Original Research Article   https://doi.org/10.20546/ijcmas.2018.704.178

Assessment of Soil Quality and Performance of Chickpea under Permanent Manurial Trial on Soybean-Chickpea Sequence in Rainfed Vertisols

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A B S T R A C T

The present study is carried out in a permanent manurial trial (PMT), which is running since 1992 in Vertisols with the following specific objectives to assess soil quality under permanent manurial trial, to determine crop quality of rain fed chickpea as influenced by long term fertility treatments under PMT, to Study the growth and productivity of chickpea under PMT and to work out the economic viability of different fertility treatments.

Introduction

Chickpea (*Cicer arietinum* L.) is the premier pulse crop of Indian subcontinent. Chickpea probably originated in southeastern Turkey and spread west and south via the Silk Route. Four centers of diversity have been identified in the Mediterranean, Central Asia, the Near East and India, as well as a secondary center of origin in Ethiopia.

It is grown and consumed in large quantities from South East Asia to India and in the Middle East and Mediterranean countries. It ranks second in area and third in production among pulses worldwide. India is the largest chickpea producer as well as consumer in the world. India grows chickpea on about 6.67 million ha area producing 5.3 million tons which represents 30% and 38% of the national pulse acreage and production, respectively. Chickpea production has gone up from 3.65 to 5.63 million tons between 1950-51 and 2004-05, registering a growth of 0.58% annually. During the period, area has marginally declined from 7.57 to 6.67 million hectare and the productivity has steadily increased to 844 kg/ha from 482 kg ha^{-1}. Notwithstanding its distribution throughout the country, six states *viz*., Madhya Pradesh, Rajasthan, Maharashtra, Uttar Pradesh, Karnataka and Andhra Pradesh together contribute 91% of the production and 90% of the area of the country.

The use of high analysis fertilizer for immediate boosting of production potentials of crop plants cast the shadow on use of organic manures. This reflects on degradation of soil quality and environments as well as sustainability of yield levels of crop plants (Virmani *et al.,* 1991). The genetic potential of different crop varieties is not changed. However, soil quality is the major functional factor in alteration of production potential of crops. To overcome this problem the integrated nutrient management system (INM) is adopted in cropping system. The basic concept of the INM is to maintain soil fertility for sustained crop productivity on long-term basis and also reduce fertilizer input cost. At present the quantity of inorganic fertilizers is reduced by substituting the various organic manures viz., FYM, vermi compost, green manuring and recycling of crop residues. The protection of environment and sustainability in yield levels can be achieved by the integrated nutrient management. This is the noble approach of organic farming.

Integrated nutrient management (INM) has shown its potential in increasing crop productivity may be due to the combined effect of nutrient supply, synergism and improvement in soil physical and biological properties and also in crop physiological processes. Therefore, it has realized that there is a need for an assessment on crop specific land quality so that the yield diminishing factors can be identified. The need for development of a land quality index with reference to type of land use was stressed by the World Bank (1995) and Karlen *et al.,* (1997).

Materials and Methods

The present investigation entitled "Assessment of soil quality and performance of chickpea under permanent manurial trial on soybean-chickpea sequence in rainfed Vertisols" was carried out in Rabi season during the year 2011-12 under All India Coordinated Research Project for Dry land Agriculture, College of Agriculture, Indore in field No.19.

The details of material used and methodology adopted are given below. There were nine treatments and each of them were randomized and replicated three times. The design used in the experiment was randomized block design. Details of treatments

FYM was applied in prescribed treatments at the time of field preparation only. The requisite quantity of nitrogen and phosphorus were applied as basal dose at the time of sowing. Crop residues were applied in prescribed treatments as surface mulch after emergence of the crop and incorporated after harvesting of crop. Method of statistical analysis

The data were analyzed by method of analysis of variance as described by Fisher (1950). The structure of analysis of variance is given below. The design of experiment was simple randomized block design with three replications. The null hypothesis was tested by the "F" test, which revealed the significance of treatment effects. The critical differences for treatment means was calculated by using equation given by Panse and Sukhatme (1967). The standard error of means and coefficient of variation were calculated from early mean square as follows:

$SEm + = EMS/r$

C.D. (5%) = $\sqrt{SEm}$ x 2 x table "t" value at 5% at 16 d.f.

Results and Discussion

The growth parameters of chickpea as influenced by various treatments are given in Table 1 with regard to plant height.

Data on seed yield of chickpea due to different treatments of chickpea have been given in Table 2.

