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INFLUENCES OF CONJOINT USE OF ORGANIC AND CHEMICAL SOURCES OF NUTRIENTS ON SOIL PROPERTIES AND YIELD OF PEA (*Pisum sativum* L.) UNDER SUB-MONTANE AND LOW HILLS SUBTROPICAL ZONE OF HIMACHAL PRADESH

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ABSTRACT

A field experiment was conducted during *rabi* season of 2019-2020 to study the effect of conjoint use of organic and chemical sources of nutrients on soil properties and yield of pea (*Pisum sativum* L.) at the Experimental Farm of the College of Horticulture and Forestry, Neri, Hamirpur, (HP).Results revealed that the application of 100 per cent RDF in conjunction with poultry manure @ 10 t ha^{-1}gave highest yields *viz*., pod yield (79.82 q ha^{-1}), stover yield (20.45 q ha^{-1}) and seed yield (14.45 q ha^{-1}). There was no significant change in the bulk density, particle density, porosity and water holding capacity of soil with the application of organic manures and fertilizers either alone or in combination.The available N, P, K, S, Ca, Mg, Fe, Cu, Zn and Mn content of soil increased with the application of organic manures and fertilizers either alone or in combination and highest was recorded in treatment receiving 100 per cent RDF + Poultry manure @ 10 t ha^{-1}.

(Key words: Pea, organic manures, soil properties and yield)

INTRODUCTION

In Himachal Pradesh pea (*Pisum sativum* L.) occupies more than one fourth of the total area under vegetable crops and ranks first in acreage.Fertilizer is an important input for pea production asit has quite high fertilizer requirements due to its high yielding potential unit^{-1} area. Use of chemical fertilizers played a crucial role in the fulfillment of nutrient needs of the crop but had a damaging effect on the soil health (Anitha *et al*., 2015). Moreover, the continued use of high levels of chemical fertilizers decreases the plant nutrients intake and induces either stagnation or decrease in yields and environmental pollution.

Organic manures contain plant nutrients which are in small quantities, in comparison to the chemical fertilizers, the presence of growth hormones and enzymes make them essential for the improvement of soil fertility and productivity. Organic materials can also ensure access to inorganic fertilizers and can effectively improve the use of inorganic fertilizers. They not only enhance the physical properties, but increase the supply of nutrients, organic carbon and cation exchange potential of the soil.

But presently in the country, the available organic resources can only meet nearly one-third of the total nutrient requirement. Therefore, to sustain high productivity and quality of crop, judicious nutrient management is vital. Neither organic manures nor chemical fertilizer alone can achieve the yield sustainability. Their integrated use may help in improving soil health, productivity and quality of the produce. Hence, a study was undertaken to record the effect of integrated nutrient management on soil properties and yield of pea.

MATERIALS AND METHODS

A field experiment was conducted at the Experimental Farm of the College of Horticulture and Forestry (YSPUHF), Neri, Hamirpur, (H.P.) during the *rabi* season of 2019-2020. The soil of the experimental site was sandy loam in texture, neutral in reaction, medium in organic carbon, low in available N, medium in P and K at the initiation of the experiment. The treatments consisted of control (T_1), 100 % RDF (T_2), VC @ 10 t ha^{-1} (T_3), 75 % RDF + VC (T_4), 100 % RDF + VC (T_5), PM @ 10 t ha^{-1} (T_6), 75 % RDF + PM (T_7), 100 % RDF + PM (T_8), FYM @ 10 t ha^{-1} (T_9), 75 % RDF + FYM (T_{10}) and 100 % RDF + FYM (T_{11}). Experiment was laid out in a randomized block design with three replications. Nitrogen, P_2O_5 and K_2O were applied @50, 60 and 60 kg ha^{-1}, respectively. Observations of plant yield were recorded. Surface soil samples collected after the harvest of pea (*rabi* 2019-20) from each plot were analyzed for all macro and micronutrients. The bulk density of the soil was determined

