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Response of Inorganic Fertilizers Organic Manure and Biofertilizer on Soil Health and Yield Attributes of Chick Pea (*Cicer aretinum* L.) Cv. Aruna

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

An experimental trial carried out on topic for the two repeated year 2021-22, start from rabi seasons at research farm of soil science and agricultural chemistry prayagraj. The geographical co-ordinates of the university campus are approximately 25.47690 N latitude and 81.85740 E longitude and 98 meters (322 feet) the area of prayagraj district comes under subtropical belt in the south east of

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uttar pradesh, which experience extremely hot summer and fairly cold winter. The maximum temperature of the location reaches up to 460C - 480C and minimum temperature is 40C - 50C. The relative humidity ranged between 20 to 94 percent. The average rainfall in this area is around 1100 mm annually. the designed lay out 48 total soil was sandy loam and samples were taken from different depths 0-15 cm and 15-30 cm the conjunctive use of N, P, & K and different vermicompost and rhizobium the treatment T16 [RDF @ 100 % + VC @ 100 % + Rhizobium @ 100 %] plant height (cm), number of branches, number of pods plant-1, number of seeds pod plant-1, grain yield, seed weight, gave best results. The maximum B:C ratio was achieved in treatment T16 [RDF @ 100 % + VC @ 100 % + Rhizobium @ 100 %], i. e. 1.95 and 2.18, for chick pea cv. aruna during respectively years and was found at par than any other treatment.

Keywords: organic carbon; nitrogen; phosphorus; potassium parameters and yield.

1. INTRODUCTION

Pulses are valuable source of dietary protein and have a specific ability to sustain and preserve soil fertility by adding biological nitrogen fixation. Pulses are restoratives crops and leaves quite enough as 30 kg ha^{-1} nitrogen in soil (Choudhury *et al.*, 2004). among the pulses, chickpea is an important rabi season crop with high acceptability and wider use in nutritional food basket. the essential components of balanced nutritional food are protein, fat, fibre and mineral nutrients (Reddy and Reddy, 2010).

Chickpea is a valued crop and provides nutritious food for increasing world population and will become important with climate change (Muehlbauer and Sarker, 2017). It is one of the most important *rabi* season crops grown in india and as whole in asia for economic importance and maintaining soil fertility. chickpea is commonly known as gram or bengal gram belongs to fabaceae family [1-5]. Being a rich and cheap source of protein, it can help people to improve the nutritional quality of their diet (Singh *et al.,* 2021). it is grown and consumed in large quantities in south east asia to india and in the middle east and mediterranean countries (FAO, 2021). chickpea is the third most important pulse crop in the world after french and field pea. India has first position in area and production in the world (Singh *et al.,* 2014). Dried seeds of gram have a high nutritional value. Its dried seed contain about 7% moisture, 22.19% protein, 64.90% carbohydrate, 2.10% fat, 3.20% mineral ash, 45 mg 100 g^{-1} Ca, 2.8 mg 100 g^{-1} Fe and high calorific value 370 K cal. 100 g^{-1} (Singh and Garg 2012). it is also important for sustainable agriculture as it improves the physio-chemical and biological properties of the soil. Its deep roots also open the soil, which ensure better aeration and heavy leaf drop increases the organic matter in the soil. it can fix about 25-30 kg N ha^{-1} through symbiosis and these minimize dependency on chemical fertilizers. Thus, chickpea plays a vital role in improving the soil health, DES, 2018 the top producers of chickpeas in the world are India, Myanmar, Turkey, Iran and Pakistan. the global production in 2020 was around 13.1 million tonnes. India was the largest producer, accounting for around 67% of the world's production. Other major producing countries include Turkey, Myanmar, and Australia (FAO, 2020). chickpea is largely grown in marginal and sub marginal lands of semi-arid tropics, which are characterized by poor fertility status and moisture stress, with an estimated global production of 162.25 lakh tonnes in 2019, chickpea is grown in about 50 countries around the world covering an area of 149.66 lakh ha with an average global productivity of 1252 kg ha^{-1} (Sinha *et al.*, 2020). India is the leading producer of chickpea contributing to about 70% of the world's chickpea production. In India, Madhya Pradesh (39%), Maharashtra (14%), Rajasthan (14%), Uttar Pradesh (7%), Karnataka (6%) and Gujarat (5%) are the major chickpea growing states. in india pulses are grown nearly in 28.83 m ha with an annual production of 25.72 and productivity of 0.8 t ha^{-1}. In our country, it covered about 10.17million-hectare area, with 11.35 MT production and 1116 kg ha^{-1} productivity in 2019-20. During 2020-21, chickpea a had a lion's share of 49.3% in the total pulses production. Madhya Pradesh leading state in area and production of chickpea (GOI, 2019-20).