Summary

The present investigation entitled "Assessment of Soil Quality and Performance of Chickpea under Permanent Manurial Trial on Soybean-Chickpea Sequence in Rainfed Vertisols" was carried out in Rabi season during the year 2011-12 under All India Coordinated Research Project for Dryland Agriculture, College of Agriculture, Indore. The details of material used and methodology adopted are given in present chapter. A field experiment was laid out in Randomized block design with nine treatments with three replications. The treatment comprises of nine fertility treatments viz. T_1- N0 P0 - Control, T_2- N20 P13 - Fertilizer N and P at the rate of 20 and 13 Kg ha^{-1}, T_3- N30 P20 -Fertilizer N and P at the rate of 30 and 20 Kg ha^{-1}, T_4- N40 P26 - Fertilizer N and P at the rate of 40 and 26 Kg ha^{-1}, T_5- N60 P35 - Fertilizer N and P at the rate of 60 and 35 Kg ha^{-1}, T_6- FYM 6t ha^{-1} + $N_{20}P_{13}$ - Farmyard manure was applied @ 6t ha^{-1} prior to sowing of soybean plus fertilizer N and P @ 20 and 13 Kg ha^{-1}, T_7- Residues 5t ha^{-1} + $N_{20}P_{13}$ - Crop residues of soybean @ 5t ha^{-1} as surface mulch in between Crop rows + fertilizer N and P at the rate of 20 and 13 Kg ha^{-1}, T_8- FYM 6tha^{-1} - Farmyard manure alone @ 6t ha^{-1}, T_9- Residues 5t ha^{-1}-Soybean crop residues alone @ 5t ha^{-1} after emergence in between crops rows as surface mulch. The gross plot size was 10 m x 7.2 m and after leaving non-experimental margin on both sides, the net experimental plot size was 9.0 m x 6.6 m. Chickpea (*Cicer arietinum* L.) crop (JG-412) was sown on October 16, 2011 and harvested on February 07, 2012. Chickpea seed at the rate of 80 kg per hectare were sown at row-to-row distance of 30 cm and plant to plant distance of about 3 cm at 2 to 3 cm deep in soil.

The results obtained in this study as elucidated in chapter IV lead to the following conclusions:-Growth parameters and yield attributing characters of chickpea were improved significantly by the use of organics and 50% of recommended dose of chemical fertilizer. Root length was affected by fertility treatments It was higher in INM treatments Like T6- $_{FYM}$ 6t ha^{-1} + $N_{20}P_{13}$, T7- Residues 5t ha^{-1} + $N_{20}P_{13}$ as well as organic treatments as compeered to inorganic fertilizer application. Lowest root length was recorded in control.

The highest chickpea seed yield was recorded due to half of the recommended dose of N and P + 6 t ha^{-1} of FYM (T6: FYM 6 t ha^{-1} +T2), Treatments T4, T5 and T6 were at par among themselves and Treatment T6 was found superior to rest of the treatments. The treatment T1 i.e. control was found statistically inferior to all the treatments. The highest Gross and net return was obtained due to INM treatment followed by RDF, pure organic and lowest in case of control.

There was a non-significant difference in the B: C ratio of the treatments T2, T4, T5 and T6, Lowest B; C ratio was observed in Control treatment. FYM and crop residue added treatments gave higher MWD in comparison to chemical fertilizer added treatment. Addition of organic along with chemical fertilizer and alone reduced the bulk density. The porosity was highest in the treatment T6 (FYM + $N_{20} P_{13}$) and lowest in case of control. The application of organic manure considerably decreases the penetration force. Three is a marked difference in the initial infiltration rate of different treatments this difference was persisted till 9 hours of elapse time, but the magnitude of difference was reduced with time. Treatments involving FYM and crop residue resulted in a considerable buildup of soil fertility particularly available N, P and organic carbon content in plough layer.

Nine treatments given to Chickpea crop

T_1	N_0P_0	-	Control i.e. no fertilizer from any source
T_2	$N_{20}P_{13}$	-	Fertilizer N and P @ of 20 and 13 kg ha^{-1}
T_3	$N_{30}P_{20}$	-	Fertilizer N and P @ of 30 and 20 kg ha^{-1}
T_4	$N_{40}P_{26}$	-	Fertilizer N and P @ of 40 and 26 kg ha^{-1}
T_5	$N_{60}P_{35}$	-	Fertilizer N and P @ of 60 and 35 kg ha^{-1}
T_6	FYM 6 t + $N_{20}P_{13}$	-	Farmyard manure @ 6 t/ha in rainy season only + fertilizer N and P @ 20 and 13 kg ha^{-1}
T_7	Residues 5 t + $N_{20}P_{13}$	-	Crop residues of soybean @ 5 t ha^{-1} as surface mulch in between crop rows + fertilizer N and P @ of 20 and 13 kg ha^{-1}
T_8	FYM 6 t ha^{-1}	-	Farmyard manure @ 6 t ha^{-1} in rainy season
T_9	Residues 5 t ha^{-1}	-	Crop residues of soybean @ 5 t ha^{-1} after emergence in between crop rows as surface mulch