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by Core Sampler method (Black and Hartge, 1986). The particle density of the soil was determined by Pycnometer method given by Gupta and Dhakshinamoorthy (1980). Porosity of the soil was calculated by using Empirical method (Gupta and Dhakshinamoorthy, 1980). Water holding capacity of the soil was determined by Keen's method (Piper,1950).The soil pH was estimated in 1:2 soil: water suspension and the electrical conductivity of the supernatant liquid was recorded as per the method detailed by Jackson (1973) and organic carbon (Walkley and Black, 1934). Available N was determined by alkaline potassium permanganate method (Subbiah and Asija, 1956), available P by Olsen's method (Olsen *et al*., 1954) and determined by stannous chloride reduced ammonium molybdate method (Jackson, 1973), available K by neutral normal ammonium acetate (Merwin and Peach, 1951). Sulphate-S was determined by Turbiditeric method (Chesnin and Yien, 1950). Exchangeable Ca and Mg were determined by using ammonium acetate extract by atomic absorption spectro-photometer (Sarma *et al*., 1987). The data so generated was statistically analysed using analysis of variance (ANOVA) for randomized block design. The treatments mean were tested for significant level at P=0.05.

RESULTS AND DISCUSSION

Pod yield

The data with respect to the effect of integrated nutrient management on pod yield of pea have been presented in Table 1.Critical look at the data revealed that highest pod yield (79.82 q ha^{-1}) was recorded in T_8 where 100 per cent recommended dose of fertilizer + poultry manure @ 10 t ha^{-1} was applied, while the lowest (35.19 q ha^{-1}) in control plots (T_1). Application of 100 per cent recommended doses of fertilizers (T_2) recorded 63.63 q ha^{-1} pod yields and showed an increase of 80.81 per cent in pod yield as compared to control (T_1). Treatment T_8 showed 25.44 per cent increase of pod yield over T_2(RDF).The substantial increase in pea yield with the integrated use of chemical fertilizers alone or in combination with organic manures could be due to the contribution of organic manure containing mainly macro and micro nutrients, as well as growth-promoting substances that have led to better plant growth. Initially, chemical fertilizers provided all essential nutrients and their absorption by the plant which rapidly improved nutrition, leading to better plant growth. In the latter stage, decomposed organic manures provided the necessary plant nutrients for the good growth of the plant, which in turn resulted in higher crop yields. The results are in conformity with Lalito *et al.* (2018), who reported that pod yield of pea was recorded highest in treatment receiving NPK 100 per cent + Vermicompost @ 10 t^{-1}+FYM @ 10 t^{-1}.

Stover yield

It is evident from the data given in Table 1 revealed that stover yield of pea was significantly affected by the integrated nutrient management in pea. The highest stover yield of 20.45 q ha^{-1} was recorded under T_8 where 100 per cent recommended dose of fertilizer + poultry manure @ 10 t ha^{-1} was applied and lowest of 8.41 q ha^{-1} in control (T_1). There was 36.06 per cent increase in yield of treatment T_8 (100 per cent recommended dose of fertilizer + poultry manure @ 10 t ha^{-1}) over treatment T_2 (100 per cent recommended dose of fertilizer). Among the sole application of organic manures, the highest stover yield was observed in plots applied with poultry manure @ 10 t ha^{-1} (T_6), followed by plots applied with vermicompost @ 10 t ha^{-1} and least in plots receiving farmyard manure @ 20 t ha^{-1} (T_9), however the difference were not significant. The plots applied with 100 per cent recommended dose of fertilizer (T_2) recorded 6.62 q ha^{-1} higher stover yields over control. The integration of different organics and fertilizer doses were found to affect the stover yield significantly. Increased stover yield of pea with combined application of fertilizers and organic manures might be attributed to the balanced and sufficient supply of nutrients from chemical fertilizers and organics, improved properties of the soil which might have augmented root system and promoted higher nutrient and water absorption, thus better plant growth which led to higher crop productivity. Similar effect of integrated nutrient management on stover yield of pea was also reported by Lalito *et al*. (2018), who observed that stover yield of pea was highest in treatment receiving NPK 100 per cent + Vermicompost @ 10 t^{-1} + FYM @ 10 t^{-1}.