Nitrogen is an essential nutrient for the growth and development of plants, including chickpea crop [6]. It is a component of many important plant molecules, such as amino acids, proteins, nucleic acids and chlorophyll (Hossain *et al.*, 2013). Nitrogen is required in large quantities by plants and is often the most limiting nutrient for plant growth and crop yield (Mondal *et al.*, 2014).

Phosphorus is an essential macronutrient for plant growth and development and it plays a crucial role in various physiological and metabolic processes of plants [7-11] Phosphorus is particularly important for chickpea because it promotes root development, improves seedling growth and enhances the uptake and utilization of other nutrients such as nitrogen and potassium (Garg and Bhandari 2016). Chickpea requires a significant amount of phosphorus during its early growth stages and a deficiency of this nutrient can lead to stunted growth, reduced yields and poor quality of seeds. Studies have shown that phosphorus application can significantly increase the yield of chickpea crops [12-15]. Phosphorus helps in the uptake of other nutrients such as nitrogen, potassium and calcium by chickpea plants, which leads to better growth and development (Kumar *et al.*, 2018; and Singh *et al.*, 2020). Phosphorus plays a vital role in improving the tolerance of chickpea plants to biotic and abiotic stresses, such as drought, salinity and disease (Hussein *et al.*, 2018; and Niazi *et al.*, 2020).

Potassium is an essential macronutrient that plays a critical role in the growth and development of the chickpea crop and is involved in many physiological and biochemical processes in plants, including osmoregulation, enzyme activation and protein synthesis (Yadav *et al.*, 2011). It is essential for the proper growth and development of chickpea plants. Studies have shown that the application of potassium fertilizers can increase the yield of chickpea crops (Nawar *et al.*, 2020) and plays a crucial role in regulating the opening and closing of stomata, which in turn affects photosynthesis rates. Adequate potassium supply can enhance the efficiency of photosynthesis and increase crop productivity (Wani *et al.*, 2018), helps in maintaining the turgor pressure of plant cells, which is important for plant water balance. Adequate potassium supply can increase water-use efficiency and reduce water stress in chickpea crops (Gupta *et al.*, 2019), plays a vital role in regulating the response of plants to abiotic stress, such as drought, salinity, and high temperatures. Adequate potassium supply can improve the chickpea crop's ability to tolerate and recover from abiotic stress (Rizwan *et al.*, 2020), has been shown to improve the chickpea crop's resistance to pests and diseases, such as Fusarium wilt, root rot and aphids and has been shown to improve the chickpea crop's resistance to pests and diseases, such as Fusarium wilt, root rot and aphids (Bhardwaj *et al.*, 2019), it can also improve the quality of chickpea crops, including protein content, oil content and seed size (Gupta *et al.*, 2019).

2. MATERIALS AND METHODS

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^{0}C and seldom falls below 4^{0}C-5^{0}C. 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 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 chemical analysis Percent Organic Carbon (%), Available Nitrogen, Available Phosphorus and Available Potassium (kg ha^{-1}).

Table 1. Chemical analysis parameters

Parameters	Results	Method
Soil pH (1:2.5) (w/v)	7.40	(Jackson, 1958)
Soil EC (1:2.5) (dS m^{-1}) at 25^0 C	0.31	(Wilcox, 1950)
Percent Organic Carbon (%)	0.34	(Walkley and Black, 1947)
Available Nitrogen (kg ha^{-1})	255.23	(Subbiah and Asija, 1956)
Available Phosphorus (kg ha^{-1})	22.62	(Olsen *et al*., 1954)
Available Potassium (kg ha^{-1})	200.32	(Toth and Prince, 1949)

3. RESULTS AND DISCUSSION

As decrypted in Table 2., that maximum pH (1:2.5) w/v of soil found in year 2021-22 and at 0-15 cm and 15-30 cm depth in T_{16} 8.28 and 8.39 and T_{16} 8.54 and 8.75 respectively followed in T_{15} 8.01 and 8.08 and 8.05 and 8.35 respectively in T_1 minimum were found *i. e.* 7.32 was 7.51 and 7.46 and 7.55 respectively, statistically it was found at par were found non-significant. it was also observed that the pH of soil was gradually increased with increasing the dose of vermicompost and biofertilizer levels, due to presence of vermicompost levels in optimum amount increases particle density of soil. Similar findings given by Amrita *et al.* (2010).

