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Short Communication

Productivity and profitability of soybean as influenced by site-specific nutrient management under mid-hill conditions of Himachal Pradesh

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ABSTRACT

A field experiment was conducted at Research Farm, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur, India to study the productivity and profitability of soybean under site-specific nutrient management. The experiment was laid out in randomized block design comprising of three replications and seven treatments including $N_{43}P_{43}K_{50}$, $N_{43}P_{43}K_0$, $N_{43}P_0K_{50}$, $N_0P_{43}K_{50}$, $N_{20}P_{60}K_{40}$, Farm yard manure (5t/ha) and $N_0P_0K_0$. Experimental site was silty clay loam in texture, acidic in reaction, low in available nitrogen, and medium in available phosphorus and potassium. The highest seed yield (1840 kg/ha), harvest index (38.5%), yield gap over $N_{43}P_{43}K_{50}$(919kg/ha in T_7), net return (42234 Rs/ha) and benefit cost ratio (2.25) was recorded at $N_{43}P_{43}K_{50}$(SSNM). Omission of nutrients significantly reduced yield and monetary returns while it enhanced yield gap. The lowest seed yield, harvest index, net return and benefit cost ratio was recorded in absolute control treatment ($N_0P_0K_0$). Site specific nutrient management (N_{43} P_{43} K_{50}) proved to be the best treatment in enhancing the yield and monetary returns of soybean. The recommended dose of nutrients ($N_{20}P_{60}K_{40}$) and farm yard manure @ 5t/ha proved to be the second and third best treatment, respectively.

Key words: Productivity, Profitability, Site specific nutrient management, Soybean

Soybean is an important oilseed crop, grown under a wide range of agro-ecological conditions in different cropping systems. The Brazil, United States and Argentina are the world's largest soybean producers and represent 81% of global soybean production (Anonymous, 2019-20). In India, it was grown on an area of 11.18 million hectares with production and productivity of 13.15 million tonnes and 1235 kilogram/hectare, respectively (Anonymous, 2016b). Among the legumes, soybean is valued for its high protein (38-45%) as well as its high oil content (20%). It supplies approximately 65% world meal and 22% of the world edible oil. It is a soil building crop and its water requirement is less as compared to other crops (Imran *et al.*, 2017). The growing concern about impaired soil health, declining productivity and nutrient use efficiency are compelling the cultivars to use adequate doses of nutrients during last two decades. The low nutrient use efficiency and associated environmental pollution and global warming problems have raised serious concerns about the existing nutrient management practices. As such, it is high time to develop site-specific nutrient management technologies which are able to synergic crop-soil nutrient dynamics. It is an approach to feed crops with nutrients as and when needed. The application and management of nutrients are dynamically adjusted to crop needs of the location and season. Considering the above-said facts, the present investigation was carried out.

The field experiment was conducted at Research farm, Department of Genetics and Plant Breeding, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur, India during rainy season of 2018. The soil of the experimental site was silty clay loam with 5.4 pH and 0.5% OC. The available nitrogen, phosphorus and potassium was 131.1, 13.1 and 256.2 kg/ha, respectively. The weekly maximum and minimum temperature ranged from 23.57 ºC to 32.89 ºC and 10.14 ºC to 20.64 ºC, respectively. The mean relative humidity ranged from 24.07% to 94.93% and total of 2619.4 mm rainfall was received during the crop season.

The experiment was laid out in randomized block design with seven treatments and three replications. The treatments were $N_{43}P_{43}K_{50}$ (SSNM), $N_{43}P_{43}K_0$ (K omission), $N_{43}P_0K_{50}$ (P omission), $N_0P_{43}K_{50}$ (N omission), $N_{20}P_{60}K_{40}$ (RDN), FYM @ 5t/ha (Farmer's Practice) and $N_0P_0K_0$ (absolute control). This SSNM-NE software tool is developed by International Plant Nutrition Institute (IPNI) in collaboration with International Maize and Wheat Improvement Centre (CIMMYT). Nutrient Expert is based on SSNM principles and is an easy-to-use, highly interactive, and computer based decision support system that rapidly provides nutrient recommendations for an individual farmer's field both in the presence or absence of soil-testing data, and thus develops fertilizer recommendations for a specific plot or growing environment. To calculate the site specific doses, Nutrient Expert^R calculator was used which required information including average yield of soybean in region, recommended dose of nutrients, targeted yield, previous grown crop and nutrients applied in the field, status of organic carbon, available nitrogen, phosphorus and potassium, and soil texture. The soybean was used as test crop. Seeds were sown at an inter-row spacing of 45 cm at a seed rate of 100 kg/ha. Different doses of nitrogen, phosphorus and potassium, and farmyard manure were applied as per the respective treatment. To control the grassy and broadleaf weeds, pendimethalin (Stomp 30 EC) was applied @ 4.5 l/ha within 48 hours of sowing whereas quizalofop (Targa Super) @ 750 ml/ha + chlolrimuron (Curin) @ 37.5 g/ha were applied as post-emergence at 40 days after sowing. One hand weeding was also done at 55 days after sowing for the control of major weeds like *Echinocloa colona, Ageratum conyzoides, Polyganum alatam, Euphorbia* sp. etc. Super (Chlorpyriphos+Cypermethrin) was applied @ 1.0 l/ha at 70 days after sowing to control insects (beetles and weevils) attack on the crop. Other package of practices recommended for the region was also followed. Data were recorded on yield, yield gap and economics of soybean and subjected to analysis of variance with mean comparison of 5% level of significance (Gomez and Gomez 1984).