Seed yield

The data depicted in Table 1 revealed significant differences under different treatments on seed yield over control plot. The highest seed yield of 14.45 q ha^{-1} was recorded under T_8 (100 per cent RDF + poultry manure @ 10 t ha^{-1}) treatment followed by treatment T_5 (100 per cent RDF + vermicompost @ 10 t ha^{-1}) with seed yield of 13.50 q ha^{-1}. Sole application of poultry manure, vermicompost and FYM showed 91.63, 73.30 and 64.34 per cent increase in seed yield over control plot. The integration of fertilizer doses with different organics had significant effect on seed yield of garden pea. Treatments T_5 (100 per cent RDF + VC), T_8 (100 per cent RDF + PM) and T_{11} (100 per cent RDF + FYM) showed 24.65, 33.42 and 20.03 per cent increase respectively over treatment T_2 (100 per cent recommended dose of fertilizer). The higher seed yield under the integrated nutrient management as compared to alone application might be due to improvement in physio-chemical and biological properties of soil and optimum supply of nutrients by the soil enhanced the growth and yield attributing characters. These results are in accordance with the findings of Lalito *et al.* (2018), who reported that seed yield of pea was highest in treatment receiving NPK 100 per cent + Vermicompost @ 10 t^{-1} + FYM @ 10 t^{-1}.

Physical properties

The soil samples drawn after the harvest of pea (*rabi* 2019-20) were analyzed for various soil physical properties of soil and the results pertaining to the soil physical properties *viz.,* bulk density, particle density, porosity and water holding capacity of soil have been presented in Table 2. Results showed that there was no significant change in the bulk density, particle density, porosity and water holding capacity of soil with the application of organic manures alone or in combination with chemical fertilizers, whereas there was a slight decline in soil bulk density and particle density and slightly increase in water holding capacity and porosity over control. Slight decrease in bulk density and particle density of soil with the addition of organics might be due to addition of higher organic carbon that resulted in more pore space and good soil aggregation (Singh *et al.*, 2014),whereas improved soil porosity and water holding capacity by the application of organic manures might be due to the increased soil bio-pores and soil aeration, higher soil organic carbon content and better soil aggregation as well (Gangwar *et al.*,2006).

Chemical properties

Soil pH

Data indicates that the soil pH was not influenced by the application of different organics and fertilizer either alone or in integration. In general, it ranged from a minimum value of 6.96 to a maximum of 7.04. The highest pH of soil was observed in $T_9$where application of farmyard manure @ 20 t ha^{-1} was done and lowest of 6.96 in treatment T_2 where100 per cent recommended dose of fertilizers were applied. Application of manures either alone or along with fertilizers marginally increased the soil pH over initial (Table 3). This increase in soil pH with the application of organics may be attributable to the carbon mineralization and later on production of OH^{-} ions through exchange of ligand and basic cations like K^{+}, Ca^{2+}, and Mg^{2+} (Mkhabela and Warman, 2005).No significant changes in soil pH due to application of organic and inorganic fertilizers may be explained on the ground that soil under study has got sufficient amount of clay apart from active amounts of Al and Fe which can impart an immense buffering power to resist change in pH.

Electrical conductivity

The electrical conductivity was not influenced by the integration of different organics and fertilizer doses. Highest electrical conductivity (0.215 dS m^{-1}) was recorded in treatment applied with 100 per cent recommended dose of fertilizer + poultry manure @ 10 t ha^{-1} (T_8) and control (T_1) recorded with lowest electrical conductivity (0.197 dS m^{-1}). Application of fertilizers either alone or along with organics increased the electrical conductivity of soil over control (Table 3) which might be due to concentration of dissolved solute contents which might have enhanced the electrical conductivity because electrical conductivity of the soil solution is related and often used to measure soil salt level. The findings are in accordance with studies carried out by Jagtap *et al.* (2007) and Kumari (2017), who suggested that improvements in electrical conductivity of soil could be observed only after long-term use of organic inputs.