The maximum electrical conductivity (dS m^{-1}) of soil found in year 2021-22 and at 0-15 cm and 15-30 cm depth in T_{16} 0.417 dS m^{-1} and 0.420 dS m^{-1} and T_{16} 0.420 dS $m^{-1}$was found at par and 0.422 dS m^{-1} followed in T_{15} 8.01 dS m^{-1} and 8.08 dS m^{-1} and 8.05 and 8.35 dS m^{-1} and in minimum were found T_1 0.341 dS m^{-1} was 0.344 dS m^{-1} and 0.343 and 0.345 respectively, statistically it were found significant. it was also observed that the EC of soil was gradually increased with increasing the dose of vermicompost and biofertilizer levels, due to presence of vermicompost levels in optimum amount increases EC of soil. Similar findings given by Amrita *et al.* (2010).

The organic carbon content during 2021-22 of two years, the maximum soil organic carbon % were found in treatment T16 containing which were 0.492% and 0.510% and were 0.495% and 0.512% at soil depth 0-15 and in 2021-22 found to be at par than any other treatment, followed in T15 *i.e.,* 0.475% and 0.498% it was 0.476 and 0.499 % in 2021-22 and minimum was found in T1 which was 0.370% and 0.380 % at 0-15 and 15-30 cm and 0.371% and 0.383 %, at 0-15 and 15-30 cm in 2021-22 soil respectively were found to be significant. Similar result has been recorded by Braham *et al.* (2014).

The maximum av. nitrogen was recorded in T_{16} 328.03 N kg ha^{-1} and 359.63 N kg ha^{-1} at the depth of 0-15 cm and 15-30 cm in 2021 respectively in, T_{16} 328.52 N kg ha^{-1} and 360.62 N kg ha^{-1} in 2022 and were found to be significant, followed by T_{15} the maximum was recorded in T_{15} 321.74 N kg ha^{-1} and 353.49 N kg ha^{-1} at the depth of 0-15 cm and 15-30 cm in 2021 respectively and in the depth of 0-15 cm and 15-30 cm in 2022, T_{15} 322.72 N kg ha^{-1} and 354.30 N kg ha^{-1} in 2022 and were found to be significant respectively and minimum was recorded in T_1 265.92 N kg ha^{-1} and 268.85 N kg ha^{-1} at the depth of 0-15 cm and 15-30 cm in 2021 respectively and at depth of 0-15 cm and 15-30 cm in 2022, T_1 266.22 N kg ha^{-1} and 269.54 N kg ha^{-1} in 2022 and were found to be significant, the research work was conducted on

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 %]

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 chickpea during the two years, integral effect of inorganics fertilizers with organic manure like vermicompost found highest av, N source and observed under N P K, vermicompost and biofertilizer treated plot, which mineralization effect and be also due to the favourable soil conditions provided by N P K and vermicompost addition might have helped in mineralization of additional soil N leading to improved soil fertility. Available Nitrogen content found maximum in surface soil while minimum in lower depth due to leaching of nutrients in the lower surface of soil. Similar result has been recorded by Biswash *et al.* (2014) and Amrita *et al.* (2017).

The maximum av. phosphorus was recorded in T_{16} 34.6 P kg ha^{-1} and 37.17 P kg ha^{-1} at the depth of 0-15 cm and 15-30 cm in 2021 respectively in, T_{16} 34.87 P kg ha^{-1} and 37.78 P kg ha^{-1} in 2022 and were found to be significant, followed by T_{15} the maximum was recorded in T_{15} 32.95 P kg ha^{-1} and 36.16 P kg ha^{-1} at the depth of 0-15 cm and 15-30 cm in 2021 respectively and in the depth of 0-15 cm and 15-30 cm in 2022, T_{15} 33.01 P kg ha^{-1} and 36.27 P kg ha^{-1} in 2022 and were found to be significant respectively and minimum was recorded in T_1 13.98 P kg ha^{-1} and 15.12 P kg ha^{-1} at the depth of 0-15 cm and 15-30 cm in 2021 respectively and at depth of 0-15 cm and 15-30 cm in 2022, T_1 14.82 P kg ha^{-1} and 15.19 P kg ha^{-1} in 2022 and were found to be significant, the research work was conducted on chickpea during the two years, integral effect of inorganics fertilizers with organic manure like vermicompost) found highest av, P source and observed under N P K, vermicompost and biofertilizer treated plot, which mineralization effect and be also due to the favourable soil conditions provided by N P K and vermicompost addition might have helped in mineralization of additional soil P leading to improved soil fertility. Available Phosphorus content found maximum in surface soil while minimum in lower depth due to leaching of nutrients in the lower surface of soil. Similar result has been recorded by Biswash *et al.* (2014) and Amrita *et al.* (2017).

