 kg/ha)	Target yield equation FN=5.19T-0.48 SN FP_2O5=5.2T-4.1 SP FK_20=3.9T-0.22 SK (FN,FP_2O_5 and K_2O = fertilizer N,P and K in kg/ha, T= target yield)
3	Production system	Soybean- wheat
4	Thematic area	Nutrient management
5	Micro farming situation	Rain fed
6	Constants identified and feed back for research work	Facilities for soil testing were not available in block level
7	Process for farmers participation and their reaction	Training, soil health camp, demonstration, field day and krasak sangosthi
8	Number of trails/ farmers	Ten
9	Crop	Soybean
10	Variety	JS 93-05

Materials and Methods

The present study is a part of the mandatory programme of Krishi Vigyan Kendra, Rewa, Madhya Pradesh. Participatory rural appraisal (PRA), group discussion and transect walk were followed to explore the detail information of study area. In between the technology intervention HRD components (Trainings/ soil health camp/ Kisan mela/ field day etc.) were also included to excel the farmers understanding and skill about the demonstrated technology on soil testing crop response. The front line demonstration conducted in ten farmer's field of adopted villages viz., Khaur and Laksmanpur on soybean variety JS 93-05 during Kharif 2009-10. Information on soil condition of the fields used in this experiment was as follows; pH 6.8 to 7.4, EC 0.17 to 0.23 dSm^{-1}, organic carbon 0.33 to 0.71%, available nitrogen 105 to 214 kg /ha, phosphorus 7.30 to 16.80 kg/ha and potassium 173 to 325 kg/ha (Table 2). Two treatments, farmers practice -T_1 (50 kg Diammonium phosphate/ha only) and application of fertilizer on the basis of soil test value -T_2 (recommended practice) for targeted yield 15 q/ha, were performed. Extension and technological gaps were also calculated.

The agro techniques viz., land preparation, seed rate, sowing, nutrients input dose/application, herbicides/insecticides application and harvesting were followed for soybean crop as per recommended practices and need of crop. As fertilizers single super phosphate (SSP) and Potassium chloride were used as basal dressing. Soil and plant samples were collected after the harvest of soybean crop from each farmer field and were analyzed by the standard procedures.

Table 2. Soil test values and fertilizer dose under various farmers field

Farmers	Soil test values (kg/ha)			Fertilizer dose (kg/ha) as per soil test		
	N	P	K	N	P_2O_5	K_2O
1	105	9.93	191	43.02	52.89	28.18
2	178	7.30	225	7.84	63.67	20.77
3	210	12.50	217	-7.38	42.35	22.46
4	172	14.20	261	10.86	35.38	12.78
5	213	12.90	213	-8.82	40.71	23.34
6	210	15.50	205	-7.38	30.05	25.10
7	214	11.30	280	-9.30	47.27	8.65
8	194	16.80	325	0.30	24.72	-1.30
9	166	9.07	173	13.74	56.41	32.14
10	160	10.40	213	16.62	50.96	23.34

Results and Discussion

Yield attributes and biomass yield analysis

The yield attributing characters have direct influence on the plant productivity and for increasing the yield. In the present findings number of branching were influenced positively due to nutrient supply on the basis of soil test. Thus, the maximum number of branching 9 per plant was noted in case of recommended practice treatment (T2). This treatment having all the essential plant nutrients, so that supply of nutrient enhanced the growth of plant and helped in well development of yield attributes.

The increase in fertility level through application of fertilizers on the basis of soil testing (RP) treatment from different sources increased the quantitative parameters of soybean. Higher grain and straw yield of soybean (1880 and 2640 kg/ha) were observed in T2 (RP) over T1-farmers practice (1180 and 1770 kg/ha) respectively (Table 3). The maximum increase in soybean yield was noted due to applied fertilizers on the basis of soil testing in recommended practice, which increases the yield attributing characters responsible for higher yield (Thakur *et al*. 2011 and Bodkhe *et al*. 2014).