Organic carbon

The data depicted in Table 3 indicates that the application of 100 per cent recommended dose of fertilizer + farmyard manure @ 10 t ha^{-1} (T_{11}) gave the highest organic carbon content (5.23 g kg^{-1}) and was at par with the plots receiving 75 per cent recommended dose of fertilizer + farmyard manure @ 10 t ha^{-1} (T_{10}) and 100 per cent recommended dose of fertilizer + vermicompost @ 10 t ha^{-1} (T_5).The increase in organic carbon content with the application of manures might be attributed to addition of organic materials directly. This effect is further enhanced by addition of chemical fertilizers that improved the root and shoot growth. These findings are in consonance with the findings of Lalito *et al.* (2018), who reported that organic carbon was highest in pea with treatment receiving NPK 100 per cent + Vermicompost @ 10 t ha^{-1}+FYM @ 10 t ha^{-1}.

Available nitrogen

The data indicated in Table 4 revealed that the maximum available nitrogen content of 256.80 kg ha^{-1} was recorded from the plots getting 100 per cent recommended dose of fertilizer + poultry manure @ 10 t ha^{-1}(T_8) and lowest of 156.80 kg ha^{-1}was recorded in control (T_1). The plots applied with 100 per cent recommended dose of fertilizer (T_2) recorded 42.65 per cent increases in available nitrogen content over control plot. The higher available nitrogen was observed in plots receiving 100 per cent recommended dose of fertilizer application along with organic manures *viz.*, poultry manure, vermicompost, farmyard manure as compared to those applied with 75 per cent of recommended dose of fertilizer with respective organic manures; however the differences were at par. Whereas, alone application of manures were found to be inferior over their integrated use with graded doses of fertilizers.The increase in available nitrogen status with the addition of organics manures might be attributed to direct addition of nitrogen through these sources and reduction of loss of nitrates through leaching from the soil by providing a significant amount of plant nutrients which created a balancing effect on the supply of nitrogen. Further the addition of organic manure might have increased the activity of nitrogen fixing bacteria there by resulting in higher accumulation of nitrogen in soil, besides additional supply of nitrogen to the soil. These results are in conformity with the findings of Kalappanavar and Gali (2019), who reported that available nitrogen content was highest in maize with treatment receiving 100 per cent RDF + poultry manure.

Available phosphorus

Highest available phosphorus content of 21.78 kg ha^{-1} was recorded in treatment T_8 where 100 per cent recommended dose of fertilizer + poultry manure @ 10 t ha^{-1} was applied,while the lowest of 15.93 kg ha^{-1}was recorded in control plots (T_1).Application of 100 per cent recommended dose of fertilizer (T_2) recorded 19.15 kg ha^{-1} available phosphorus content and showed an increase of 20.20 per cent over control (T_1). Among sole application of manures, application of poultry manure @ 10 t ha^{-1} was found superior over the farmyard manure @ 20 t ha^{-1} and vermicompost @ 10 t ha^{-1} in terms of available phosphorus content (Table 4).The increase in available phosphorus content of soil with the integrated nutrient management might be due to the direct addition of phosphorus by the incorporation of organic manure and chemical fertilizers. These findings are in agreement with the observations of Kalappanavar and Gali (2019), who also recorded highest available phosphorus content in maize with treatment receiving 100 per cent RDF + poultry manure.