The maximum av. potassium was recorded in T_{16} 196.67 K kg ha^{-1} and 207.22 K kg ha^{-1} at the depth of 0-15 cm and 15-30 cm in 2021 in, T_{16} 196.81 K kg ha^{-1} and 207.97 K kg ha^{-1} in 2022 and were found to be significant, followed by T_{15} the maximum was recorded in T_{15} 191.64 K kg ha^{-1} and 204.37 K kg ha^{-1} at the depth of 0-15 cm and 15-30 cm in 2021 and in the depth of 0-15 cm and 15-30 cm in 2022, T_{15} 191.82 K kg ha^{-1} and 205.41 K kg ha^{-1} in 2022 and were found to be significant respectively and minimum was recorded in T_1 145.82 K kg ha^{-1} and 153.15 K kg ha^{-1} at the depth of 0-15 cm and 15-30 cm in 2021 and at depth of 0-15 cm and 15-30 cm in 2022, T_1 146.72 K kg ha^{-1} and 154.42 K kg ha^{-1} in 2022 and were found to be significant, the research work was conducted on chickpea during the two years, integral effect of inorganics fertilizers with organic manure like vermicompost) found highest av, K source and observed under N P K, vermicompost and biofertilizer treated plot, which mineralization effect and be also due to the favourable soil conditions provided by N P K and vermicompost addition might have helped in mineralization of additional soil K leading to improved soil fertility. Available potassium content found maximum in surface soil while minimum in lower depth due to leaching of nutrients in the lower surface of soil. Similar result has been recorded by Biswas *et al.* (2014) and Sharma *et al.* (2018).

As revealed in Table 3. the highest grain yield of 17.1 q ha^{-1} and 17.56 q ha^{-1} in treatment T_{16}, [RDF @ 100 % + VC @ 100 % + Rhizobium @ 100 %], in comparison with treatment T_{13} consisting of 100% RDF alone, *i.e.,*16.04 and 16.58 q ha^{-1}, over control T_1, *i.e.,* 10.96 and 11.01 kg ha^{-1}. However, treatment T_{15}, followed by treatment T_{14}, [RDF @ 100 % + VC @ 50 % + Rhizobium @ 50 %], *i.e.,* 16.87 and 16.97 q ha^{-1}, in which both are statistically at par with each other and on par, respectively during both the years of experimentation.

Increased grain yield might be due to use of different levels of vermicompost with RDF may be due to synergistic effect of all inputs when combined together It might be also due to steady release of nutrients throughout the crop growth period coupled with better nutrient assimilation in developing reproductive structures, greater availability of metabolites (photosynthates), have resulted positive in formation of yield components which ultimately improved the yield of the crop. Similar findings are in collaboration with Kumar *et al.* (2017).

Table 3. Response of inorganic fertilizer, organic manure and biofertilizer on Chemical analysis parameters

S. No.	Soil organic carbon (%)			
	2020-21		2021-22	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm
T_1	0.370	0.381	0.371	0.383
T_2	0.378	0.387	0.379	0.390
T_3	0.382	0.397	0.383	0.398
T_4	0.39	0.401	0.391	0.402
T_5	0.397	0.409	0.399	0.41
T_6	0.41	0.415	0.409	0.416
T_7	0.415	0.422	0.416	0.423
T_8	0.42	0.429	0.421	0.43
T_9	0.424	0.437	0.425	0.438
T_{10}	0.431	0.442	0.432	0.443
T_{11}	0.438	0.452	0.439	0.453
T_{12}	0.445	0.461	0.446	0.462
T_{13}	0.457	0.476	0.457	0.477
T_{14}	0.467	0.485	0.468	0.485
T_{15}	0.475	0.498	0.476	0.499
T_{16}	0.492	0.510	0.495	0.512
F- test	**S**	**S**	**S**	**S**
S. Em.**(±)**	0.05	0.02	0.03	0.02
C. D. @ 5 %	0.04	0.01	0.02	0.01

