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Effect of nutrient management for sustainable soil health under soybean (*Glycine max)*: Chickpea (*Cicer arietinum*) cropping system

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Abstract
A field experiment was conducted during 2017-18 to 2018-19 at Research Farm, under Indira Gandhi Krishi Vishwavidyalaya, Raipur (CG). With four nutrient management practices to evaluate the effect of residual and direct nutrient application on quality and seed yield of soybean and chickpea on system under *Vertisols* of Chhattisgarh plains. Results revealed that soil quality parameters such as Dehydrogenase activity, acid phosphates activity and alkaline phosphates activity recorded highest under treatment of 50% recommended doses of NPK and 50% organic on soybean. In chickpea crop, the residual effect of previous crop and direct nutrient application significantly highest yield parameters as well as quality parameters recorded under recommended dose of NPK (25:60:40 kg ha^{-1}) in chickpea which was found at par to the treatment of 50% doses of N and 100% P and K, Under soybean-chickpea cropping system.

Keywords: Soybean, chickpea, cropping system, yield, soil biological activity

Introduction

Soybean in rainy season followed by chickpea in winter forms the most important cropping systems under *rainfed* condition on *Vertisols.* Soybean is the chief oilseed crop specific has been far underneath the potential yield feasible. Based on imperative investigations have shown that imbalanced nourishment is one of the vital explanations behind limited development in profitability, (Tiwari, 2001) [14]. In India, chickpea is an important legume crops and plays an important role to improve soil fertility due to nitrogen fixation by *Rhizobium* bacteria found in its root nodules. It is capable of thriving in harsh and fragile environments. It has comparative advantage in contributing to crop diversification, rotation and mixed cropping. It is also called low agriculture crop due to its nitrogen fixation property and an important source of vegetable protein. Conjunctive use of organic and inorganic fertilizer boost up crop yield as well as maintain soil health on long term basis (Singh *et al.* 2003) [12] have reported that application of organic manures either as farm yard manure in combination with chemical fertilizer improve the nutritional quality of soybean and sorghum grown in sole and intercrop system. Due to pulse-pulse existing cropping system of fertilizer applications based on nutrient requirement of individual crop ignoring the carryover effect of manure of fertilizer application to succeeding crop to a great extent and the system productivity become sustainable through integrated use of organic and inorganic source of nutrient. Hence a field experiment was conducted to study the effect of nutrient management for sustainable soil health under soybean-chickpea cropping system for improving seed yield, quality and biological activity of soil.

Materials and Methods

Experiment conducted on two years on the problem of Effect of nutrient management for sustainable soil health under soybean-chickpea cropping system was carried out 2017-18 to 2018-19 at Research Farm, under "Indira Gandhi Krishi Vishwavidyalaya, Raipur (CG)." With four nutrient management practices *viz*. (T_1)-RDF of NPK (25:60:40) kg. ha^{-1}. (T_2)-50% RDF of N, P and K. (T_3)-50% RDF of NPK and 50% organic. (T_4)-absolute control (Rhizobium only) on soybean crop during *kharif* season was carried out on RBD with four replication. On succeeding chickpea crop during *rabi* season effect of residue of *kharif* season crop and four nutrient management practices *viz*.(T_1)-RDF of nutrients (NPK 25:60:40) kg ha^{-1}.(T_2) -50%

doses of N and 100% P and K.(T_4)-absolute control (*Rhizobium* only) crop laid on design of split plot with four replication. Experimental soil was in clayey nature, in pH neutral and low quantity of nitrogen, in medium range of phosphorus and high range in potassium. During the crop growing periods a total precipitation of 100.0 mm and 141.0 mm during *kharif* season and 2.34 mm and 2.48 mm during *rabi* season was taken. Various growth, yield attributes observations and economics were recorded and data was analyzed on the basis of statistics."