Available potassium

The plots applied with 100 per cent recommended dose of fertilizers (T_2) recorded 11.29 per cent increases in available potassium content over control (T_1). Where different organics were applied with 100 per cent of recommended dose of fertilizer, highest available potassium was obtained in plots getting poultry manure along with 100 per cent RDF followed by plots getting 100 per cent recommended dose of fertilizer + vermicompost and lowest in plots getting 100 per cent recommended dose of fertilizer + farmyard manure (Table 4). Plots getting 75 per cent recommended dose of fertilizer with different organics also followed the same trend as by the plots getting 100 per cent RDF. However, the differences among graded doses were at par when applied with respective manure. The increment in the available K content with the integrated application of inorganic fertilizer and organic manures might be due to the beneficial effects of organic manures affecting clay-oregano interaction and direct K_2O additions widening available K pool of soil. Increase in potassium availability with the use of chemical fertilizers and organics has been reported by Kalappanavar and Gali (2019), who also observed that available potassium content was highest in maize with treatment receiving 100 per cent RDF + poultry manure.

Available sulphur

Sole application of poultry manure, vermicompost, and farmyard manure showed 14.69, 11.40 and 9.67 per cent increase in available sulphur content over control (Table 4). The integration of different organics and fertilizer doses on available sulphur were found to be significant. Treatment T_8 (100 per cent RDF + PM) showed 7.96 per cent increase than T_2 (100 per cent recommended dose of fertilizer). On comparing the treatments receiving 75 and 100 per cent RDF with different organics, it was found that application of 100 per cent RDF with manures resulted in higher available S content in soil, and was at par with the treatments receiving 75 per cent RDF with manures. The application of organic manures and chemical fertilizers generally resulted in buildup of available S status of the soil which might be due to direct addition of sulphur from these sources. The buildup in available sulphur of the soil with the addition of organics has also been reported by Kalappanavar and Gali (2019), who reported that available sulphur content was highest in maize with treatment receiving 100 per cent RDF + poultry manure.

Exchangeable calcium and magnesium

The exchangeable calcium and magnesium content (Table 4) varied from a minimum value of 9.23 and 2.49 (cmol (p+) kg^{-1}), respectively under control (T_1) to a maximum of 11.52 and 2.82 [cmol (p+) kg^{-1}], respectively under 100 per cent RDF + poultry manure @ 10 t ha^{-1} (T_8). Among sole application of organic manures, the maximum exchangeable calcium and magnesium was recorded with poultry manure @ 10 t ha^{-1} application, followed by vermicompost @ 10t ha^{-1} and lowest with farmyard manure @ 20 t ha^{-1}application. An increase in exchangeable calcium and magnesium content of soil was observed in all treatments over control. On comparing different rates of fertilizer application, 100 per cent recommended rate was found to be superior over 75 per cent recommended rate.The increase in the exchangeable calcium and magnesium content of soil with conjoint application of fertilizers and manures might be due to the release of nutrients from added organic sources with which after mineralization released magnesium. Such a trend of increased Ca and Mg content with organics application has also been reported by Reddy *et al.* (2020), who also reported that exchangeable calcium was highest in treatment receiving press mud cake @ 10 t ha^{-1} followed by poultry manure @ 4 t ha^{-1},whereas highest exchangeable magnesium content was observed in treatment receiving FYM @ 10 t ha^{-1} followed by press mud cake @ 10 t ha^{-1} in groundnut.

DTPA extractable micronutrients

The data presented in Table 4 revealed that the application of chemical fertilizers or organic manures either alone or in combination significantly increased the content of DTPA extractable Fe, Cu, Zn and Mn. The highest content of DTPA extractable Fe (15.92 mg kg^{-1}), Cu (1.69 mg kg^{-1}), Zn (1.26 mg kg^{-1}) and Mn (18.35mg kg^{-1}) was recorded in treatment T_8(100per centRDF + Poultry manure @ 10 tha^{-1}) and lowest content of DTPA extractable Fe (14.41 mg kg^{-1}), Cu (1.38 mg kg^{-1}), Zn (0.89 mg kg^{-1}) and Mn (15.96 mg kg^{-1}) was observed under control (T_1). Among the different organics, poultry manure gave higher values of DTPA extractable Fe, Cu, Zn and Mn, followed by vermicompost and FYM application.Amongst different rates of fertilizers application, 100 per cent RDF rate in conjunction with organic manures was significantly superior over 75 per cent RDF rate.