Table 4. Concentration of available nitrogen, phosphorus and potassium with different treatment modalities

S. No.	Available nitrogen (kg ha^{-1})				Available phosphorus (kg ha^{-1})				Available potassium (kg ha^{-1})			
	2020-21		2021-22		2020-21		2021-22		2020-21		2021-22	
	0-15 cm	15-30 cm	0-15 cm	15-30cm	0-15 cm	15-30cm	0-15 cm	15-30cm	0-15 cm	15-30cm	0-15 cm	15-30cm
T_1	265.92	268.85	266.22	269.54	13.98	15.12	14.82	15.19	145.82	153.15	146.72	154.42
T_2	267.38	273.85	268.53	273.89	15.79	16.21	15.90	16.26	148.73	158.31	147.63	159.12
T_3	270.59	279.75	271.83	279.11	16.86	17.32	16.89	17.85	153.75	162.45	153.78	162.75
T_4	276.95	285.03	275.74	285.38	18.91	19.34	19.69	19.86	155.66	168.16	156.61	168.31
T_5	280.94	292.79	280.05	292.93	19.81	20.23	20.75	21.20	157.59	171.27	158.72	171.83
T_6	284.74	298.75	285.60	299.6	21.82	22.32	21.92	22.78	161.85	176.48	162.72	176.78
T_7	287.49	305.68	287.74	306.44	22.74	23.12	22.81	24.10	165.67	178.36	165.93	178.81
T_8	291.59	312.04	291.64	312.73	23.70	24.21	23.83	25.21	170.83	182.54	170.95	182.64
T_9	296.63	318.75	298.64	318.82	25.69	26.23	25.73	26.88	174.66	186.25	174.73	186.29
T_{10}	300.5	323.74	301.53	324.47	26.87	28.90	26.92	27.18	177.83	188.33	178.84	190.41
T_{11}	305.73	329.64	306.92	330.02	27.80	29.29	27.90	29.32	179.85	192.24	180.76	193.23
T_{12}	308.55	332.73	309.89	333.63	27.87	31.20	28.81	31.79	182.74	197.23	182.82	198.14
T_{13}	313.74	340.92	314.62	341.82	29.70	33.28	29.78	33.70	186.63	199.53	186.83	200.20
T_{14}	318.76	348.53	319.52	348.81	31.86	34.19	32.40	34.77	189.76	201.52	190.75	202.32
T_{15}	321.74	353.49	322.72	354.30	32.95	36.16	33.01	36.27	191.64	204.33	191.82	205.41
T_{16}	328.03	359.63	328.52	360.62	34.60	37.17	34.87	37.78	196.67	207.22	196.81	207.93
F- test	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**
S. Em.(±)	11.01	12.83	12.67	11.98	0.70	0.55	0.56	0.56	7.90	8.67	9.26	8.34
C. D. @ 5 %	5.39	6.28	6.21	5.67	0.34	0.27	0.27	0.27	3.87	4.24	4.55	4.08

Table 5. Effects of Inorganic fertilizers Organic manure and Biofertilizer on Grain yield (kg ha^{-1}) of chickpea at Harvest

S. No.	Treatment	2020	2021
T_1	**Absolute control**	**10.96**	**11.01**
T_2	[RDF @ 0 % + VC @ 25 % + Rhizobium @ 25 %]	11.68	11.75
T_3	[RDF @ 0 % + VC @ 50 % + Rhizobium @ 50 %]	11.99	12.08
T_4	[RDF @ 0 % + VC @ 100 % + Rhizobium @ 100 %]	12.28	12.49
T_5	[RDF @ 25 % + VC @ 0 % + Rhizobium @ 0 %]	12.87	12.92
T_6	[RDF @ 25 % + VC @ 25 % + Rhizobium @ 25 %]	13.04	13.27
T_7	[RDF @ 25 % + VC @ 50 % + Rhizobium @ 50 %]	13.5	13.73
T_8	[RDF @ 25 % + VC @ 100 % + Rhizobium @ 100 %]	14.02	14.25
T_9	[RDF @ 50 % + VC @ 0 % + Rhizobium @ 0 %]	14.53	14.67
T_{10}	[RDF @ 50 % + VC @ 25 % + Rhizobium @ 25 %]	15.07	15.19
T_{11}	[RDF @ 50 % + VC @ 50 % + Rhizobium @ 50 %]	15.23	15.97
T_{12}	[RDF @ 50 % + VC @ 100 % + Rhizobium @ 100 %]	15.67	16.10
T_{13}	[RDF @ 100 % + VC @ 0% + Rhizobium @ 0 %]	16.04	16.58
T_{14}	[RDF @ 100 % + VC @ 25 % + Rhizobium @ 25 %]	16.02	16.80
T_{15}	[RDF @ 100 % + VC @ 50 % + Rhizobium @ 50 %]	16.87	16.97
T_{16}	[RDF @ 100 % + VC @ 100 % + Rhizobium @ 100 %]	17.01	17.56

