Original Research Article

Response of inorganic fertilizers, organic manure and biofertilizer on soil physical parameters in chick pea (*Cicer aretinum* L.) Cv. Aruna

ABSTRACT

The use of inorganic fertilizer, biofertilizer and organic manure in combination with soil can have various effects on the physical parameters of soil, such as soil structure, porosity, water holding capacity, bulk density. The designed lay out 48 total soil samples were taken from different depths 0-15 cm and 15-30 cm. The optimal combination of these inputs depends on the type of soil, crop and climate. Generally, the application of organic manure can improve the soil structure and porosity, while the addition of biofertilizer can enhance the soil fertility and microbial activity. The use of inorganic fertilizer can provide essential nutrients for plant growth, but it should be applied in appropriate amounts and forms to avoid negative impacts on the soil quality and environment. The conjunctive use of N P K and different vermicompost and rhizobium the treatment T_{16}- [RDF @ 100 % + VC @ 100 % + Rhizobium @ 100 %] gave best results physical properties of soil.

***Key words*:** Vermicompost, rhizobium, soil health parameters, *etc.*

Introduction

Soil is a complex mixture of minerals, organic matter water, air and micro-organisms that serves as a foundation for plant growth as well as a variety of ecosystem services. It is an essential natural resource that supports human livelihoods biodiversity and a variety of ecosystem services such as carbon sequestration, nutrient cycling and water regulation. Achieving sustainable farming practices, reducing climate change and preserving global food security depend on managing and conserving soil health **(Lal, 2009).** the health of the soil and the services it offers are seriously threatened by soil degradation, which is caused by problems including erosion, pollution and misuse. using techniques like crop rotation, conservation tillage and organic farming, which enhance soil health and reduce the adverse effects of agricultural activities on soil quality is essential for maintaining the long-term health and sustainability of soils **(Pimentel *et al.*, 2005).** Soil plays a crucial role in the growth and development of chickpeas, which are a type of legume that is commonly grown for its nutritious seeds. chickpeas require well-drained soils with good structure, a neutral pH, and adequate levels of nutrients, particularly nitrogen, phosphorus, and potassium **(Thakur *et al.*, 2019).** Physical properties play an important role in determining soil's suitability for agricultural, environmental and engineering uses. The supporting capability; movement, retention and availability of water and nutrients to plants; ease in penetration of roots, and flow of heat and air are directly associated with physical properties of the soil. physical properties also influence the chemical and biological properties. The most pertinent physical properties of soil relevant to its use as a medium for plant growth **(Hillel 2015).**Vermicompost is a nutrient-rich organic fertilizer produced by the breakdown of organic matter by earthworms. vermicompost contains beneficial microorganisms that help to improve soil health by increasing soil fertility, water-holding capacity and nutrient availability. Studies have shown that the application of vermicompost can significantly improve soil health in chickpea fields **(Singh *et al.*, 2019; and Sharma *et al.*, 2020)**.A judicious use of organic manures and biofertilizers may be effective not only sustaining crop productivity and in soil health, but also in supplementing chemical fertilizers of crop **(Jaipal *et al.*, 2011)**

Material and Method

Site details

The field experiment was carried out at the research farm of Soil Science and Agricultural Chemistry, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during in *rabi* season 2021-22. The maximum temperature of the location ranges between 46.0-48^0C and seldom falls below 4^0C-5^0C. The relative humidity ranges between 20-94%. The average rainfall of this area is around 1100 mm annually. The experiment was laid out in randomized block design (RBD) with 16 treatments. The treatments have been replicated three times. The different treatments were employed randomly in each replication.

Soil Sampling and laboratory testing

Soil sampling was done with the standard sampling tools from two depths 0-15cm and 15-30 cm. analysis of the soil samples was under the methods, the physical parameters include bulk density, particle density, pore space, water holding capacity.