Result and Discussion

Soil enzyme activity

Dehydrogenase activity (µg TPF/h/g soil), Acid phosphatase activity (µg PNP $g^{-1}h^{-1}$ soil) and Alkaline Phosphatase activity (µg PNP $g^{-1}h^{-1}$ soil) Soil enzyme play vital role in nutrient transformations, recycling and nutrient availability to the plant from the soil and they are likely to be influenced fertilizer and manures (Shrivastava and Lal 1994) Dehydrogenase activity (µg TPF/h/g soil) as an index of microbial activity because it refer to a group of moistly intracellular activity which catalyses the oxidation of soil organic matter (Foster *et al.* 1993). It is an enzymes that involve in microbial oxido-reductase metabolism. Activity of this enzymes significantly correlates with soil biomass carbon. Thus Dehydrogenase activity is indicated to be good indicator of soil microbial activity (Garcia *et al.* 1994) Acid phosphatase of fertilizer and organic manure as compared to control." Alkaline Phosphatase activity (µg PNP $g^{-1}h^{-1}$ soil) activities are important soil enzyme, which play an essential role in mineralization of organic phosphorus to available phosphorus. Higher dehydrogenase activity (µg TPF/h/g soil) Acid phosphatase activity (µg PNP $g^{-1}h^{-1}$ soil) and Alkaline Phosphatase activity (µg PNP $g^{-1}h^{-1}$ soil) was recorded under treatment of 50% recommended doses of N, P and K and 50% organic. This can be attributed mainly due to the large number of variable, dead and living microorganism and the large quantity of readily utilizable energy source introduced by organic manure, (Ladd *et al.* 1994). This result also in apparent with finding by (Singh *et al.* 2008) [13].

Soy bean seed yield (kg ha^{-1})

Result of two year experiment increased seed yield significantly higher seed yield was registered under treatment of RDF of NPK (25:60:40 kg NPK ha^{-1}), which was significantly higher than rest of the treatments due to higher production of seed. The significantly lowest seed yield was recorded under the treatment of absolute control (*Rhizobium* only). The improvement in soil fertility status (NPK) facilitated quick and greater availability of plants nutrients, which increase the productivity of crops. The higher yield in the above treatments might be due to improvement in growth and yield components Enhancement in yield attributes might be because of higher dose and quick response and increasing availability of soil nutrient through inorganic fertilizer better availability of nutrients and hence such response. The results are in close agreement with the findings of Chaturvedi and Chandel (2005). Better source-sink relationship is a pre requisite to achieve increased yield attributes and yield which was reflected by increase in two number of pods plant^{-1}and higher LAI with 100% RDF as compared to control due to greater nutrient availability and dry matter production. The above result in turn was supported by the significant and positive correlation between seed yield and number of seeds these results were in conformity with the findings of Mohod *et al*. (2010) [5]

Stover yield (kg ha^{-1})

Result of two year experiment increased significantly higher stover yield was recorded under the treatment of RDF of NPK (25:60:40 kg NPK ha^{-1}). The significantly lowest stover yield (kg ha^{-1}) was recorded under the treatment of absolute control (*Rhizobium* only). It may be due to fertilizers increased the production of dry matter in plants, which enhanced the potential of plant to produce taller plants, coupled with more number of leaves and increased LAI that ultimately results in higher stover yield of soybean. Similar results have also been reported by Shivakumar and Ahlawat (2008). Enhancement in yield attributes might be due to higher dose and quick response and increasing availability of soil nutrient through inorganic fertilizer better availability of nutrients and hence such response. The results are in close agreement with the findings of Chaturvedi and Chandel (2005). This is due to the fact that the availability of nutrients was more from higher doses of nutrient than crop residue due to lower C:N ratio value, like seed yield of soybean, 100% RDF produced significantly maximum stover yield over other treatments. The variation in stover yield could also be attributed to the variations in growth components of soybean. Similar result also reported by Deshmukh *et al.* (2010).

Harvest index (%)

Significantly higher HI was recorded under treatment of RDF of NPK (25:60:40 kg NPK ha^{-1}) which was at par to the treatment of 50% recommended doses of N, P and K and 50% Organic and 50% RDF of N, P ad K. Harvest index (HI) is a useful parameter to assess the translocation efficiency of crop plants. In the present study higher harvest index was found to be which implies greater accumulation of dry matter. Similar observations in soybean were also reported by Deshmukh *et al.* (2010). Application of inorganic fertilizers, (100% RDF) produced higher value of harvest index which might be due to higher value of seed yield as compared to rest of the treatments.