Increase in DTPA micronutrients content with the application of organics may be ascribed to the addition of micronutrients from these sources. In addition, organic applications increase the solubility of iron through effects on the soil redox potential. Such a trend of increased DTPA extractable Fe with organics application has been reported by Kalappanavar and Gali (2019).Increase in DTPA extractable Cu with the application of organics alone or in combination with RDF may be ascribed to the great affinity of Cu for organic complexing. Soluble Cu–organic forms seem to comprise most of the Cu in soil solution over a wide range of pH, so they would play an important role in the bioavailability of Cu in soil (McBride and Blasiak, 1979). These results corroborate the findings of Kalappanavar and Gali (2019), who also reported that DTPA extractable Cu was highest in treatment receiving 100 per cent RDF + poultry manure.

Buildup of zinc status of the soil with the application of organics might be ascribed to the capability

Table 1. Effect of integrated nutrient management on yields (q ha^{-1}) of garden pea

Treatments		Pod yield (q ha^{-1})	Stover yield (q ha^{-1})	Seed yield (q ha^{-1})
T_1	Control	35.19	8.41	5.02
T_2	100 % RDF	63.63	15.03	10.83
T_3	Vermicompost @ 10 t ha^{-1}	54.70	13.28	8.70
T_4	75% RDF + Vermicompost @ 10 t ha^{-1}	72.68	17.43	12.82
T_5	100% RDF + Vermicompost @ 10 t ha^{-1}	76.18	19.33	13.50
T_6	Poultry manure @ 10 t ha^{-1}	59.68	14.16	9.62
T_7	75 % RDF + Poultry manure @ 10 t ha^{-1}	75.55	18.46	13.39
T_8	100% RDF + Poultry manure @ 10 t ha^{-1}	79.82	20.45	14.45
T_9	Farmyard manure @ 20 t ha^{-1}	52.20	12.19	8.25
T_{10}	75% RDF + Farmyard manure @ 20 t ha^{-1}	71.46	16.52	12.30
T_{11}	100% RDF + Farmyard manure @ 20 t ha^{-1}	73.54	17.60	13.00
	SE (d)±	3.67	1.56	0.68
	C D at 5%	7.70	3.28	1.43

Table 2.Effect of integrated nutrient management on the physical properties of soil

Treatments		Bulk Density (Mg m^{-3})	Particle Density (Mg m^{-3})	Porosity (%)	WHC (%)
T_1	Control	1.38	2.57	46.53	33.13
T_2	100 % RDF	1.38	2.57	46.50	33.37
T_3	Vermicompost @ 10 t ha^{-1}	1.37	2.56	46.70	33.53
T_4	75% RDF + Vermicompost @ 10 t ha^{-1}	1.36	2.56	46.98	33.67
T_5	100% RDF + Vermicompost @ 10 t ha^{-1}	1.36	2.57	47.13	33.77
T_6	Poultry manure @ 10 t ha^{-1}	1.37	2.56	46.50	33.22
T_7	75 % RDF + Poultry manure @ 10 t ha^{-1}	1.36	2.57	47.19	33.49
T_8	100% RDF + Poultry manure @ 10 t ha^{-1}	1.36	2.57	46.96	33.53
T_9	Farmyard manure @ 20 t ha^{-1}	1.36	2.57	47.12	33.28
T_{10}	75% RDF + Farmyard manure @ 20 t ha^{-1}	1.36	2.57	46.95	33.58
T_{11}	100% RDF + Farmyard manure @ 20 t ha^{-1}	1.36	2.57	47.02	33.63
	SE (d)±	-	-	0.589	0.559
	C D at 5%	-	-	-	-

Table 3.Effect of integrated nutrient management on pH, EC and organic carbon content of soil