Physio-chemical properties of the soil of the experimental field

SN	Soil parameters		Value	Methods used
1	Mechanical composition			
	Sand %		13.25	International Pipette method
	Silt %		30.75	- do -
	Clay %		56.00	- do -
2	Soil pH (1: 2)		7.6	Glass electrode pH meter
3	Electrical conductivity (dSm^{-1}) (1: 2 soil/water ratio)		0.22	(Piper, 1950)
4	Organic carbon (%)	0-30 cm	0.38	Walkley and Black method (1934)
5	Calcium carbonate (%)		4.00	
6	Terminal infiltration rate		10 mm	Infiltrometer Ring method (Richards, 1954)
7	Moisture retention	At 0.3 bar	400 mm m^{-1}	Pressure plate and Pressure membrane apparatus (Richards, 1954)
		At 15 bar	220 mm m^{-1}	
8	Available nutrient status			
	(i) Available nitrogen (kg N ha^{-1})	0-30 cm	180.13	Alkaline Permanganate method (Subbiah and Asija, 1965)
	ii) Available phosphorus (kg P ha^{-1})	0-30 cm	5.98	Spectro Photometer with Olsen's extractant (Olsen *et al.,* 1954)
	iii) Available potassium (kg K ha^{-1})	0-30 cm	332.31	Flame Photometer (Jackson, 1967)
	iv) Available sulphur (kg S ha^{-1})	0-30 cm	12.58	Bardsley and Lancastor method (1960).

Table.1 Plant growth and yield attributing characters of chickpea as influenced by different treatments at harvest (2011-12)

TREATMENTS	Plant height (cm)	Branch plant^{-1}	Pods plant^{-1}	TDM plant^{-1} (g)	Yield plant^{-1} (g)	Test wt.(g)
T1-N0 P0- Control	36.67	3.60	33.20	14.1	6.6	15.53
T2- N20 P13	41.93	3.07	33.73	19.4	8.9	16.83
T3-N30 P20	44.33	3.60	41.47	20.2	10.3	16.90
T4-N40 P26-	47.80	3.53	41.13	21.9	11.2	17.87
T5-N60 P35	49.03	3.27	43.67	24.7	11.9	17.73
T6- FYM 6 t ha^{-1} + T2	52.80	4.13	48.13	24.1	12.6	17.80
T7-Residues 5t ha^{-1}+T2	49.90	2.93	47.47	20.7	11.0	17.43
T8-FYM 6t ha^{-1}	44.00	3.87	43.73	23.3	12.0	17.67
T9 –Residues 5t ha^{-1}	47.53	3.47	41.73	21.9	11.0	17.40
SEm ±	3.4	0.44	3.87	1.7	0.9	0.40
CD 5%	10.1	1.31	11.61	5.2	2.7	1.20

Table.2 Seed and straw yield, harvest index and economics of chickpea production due to different treatments (kg plot^{-1})

Treatments	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})	HI %	Net returns (Rs ha^{-1})	BC ratio
T1 Control	566	592	49.6	12122	2.15
T2 N20 P13	762	684	52.7	19307	2.73
T3 N30 P20	999	737	57.6	28476	3.48
T4 N40 P26	1044	779	57.2	29905	3.52
T5 N60 P35	1211	930	57.1	35893	3.86
T6 FYM 6 tha^{-1} + T2	1372	1001	57.7	44594	5.34
T7 Residues 5 tha^{-1}+ T2	1258	941	56.4	38831	4.38
T8 FYM 6 tha^{-1}	1052	858	54.9	31978	4.17
T9 Residues 5 tha^{-1}	1020	803	55.6	30291	3.88
SEm ±	94	75.6		4161	1.02
CD (5%)	281	160		1577	15.79

The percent increase in organic carbon, N, P, K and S was 154%, 58%, 107%, 53% and 171%, respectively due to treatments T6 over control. Addition of organics and RDF has helped to build up soil fertility but lower doses of N and P as compared to RDF has depleted the soil fertility in terms of OC, N, P, K and S content. The perusal of the data revealed that OC balance was found negative in the treatment T1, T2, and T3. The highest buildup of OC was obtained in T6- FYM 6 t ha^{-1} + T2 followed by T8-FYM 6t ha^{-1}, T7-Residues 5t ha^{-1} + T2, T9 –Residues 5t ha^{-1}, T5-N60 P35 and T4-N40 P26. In case of nitrogen there was a negative balance in T1 (Control) and T2 treatments rest of the treatments have positive balance. The P and K balance was found +ve in all the treatments except T1 Control, where it was found -ve. S balance was found –ve balance in all the treatments. The soil quality assessment study on the basis of the criteria given by Pierce and Larson (1993) and Larson and Pierce (1994) conclude that there was a great increase in soil quality in the treatments T6, T7, T8 and T9 due to addition of organics, while this increase was moderate in the treatments T3, T4, and T5. The increase in soil quality in case of inorganic fertilization with 50% of RDF was slight. Treatment T6: FYM 6t ha^{-1} + T2 recorded higher uptake of N, P, K and S as compared to any level of application of fertilizer source. Lowest uptake of all the nutrients was recorded in the control i.e. T1. The WUE being lowest in T1: N0 P0 Control plots and highest in T6: FYM 6 t ha^{-1} + T2.

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