Table 1. Soil physical parameters

S. No.	Particulars	Scientist Name	Methods	Unit
	Physical Properties			
1.	Bulk density	Black (1965)	Pycnometer	Mg m^{-3}
2.	Particle density	Black (1965)	Pycnometer	Mg m^{-3}
3.	Pore space	Black (1965)	-	(%)
4.	Water holding capacity	Muthuval *et al.* (1992)	Graduated measuring cylinder	(%)

Results and Discussions

As presented in table 2., the maximum bulk density Mg m^{-3} was found in 2020-21 and 2021-22 at different depths at 0-15 cm and 15-30 cm were in T_{16} were 1.32 Mg $m^{-3}$and 1.36 Mg m^{-3} found to be non-significant followed by in T_{15} *i.e.*,1.31 Mg m^{-3} and 1.35 Mg m^{-3}, minimum was found T_1 *i.e.*,1.12 and 1.22 Mg M^{-3}. The maximum bulk density in the year 2021-22 were found in T_{16} were 1.33 Mg $m^{-3}$and 1.37 Mg m^{-3} found to be non-significant followed by in T_{15} *i.e.*, 1.13 Mg m^{-3} and 1.23 Mg m^{-3}, minimum was found T_1 *i.e.*, 1.13 and 1.23 Mg m^{-3} respectively. higher bulk density may be due to more organic matter in T_{16}. Similar results were reported by **(Goyal *et al*., 2019)**.

The maximum particle density of soil were found in treatment T_{16} *i.e.*, the particle density was 2.67 Mg m^{-3} at 0-15 cm depth and 2.74 Mg m^{-3} at 15-30 cm depth during 2020-21 while in 2021-22, it was 2.68 Mg m^{-3} at 0-15 cm depth and 2.75 Mg m^{-3} at 15-30 cm depth of soil, in comparison with T_1 where minimum values of the result were found *i.e.* 2.50 Mg m^{-3} at 0-15 cm depth and 2.61 Mg m^{-3} at 15-30 cm depth of soil during 2021 while in 2022 it was 2.51 Mg m^{-3} and 2.62 Mg m^{-3} at both 0-15 cm and 15-30 cm depth of soil, respectively. higher particle density was found due to proper incorporation of N P K, vermicompost and rhizobium parallel results were reported by **(Goyal *et al*., 2019)**.

The maximum pore space (%) of soil in treatment T_{16} *i.e.*, 50.74 and 47.01 % at 0-15 and 15-30 cm of soil depth during 2021 and for 2022 it was 51.23 and 48.42 % at soil depth 0-15 and 15-30 cm, respectively. The minimum values of the result were found be significant in treatment T_1, which was 44.50 and 43.30 % at 0-15 and 15-30 cm of soil depth during 2020-21 while during year 2021-22 it was 44.67 and 43.61 % at soil depth 0-15 and 15-30 cm respectively. There is almost a linear increase in porosity with increase in doses of vermicompost and rhizobium. correspondent results were reported by **(Das *et al*., 2016)**.

The maximum water holding capacity (%) of soil found in treatment T_{16} *i.e.*, which was 45.25% at 0-15 cm depth and 46.60 % at 15-30 cm soil depth during 2021 while during 2022 it is observed as 46.36 % at 0-15 cm and 47.57 % at 15-30 cm soil depth. Timely the minimum values of the result were found in treatment T_1 which was 34.32 % at 0-15 cm and 34.76 % at 15-30 cm soil depth during 2020-21 similarly, 35.42 % and 35.77 % at 0- 15 and 15-30 cm soil depth during 2021-22, respectively. There is increase in water holding capacity with increase in doses of vermicompost and rhizobium. comparable results were reported by (**Singh *et al*.,2018).**

Conclusion

It revealed from the trial that application of N P K, vermicompost and rhizobium Bio-fertilizers in treatment T_{16} was found best, since the results is based on one season physical properties. The T_1 shows the poor physical condition where N P K, vermicompost and rhizobium bio-fertilizers was applied in least amount. This concludes that use of vermicompost and rhizobium Bio-fertilizer has improved the physical health of soil which leads to overall better health of soil.

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Table 2. Treatment combination of Chickpea var. Aruna2021-22