Chickpea seed yield (kg ha^{-1})

The significantly maximum seed yield was recorded under the application of recommended dose of NPK (25:60:40 kg NPK ha^{-1}) to preceding crop. However it found at par to the application of 50% recommended doses of N, P and K and 50% organic, during previous years and mean of two years of investigation and 50% recommended doses of N, P and K. Concerning on direct nutrient application significantly higher seed yield was recorded under the application of recommended dose of NPK (25:60:40 kg NPK ha^{-1}) However it was at par to the treatment of 50% doses of N and 100% P and K. The higher seed yield may be attributed to release of sufficient plant nutrients from inorganic sources required for better crop growth and yield reported by Saha *et al.* (2008) [13]. It might be due to variation in yield attributes. Seed index, and seeds per pod. The findings are in agreement with the results of Shrivastav *et al.* (2006) [11]. It might be due to balanced nutrient supply to the plant so that plant growth and development was found vigorous under higher fertilizers level. The weight of individual seed is governed by the seed growth supported by concurrent CO2 assimilation during the seed filling phase rather than by the stored reservoir of carbohydrates during the vegetative phase. Thus, better nutrition of plants associated with increased fertilization helped in maintaining significantly better vegetative growth leading to greater interception of solar radiation by the crops and ultimately contributed towards the significant increase in number of filled grains (Sharma, 2009) [9]. These results corroborate the findings of Pandey, *et al*. (2009) [7] Paliwal, *et al*. (2011) [6] and Kaushik, *et al*. (2012) [3].

Stover yield (kg ha^{-1})

The stover yield as affected by residual effect of *kharif* treatments and direct application of nutrients on chickpea. Significantly higher stover yield recorded under the application of recommended dose of NPK (25:60:40 kg NPK ha^{-1}) to preceding crop. However it was found at par the application of 50% recommended doses of N, P and K and 50% organic. And 50% recommended doses of N, P and K. Significantly lowest stover yield recorded under the application of absolute control (*Rhizobium* only). Concerning on direct nutrient application significantly higher seed yield was recorded under the application of recommended dose of NPK (25:60:40 kg NPK ha^{-1}). Which was found at par the application of 50% dosed of N and 100% P and k. And 50% dosed of NPK. The significantly lowest stover yield was recorded under the application of absolute control (*Rhizobium* only) during two years of experimentation and their mean. The interaction effect between residual effect of *kharif* crop treatment and nutrient management practices on stover yield of crop did not showed significant value. It might be due to higher nutrient uptake by plants increase the growth of plant of plant which ultimately increases stover. The findings are in agreement with the results of panwar (2009).

Table 1: Effect of nutrient management on yield (kg ha^{-1}) of soybean 1 of soybean under soybean-chickpea cropping system

Treatment		Seed yield (kg ha^{-1})			Stover yield (kg ha^{-1})			Harvest index (%)			Seed index		
		2017	2018	Mean	2017	2018	Mean	2017	2018	Mean	2017	2018	Mean
T_1	Recommended dose of NPK (25:60:40 kg NPK ha^{-1})	2396	2420	2407	3246	3282	3264	43.2	42.3	42.8	11.5	11.3	11.4
T_2	50% Recommended dose of N, P and K	1542	1525	1533	2306	2365	2335	39.9	39.2	39.5	10.5	10.4	10.4
T_3	50% Recommended dose of N, P and K and 50% Organic	2013	2082	2047	2832	2825	2832	41.4	42.6	42.0	11.3	11.2	11.2
T_4	Absolute control (Rhizobium only)	1050	1067	1058	2221	2147	2184	37.1	33.2	35.1	9.40	9.30	9.3
S.Em±		107.2	22.68	64.99	14.69	36.25	25.47	1.38	0.54	0.96	0.22	0.18	0.20
CD (0.05)		343.2	72.58	207.9	47.05	115.9	81.51	4.41	1.73	3.07	0.69	0.58	0.63

Table 2: Effect of residual and direct application of nutrient on seed yield (kg ha^{-1}) of chickpea under soybean-chickpea cropping systems

Treatment		Seed yield (Kg ha^{-1})			Stover yield (kg ha^{-1})		
		2017-18	2018-19	Mean	2017-18	2018-19	Mean
A. Main plot (Residual effect of kharif treatments)							
RT_1	Recommended dose of NPK (25:60:40 kg NPK ha^{-1})	1689	1735	1712	2517	2567	2542
RT_2	50% Recommended dose of N, P and K	1545	1546	1545	2374	2437	2405
RT_3	50% Recommended dose of N, P and K and 50% Organic	1609	1654	1631	2434	2454	2444
RT_4	Absolute control (Rhizobium only)	830	831	830	1955	1970	1962
S.Em±		30.26	30.37	30.25	76.2	75.6	75.6
CD (0.05)		96.80	97.16	96.70	243.8	242.0	242.0
B. Sub plot (Direct nutrient application)							
F_1	Recommended dose of NPK (25:60:40 kg NPK ha^{-1})	1677	1691	1686	2491	2521	2506
F_2	50% Recommended dose of NPK	1509	1586	1521	2383	2420	2402
F_3	50% Doses of N and 100% P and K	1620	1634	1632	2413	2464	2439
F_4	Absolute control (Rhizobium only)	869	882	881	1991	2021	2006
S.Em±		19.30	19.15	1922	69.7	68.9	68.9
CD (0.05)		55.40	54.92	55.16	199.9	197.3	197.6