The data on effect of different treatments on seed and straw yield, and harvest index were presented in table 1. Seed and straw yields were significantly influenced by different treatments. The highest seed and straw yields was recorded in N_{43} $P_{43}K_{50}$ (SSNM) while the lowest yields was recorded in absolute control. $N_{20}P_{60}K_{40}$ (RDN) and farmer's practice (farmyard manure, 10 t/ha) recorded significantly higher yields over $N_{43}P_{43}K_0$ (K omission), $N_{43}P_0K_{50}$ (P omission) and $N_0P_{43}K_{50}$ (N omission) and was 2nd and 3rd best treatment, respectively. N_{43} P_{43} K_{50} (SSNM) resulted in 9.1, 11.2 and 99.8 percent increased seed yield over $N_{20}P_{60}K_{40}$ (RDN), FYM @ 5t/ha (Farmer's Practice) and $N_0P_0K_0$, respectively. Omission of nitrogen, phosphorus and potassium from N_{43} P_{43} K_{50} (SSNM) reduced 34.23, 33.85 and 37.71 percent seed yield in $N_{43}P_{43}K_0$ (K omission), $N_{43}P_0K_{50}$ (P omission), $N_0P_{43}K_{50}$ (N omission), respectively (Table 1). This shows that if nutrients are applied according to site specific needs targeted yield can be easily achieved. This might be due to fulfilment of nutritional needs of crop on that site. The findings of Kauraw *et al.* (2007), Patil *et al.* (2016) and Rana and Badiyala (2014) confirm the present experimental results. The harvest index also followed the similar trend like yield. The highest harvest index was noted in N_{43} P_{43} K_{50} (SSNM) while the lowest was in absolute control. This might be due to reason that balanced application of nutrients resulted in the higher seed yield over straw yield. Similar results have also been reported by Swati and Singh (2018) in soybean.

A perusal of data on effect of different treatments on yield gap over $N_{43}P_{43}K_{50}$ (SSNM) and yield gap over $N_{20}P_{60}K_{40}$ has been presented in table 1. The lowest yield gap (153kg/ha) over $N_{43}P_{43}K_{50}$ (SSNM) was recorded in $N_{20}P_{60}K_{40}$ while the highest yield gap (919 kg/ha) was in absolute control. Farmers' practice (FYM, 5t/ha) resulted in higher yield gap as compared to $N_{20}P_{60}K_{40}$. The lowest yield gap (32 kg/ha) over $N_{20}P_{60}K_{40}$ was recorded in farmers' practice (FYM, 5t/

Table 1. Effect of different treatments on yield, yield gap and monetary returns

Treatment	Yield (kg/ha)		HI (%)	Yield gap (kg/ha)		Monetary returns (Rs/ha)		
	Seed	Straw		Yield gap over T_1	Yield gap over T_5	Gross	Net	B:C
T_1 - N_{43} P_{43} K_{50} (SSNM)	1840	2939	38.5	-	-153	76156	42234	2.25
T_2 - N_{43} P_{43} K_0 (T_1- K omission)	1210	2307	34.4	630	477	51578	18577	1.56
T_3 - N_{43} P_0 K_{50} (T_1- P omission)	1217	2311	34.5	623	470	51839	20902	1.68
T_4 - N_0 P_{43} K_{50} (T_1- N omission)	1146	2255	33.7	694	541	49130	15738	1.47
T_5 - N_{20} P_{60} K_{40} (RDN)	1687	2891	36.8	153	-	70609	35981	2.04
T_6 - FYM@5t/ha(Farmer's Practice)	1655	2898	36.3	185	32	69517	30031	1.76
T_7 - N_0 P_0 K_0(Absolute control)	921	2104	30.4	919	766	40651	11165	1.38
SEm±	80	62	-	-	-	-	-	-
CD (P=0.05)	248	192	-	-	-	-	-	-

SSNM – Site specific nutrient management RDN – Recommended dose of nutrients ha) while the highest (766 kg/ha) was in absolute control. Application of major N, P and K nutrients in addition to micronutrient like in case of farmyard manure resulted in higher seed yield. Omission of nutrients, N, P and K like in case of $N_{43}P_{43}K_0$ (K omission), $N_{43}P_0K_{50}$ (P omission), $N_0P_{43}K_{50}$ (N omission) and absolute control resulted in drastic reduction in yield. Yield gap might be due to the variation in yield in different treatments. This indicates that adequate quantity of nutrients should be supplied to harvest good yield of soybean.