Treatments	Treatment Combination

T_1	Absolute control
T_2	[RDF @ 0 % + VC @ 25 % + Rhizobium @ 25 %]
T_3	[RDF @ 0 % + VC @ 50 % + Rhizobium @ 50 %]
T_4	[RDF @ 0 % + VC @ 100 % + Rhizobium @ 100 %]
T_5	[RDF @ 25 % + VC @ 0 % + Rhizobium @ 0 %]
T_6	[RDF @ 25 % + VC @ 25 % + Rhizobium @ 25 %]
T_7	[RDF @ 25 % + VC @ 50 % + Rhizobium @ 50 %]
T_8	[RDF @ 25 % + VC @ 100 % + Rhizobium @ 100 %]
T_9	[RDF @ 50 % + VC @ 0 % + Rhizobium @ 0 %]
T_{10}	[RDF @ 50 % + VC @ 25 % + Rhizobium @ 25 %]
T_{11}	[RDF @ 50 % + VC @ 50 % + Rhizobium @ 50 %]
T_{12}	[RDF @ 50 % + VC @ 100 % + Rhizobium @ 100 %]
T_{13}	[RDF @ 100 % + VC @ 0% + Rhizobium @ 0 %]
T_{14}	[RDF @ 100 % + VC @ 25 % + Rhizobium @ 25 %]
T_{15}	[RDF @ 100 % + VC @ 50 % + Rhizobium @ 50 %]
T_{16}	[RDF @ 100 % + VC @ 100 % + Rhizobium @ 100 %]

Note: RDF- Recommend dose of fertilizer, Basal dose of Nitrogen (20 kg ha^{-1}) Phosphorus (40 kg ha^{-1}), Potassium (20 kg ha^{-1}), vermicompost and biofertilizer was applied at the start of the experiment.

Table 3. Response of inorganic fertilizer, organic manure and biofertilizer on physical soil properties

S. No.	Soil bulk density (Mg m^{-3})				Soil particle density (Mg m^{-3})				Soil porosity (%)				Soil water holding capacity (%)			
	2020-21		2021-22		2020-21		2021-22		2020-21		2021-22		2020-21		2021-22	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
T_1	1.12	1.22	1.13	1.23	2.50	2.61	2.51	2.62	44.5	43.3	44.67	43.61	34.32	34.76	35.42	35.77
T_2	1.15	1.25	1.15	1.25	2.52	2.62	2.52	2.62	45.51	44.31	45.55	44.51	35.31	35.67	36.13	36.86
T_3	1.16	1.26	1.17	1.27	2.52	2.63	2.53	2.62	45.51	44.32	45.54	45.63	36.24	36.68	37.33	37.89
T_4	1.17	1.29	1.17	1.29	2.54	2.64	2.55	2.64	47.52	46.34	47.59	46.94	36.02	36.86	37.23	37.9
T_5	1.19	1.30	1.20	1.30	2.55	2.64	2.56	2.65	47.53	46.35	48.86	47.56	36.44	37.8	37.75	38.08
T_6	1.19	1.28	1.20	1.29	2.57	2.66	2.58	2.66	47.54	45.37	47.53	46.24	37.53	37.86	38.36	38.76
T_7	1.20	1.27	1.21	1.30	2.58	2.67	2.59	2.68	47.56	45.85	47.63	46.46	37.25	38.09	38.95	38.94
T_8	1.22	1.28	1.23	1.30	2.59	2.68	2.6	2.68	47.59	46.04	48.54	46.45	38.43	38.95	39.46	39.83
T_9	1.24	1.29	1.25	1.29	2.59	2.69	2.62	2.69	47.59	46.15	47.52	46.24	39.46	39.98	40.45	40.7
T_{10}	1.25	1.30	1.27	1.31	2.6	2.69	2.62	2.7	47.62	46.34	47.62	46.46	39.23	40.4	41.26	41.74
T_{11}	1.25	1.30	1.28	1.32	2.61	2.69	2.63	2.7	48.55	45.54	48.96	45.34	40.35	41.54	42.16	41.92
T_{12}	1.27	1.31	1.31	1.32	2.62	2.7	2.63	2.71	49.52	45.58	49.74	46.47	41.24	41.91	43.25	42.67
T_{13}	1.30	1.32	1.32	1.33	2.64	2.71	2.65	2.72	50.64	47.4	50.78	47.75	42.46	43.54	44.56	43.65
T_{14}	1.30	1.33	1.32	1.33	2.64	2.72	2.66	2.73	50.68	47.5	50.94	47.77	42.77	44.70	45.04	45.23
T_{15}	1.31	1.35	1.32	1.36	2.65	2.72	2.67	2.73	50.71	46.65	50.96	47.91	43.18	44.55	45.53	46.51
T_{16}	1.32	1.36	1.33	1.37	2.67	2.74	2.68	2.75	50.74	47.01	51.23	48.42	45.25	46.60	46.36	47.57
F- test	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
S. Em. (±)																
C. D. @ 5 %																