Among both the treatments Harvest Index (HI) was observed 40.0% and 40.9% in farmers practice (FP) and recommended practice (RP), respectively. This variation may be due to variation in supply of plant nutrients in both treatments. The maximum HI was found in T2-recommended practice (RP) treatment where maximum nutrient availability was occurred and minimum HI was associated with farmers practice (T1). This means that more photosynthesis were derived due to increase supply of plant nutrients from different sources applied, which was finally resulted in to superior crop harvest (Dwivedi *et al*. 2012).The greater partitioning of photosynthates towards the production straw rather than the seed yield (Tiwari and Methew 2002).

Table 3. Performance of soybean under different parameter

S. No.	Parameter	Treatment	
		Farmers Practice (T1)	Recommended Practice (T2)
1	Number of nodules/ plant	21	42
2	Grain yield (kg/ha)	1180	1830
3	Straw yield (kg/ha)	1770	2640
4	Harvest Index (%)	40.00	40.94
5	Total N uptake (kg/ha)	60.84	87.47
6	Total P uptake (kg/ha)	7.05	9.72
7	Total K uptake (kg/ha)	31.01	42.09
8	Net income (₹)	17096	30542
9	Benefit cost ratio	2.88	4.05
10	Yield capacity (q/ha)	-	20
11	Technological gap	-	1.7
12	Extension gap	-	6.5

Economics

The maximum supply of plant nutrients particularly having T2 treatment in recommended practice gave the maximum net income ₹ 30542/ha, whereas the minimum net income ₹ 17096/ha was found in farmers practice. Accordingly, the T2 treatment (recommended practice) registered the highest B:C ratio 4.05 and lowest B:C ratio 2.88 was observed in case of farmers practice (Table 3).

Uptake of nutrients

As regard total nutrient uptake of N, P and K by soybean were (87.47, 9.72 and 42.09 kg/ha) higher in recommended practice (RP) treatment over farmers practice (60.84, 7.05 and 31.01 kg/ha) respectively (Table 3). Nutrient uptake by grain and straw as well as total uptake by soybean plant increased with increasing nutrient level (Sharma *et al*. 2006; Thakur and Sawarkar 2009).

Table 4. Human Resource Development Components

S. No.	HRD Components	Frequency	Beneficiaries
1	Training		
i	Soil testing	3	86
ii	Soil and water conservation	1	23
iii	Integrated nutrient management technology	1	31
iv	Nutrient use efficiency	1	25
v	Micronutrient deficiency and their control	1	20
vi	Training on FLD	1	22
2	Radio talk	1	Mass
3	Soil health camp	1	52
4	Field day	1	32
5	CD show (on campus)	3	115
6	Popular articles	10	Mass
7	Training hand out	5	145
8	Kisan Mela	1	Mass
9	Krasak sangosthi	1	120

HRD components

Awareness among the extension functionaries and farmers as well as soil testing staff in various aspects of the programme is necessary. Starting from the methodology of soil sample collection, its analysis through deploying appropriate testing methods, framing of recommendations and timely communication of the same and the methodology for fallow up can be ensured through properly trained personnel involved in the programme. During the study period, Human Resources Development Components i.e. training, radio talk, soil health camp, field day, CD shows, popular articles, training handout, Kisan Mela and Krasak Sangosthi were also taken to increase the farmers understanding and skill about the recommended practice on soil test crop response (Table 4). The similar results were also supported by Agrawal *et al*. 2011 and Dwivedi *et al.* 2013. They concluded that farmers are required HRD components to make aware about the associated activities.

Extension and technological gap

Extension gap (6.5) was calculated by subtracting farmers practice yield from recommended practice. The different of this gap is denoted that there is a sufficient chance to increase in rice yield by adopting recommended technology. Technological gap (1.7) was calculated by subtracting recommended technological yield from yield capacity of particularly variety. This gap is express that there is need to guide and educate for adopting recommended technology (Table 3). The results are in close conformity with results of Garg *et al*.(2010) and they were reported that 36.66 per cent of the farmers had low and medium adopted use of recommended dose of fertilizers. These results are also in agreement with the findings of Khan *et al*.(2008).

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