Table 3: Effect of nutrient management on quality of soil after harvest of soybean under soybean-chickpea cropping System

Treatments		Microbial population								
		Dehydrogenase activity (µgTPFg^{-1}d^{-1})			Acid phosphatase activity(µg *p*NP g^{-1}h^{-1})			Alkaline phosphatase activity(µg *p*NP g^{-1}h^{-1})		
		2017	2018	Mean	2017	2018	Mean	2017	2018	Mean
T_1	Recommended dose of NPK (25:60:40 kg NPK ha^{-1})	491.50	494.50	493.00	311.00	313.75	312.38	383.00	384.25	383.63
T_2	50% Recommended dose of N, P and K	440.75	441.00	440.88	290.25	291.75	291.00	324.75	328.25	326.50
T_3	50% Recommended dose of N, P and K and 50% Organic	625.25	627.00	626.13	358.25	362.25	360.25	434.75	437.25	436.00
T_4	Absolute control (*Rhizobium* only)	303.50	309.00	306.25	266.25	268.00	267.13	228.50	236.25	232.38
S.Em±		25.26	25.74	25.50	1.41	1.71	1.56	5.00	4.78	4.89
CD (P=0.05)		80.81	82.35	81.58	4.53	5.48	5.00	15.99	15.30	15.64

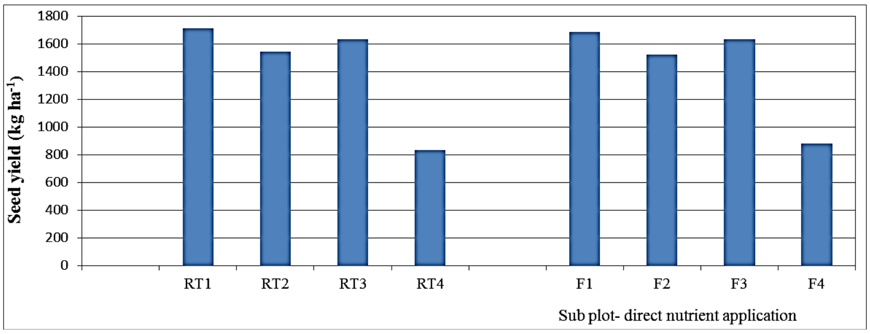

Fig 1: Effect of residual and direct application of nutrient on seed yield of chickpea under soybean-chickpea cropping system

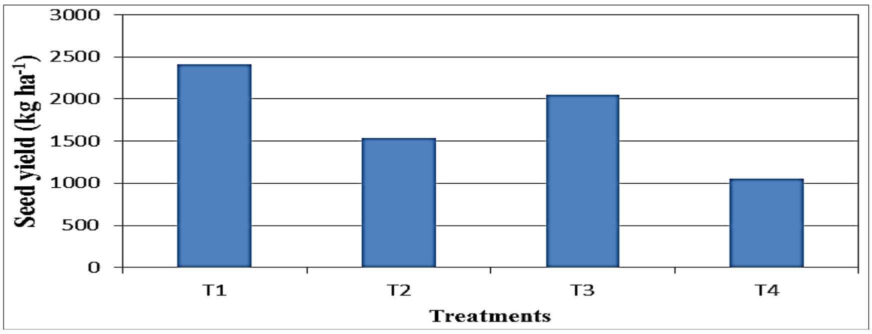

Fig 2: Effect of nutrient management on seed yield (kg ha^{-1}) of soybean under soybean-chickpea cropping system

Conclusion

Result under cropping system of soybean and chickpea gave highest seed yield, stover yield and harvest index when sown *kharif* crop soybean under treatment of RDF (25:60:40 kg ha^{-1}) and in case of chickpea *rabi* season crop gave highest yield under sown RDF (25:60:40 kg ha^{-1}) of fertilizer however it found at par to treatment of 50% doses of N and 100% P and K as well also higher in this treatment biological properties of soil and also responsible for improving soil quality.

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