The date on gross return, net return and benefit cost ratio were presented in the table-1. The maximum gross and net returns was observed in $N_{43}P_{43}K_{50}$ (SSNM). The lowest returns was noted in control treatment. Omission of nutrient drastically reduced the gross and net returns in $N_{43}P_{43}K_0$ (K omission), $N_{43}P_0K_{50}$ (P omission), $N_0P_{43}K_{50}$ (N omission) and absolute control. $N_{20}P_{60}K_{40}$ and farmer's practice (FYM @ 5t/ha) were equally better treatment like $N_{43}P_{43}K_{50}$ (SSNM) in respect of returns. This might be due to higher yields at higher nutrient level. Hellal and Abdelhamid (2013), Patil *et al.* (2018) and Billore and Srivastava (2015) reported similar results. Maximum B:C was observed in $N_{43}P_{43}K_{50}$ (SSNM) while the lowest was in control. Singh *et al.* (2013) and Swati and Singh (2018) also reported similar results in soybean.

Site specific nutrient management (N_{43} P_{43} K_{50}) proved to be the best treatment in enhancing the yield and monetary returns of soybean. The recommended dose of nutrients ($N_{20}P_{60}K_{40}$) and farm yard manure @ 5t/ha proved to be the second and third best treatment, respectively.

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Commentary

Genetic improvement for smarter pulses: Need of the hour

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With more than 31 years' experience in research and management, Dr N P Singh is a pioneer in integrating biotechnological tools for pulses improvement in the country. He started his research career as a plant breeder in ICAR-IIPR in 1987, joined as Project Coordinator, AICRP-Chickpea in 2007 and is now leading the Indian Institute of Pulses Research as Director since 2014. Dr Singh has to his credit 14 varieties in different pulses, the first draft chickpea genome, the MAB product for *Fusarium* wilt resistance (*Foc* race 2) and drought tolerance in chickpea and the Seed Hub programme of the nation to name a few. Dr Singh developed several ideas, concepts and processes which are appreciated worldwide and attracted funds. Development of extra-large seeded *kabuli* chickpea varieties (which transformed the country from net importer to net exporter of premier quality product), development of extra short duration (52-55 days maturity) mungbean (which brought substantial area of mungbean under summer fallows in Indo-gangetic plain), and application of molybdenum in soybean-chickpea system (for sustainability of system by enhancing Biological Nitrogen Fixation in Central India including Maharashtra) are few examples. His vision and efforts have been ground breaking and have aided to bring the nation to achieve self-sufficiency in pulses production. He is recipient of numerous national and international awards.

Encompassing high protein content and fifteen essential minerals, pulses are one of the most important constituents of cereal-based vegetarian diets of the Indian subcontinent. Though pulse production has witnessed a mammoth leap within recent years to reach a record production of 25.42 MT in 2017-18, sustaining to 22-24 MT thereafter which is higher by 8-9 MT than the last decade, the demand and supply gap still exists and needs to be bridged.

The effective area under pulses cultivation in the country is estimated at about 25-26 million hectares while the realized productivity is less than 1 ton per hectare. Shortfall in pulses has been attributed to a number of factors, the major being ever-increasing population, dependency on climate and abrupt climatic changes, geographical shift in the area, complex disease-pest syndrome, socio-economic conditions of the farmers, poor storage and post harvest management infrastructure and less market opportunities. The major constraints that limit the realization of potential yield of pulses include biotic and abiotic stresses prevalent in the pulses-growing areas besides socio-economic factors. Among biotic stresses, *Fusarium* wilt coupled with root rot complex is probably the most widespread disease causing substantial losses to chickpea, besides dry root rot and collar rot. While *Fusarium* wilt, sterility mosaic and *Phytophthora* blight cause substantial losses in pigeonpea, lentil, rust, powdery mildew and wilt cause considerable damage. In *Vigna* crops (mungbean and urdbean) mungbean yellow mosaic disease, *Cercospora* leaf spot, powdery mildew and leaf crinkle and leaf curl cause considerable damage. Among key insect-pests, gram pod borer (*Helicoverpa armigera*) in chickpea and pigeonpea, pod fly in pigeonpea, whitefly, jassids and thrips in mungbean and urdbean cause severe damage to the respective crops. Bruchids are the most serious pest of the stored pulse grains and require topmost priority in management. Weeds also cause substantial loss to pulses. Recently, nematodes have emerged as potential threat to the successful cultivation of pulses in many areas.

Among abiotic stresses, drought and high temperature at terminal stage, cold as well as sudden drop in temperature coupled with fog during the reproductive phase and salinity/alkalinity throughout the crop period inflict major yield losses and instability in production. All these stresses make