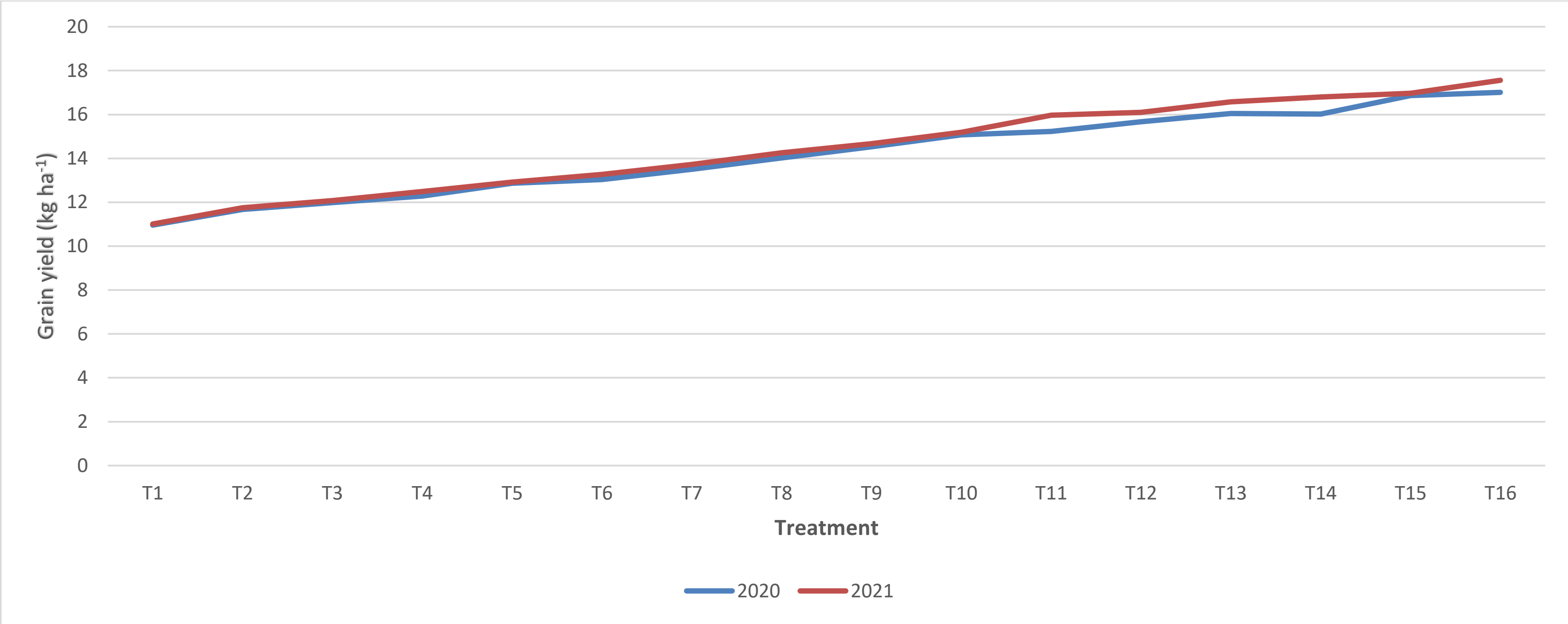

Fig. 1. Grain yield (kg ha^{-1}) of chickpea

4. 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 chemical properties. The T_1 shows the poor chemical condition where N P K, vermicompost and rhizobium bio-fertilizers was applied in least amount. This concludes that use of N P K improved the yield.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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