Treatments		Soil pH	EC (dS m^{-1})	Organic carbon (g kg^{-1})
T_1	Control	7.03	0.197	4.45
T_2	100 % RDF	6.96	0.208	4.68
T_3	Vermicompost @ 10 t ha^{-1}	7.03	0.200	5.10
T_4	75% RDF + Vermicompost @ 10 t ha^{-1}	7.01	0.208	5.17
T_5	100% RDF + Vermicompost @ 10 t ha^{-1}	7.00	0.209	5.20
T_6	Poultry manure @ 10 t ha^{-1}	7.03	0.205	4.98
T_7	75 % RDF + Poultry manure @ 10 t ha^{-1}	7.01	0.213	5.08
T_8	100% RDF + Poultry manure @ 10 t ha^{-1}	7.00	0.215	5.11
T_9	Farmyard manure @ 20 t ha^{-1}	7.04	0.204	5.13
T_{10}	75% RDF + Farmyard manure @ 20 t ha^{-1}	7.01	0.210	5.20
T_{11}	100% RDF + Farmyard manure @ 20 t ha^{-1}	7.00	0.211	5.23
	SE (d)±	0.059	-	0.16
	C D at 5%	-	-	0.32

Table 4. Effect of integrated nutrient management on the availability of nutrients in soil

Treatments	N (kg ha^{-1})	P (kg ha^{-1})	K (kg ha^{-1})	S (kg ha^{-1})	Ca [cmol (p^+) kg^{-1}]	Mg [cmol (p^+) kg^{-1}])	Fe (mg kg^{-1})	Cu (mg kg^{-1})	Zn (mg kg^{-1})	Mn (mg kg^{-1})
T_1	156.80	15.93	141.50	27.71	9.23	2.49	14.41	1.38	0.89	15.96
T_2	223.68	19.15	157.49	31.78	10.06	2.76	14.81	1.46	0.98	16.45
T_3	208.01	17.42	147.99	30.87	9.71	2.64	15.01	1.45	1.10	17.49
T_4	226.56	19.23	161.39	33.30	10.65	2.74	15.48	1.52	1.16	17.96
T_5	237.25	20.70	169.12	33.94	11.32	2.76	15.63	1.57	1.19	18.09
T_6	210.13	18.71	150.50	31.78	9.98	2.73	15.09	1.55	1.13	17.58
T_7	243.65	20.67	163.98	33.89	10.97	2.78	15.62	1.62	1.19	18.01
T_8	256.80	21.78	171.71	34.31	11.52	2.82	15.92	1.69	1.26	18.35
T_9	196.35	17.25	145.49	30.39	9.62	2.55	14.94	1.40	1.00	17.45
T_{10}	227.25	18.77	160.89	32.56	10.44	2.66	15.45	1.47	1.02	17.85
T_{11}	235.89	20.51	167.22	33.26	11.14	2.75	15.53	1.53	1.09	18.05
SE (d)±	13.57	0.60	8.16	1.27	0.54	0.27	0.40	0.100	0.094	1.345
C D at 5%	27.42	1.22	17.15	2.66	1.10	-	-	-	-	-

of organic matter to bind Zn in a stable form and retaining it in a form not immediately available to plants. However, the addition of exogenous organic matter, with functional groups that have the ability to form stable complexes, promotes Zn availability in soils (Almas *et al*., 2000 and Kimi *et al.,*2021). Similar positive influence of organic manures on Zn content of soil have also been reported by Kalappanavar and Gali (2019).Higher content of DTPA extractable Mn in soil under fertilizer and manure treated plots was probably due to increased the availability of Mn. Such a trend of increased Mn content with organics application has been reported by Kalappanavar and Gali (2019), who also reported that DTPA extractable Mn was highest in treatment receiving 100 per cent RDF + poultry manure in maize.

Thus, it is inferred from the above study that conjoint use of fertilizers and organic manures was beneficial in improving yields of pea and the physical and chemical properties of the soil.

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