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Effect of mycorrhiza and organic fertilizer on chemical properties of soil under central plain zone (Auraiya)

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Abstract
In order to assess how greenhouse soil responded to a bio fertilizer and mycorrhiza in comparison to other nutrient sources, the experiment was carried out in the Central Plain Zone (Auraiya) during the 2021–22 cropping season. Control, FYM, sheep manure, poultry manure, and chemical fertilizer, as well as FYM with half chemical, half chemical, and half chemical in poultry manure, were the treatments. The following randomized complete block design (RBCD) was used for the trials, and three replications of each treatment were conducted. Comparing significance means yielded the least significance difference (LSD) with a 5% error rate. The results indicated that half-chemical treatment of poultry manure greatly decreased the pH of the soil (7.00) while substantially raising the EC, P, and N, P, and K in the plant to 1.57 ds.m-^{1}, 22.53, 2.90, 0.585, and 3.347 ppm, respectively. Significant increases in EC, K, N, and P accessible in the soil (1.345 ds.m-^{1}), as well as P and K content in plants (0.471 and 3.29 ppm), were seen in mycorrhizae; nevertheless, the pH of the soil was dramatically lowered (7.344). Additionally, the results showed that the combination of poultry manure and 1/2 chemical with mycorrhizae significantly increased the amount of N, P, and K accessible in the soil as well as the K content in plants (2.95, 46.13, and 3.53 ppm) and TSS (8.70) and reduced pH (7.201).

Keywords: Mycorrhiza, organic fertilizer, chemical properties of soil

Introduction

Due to the possibility of growing in more than one season per year or shortening the growing season, vegetable crops are grown at higher rates of chemical fertilizer addition than other crops. This has increased the negative effects on the environment and human health, as well as the residual impact of nitrate, which is one of the moist hazards to human health (Osman, 2007) [14]. In comparison to mineral fertilizers, forcing the use of bio fertilizers to reduce the use of mineral fertilizers by 20–50% results in the production of growth inhibitors for pathogens, increases tolerance to environmental stress conditions, and reduces environmental pollution (Thiab, 2012) [18].

Increases the plant's intake of nutrients, which encourages plant growth (Al-Taei, 2016) [7]. Furthermore, compared to conventional agricultural products, organic agricultural products yield a higher economic return, particularly in industrialized nations. (Al-Abbadi, 2012 and Al-Shahat, 2007) [2, 6], The purpose of this study is to investigate how certain physical and chemical characteristics of soil are affected by organic and bio fertilizers.

Important markers of soil quality are the microbial communities in the soil (Schloter *et al*., 2018; García-Delgado *et al*., 2019) [17, 11]. The breakdown of soil organic matter and the cycling of nutrients in ecosystems are significantly influenced by soil microorganisms, which in turn determine the efficiency of nutrient use (Kallenbach *et al*., 2016; Cui *et al*., 2019) [13, 9]. Furthermore, the preservation and recovery of land productivity are clearly impacted by soil bacteria, which either directly or indirectly contribute to the process of soil material and energy movement (Reinhart *et al*., 2016; George *et al*., 2019) [16, 12]. Therefore, one of the main challenges in increasing the rate at which newly cultivated land is utilized is boosting the soil's microbial community and nutrients.

Materials and Methods

This experiment was set up at the Janta Mahavidyalaya Ajitmal, Auraiya research station for the 2021–2022 agricultural season. Two factors were examined in this study: Factor 1: Fertilisation treatments: Chemical (T5), FYM + ½ chemical (T6), Sheep manure + ½ chemical (T7), Poultry manure + ½ chemical (T8), Absolute control (T1), Sheep manure (T3), and poultry manure (T4). Factor 2: Mycorrhiza-containing (M1) and Mycorrhiza-free (M0). A randomised complete block design (RCBD) was used to allocate the treatments to experimental plots, and each treatment was administered in three replications. The least significant differences (LSD) test was used to identify significant differences between treatment mean values at the 0.05 level.

Experimental Results

1. Soil pH

Table (1) shows that there are significant differences between the fertilization parameters in the degree of soil reaction ph. The fertilization treatment with poultry manure + half of the fertilizer recommendation T_8 has the lowest value of the soil reaction rate 7.201 and significantly lower than all the fertilization treatments including the T_1 Which recorded the highest soil interaction value of 7.450. Mycorrhiza treatment was superior to control treatment on pH of soil (7.354,7.344). The interaction treatments M_1T_8 and M_0 T_8 were least significant on pH of soil (7.201 and 7.240) respectively than other interaction treatments except M_1T_7 (7.360) and T_4M_1 (7.298).

Table 1: Effect of Mycorrhiza fungi, organic fertilizer and their interaction on pH soil.

Fertilizer treatments	With mycorrhiza (M_1)	Without mycorrhiza (M_0)	Mean of fertilizer treatments
Absolute control (T_1)	7.443	7.457	7.450
FYM (T_2)	7.356	7.350	7.353
Sheep manure (T_3)	7.362	7.368	7.365
Poultry manure (T_4)	7.298	7.301	7.290
Chemical (T_5)	7.399	7.402	7.299
FYM+½chemical (T_6)	7.362	7.369	7.365
Sheep manure+½chemical (T_7)	7.36 0	7.345	7.352
Poultry Manure+½chemical (T_8)	7.201	7.240	7.225
Mean Mycorrhiza	7.344	7.354	7.349
LSD 0.05	M=0.0654	T=0.1264	MT=0.1918

2. Soil EC ($ds.m^{-1}$)

Table (2) shows that there are significant differences between the treatment fertilization on electrical conductivity (EC). The T_1 ratio was significantly lower compared with either the fertilizing treatment by recording the lowest value of EC ($1.080 ds.m^{-1}$). From the table above, there is no significant difference between the treatment of Mycorrhiza fungi with comparison treatment in soil electrical conductivity (EC). The interaction treatments of the comparison treatment with or without the addition of the fungus (T_1M_1, T_1M_0) were considered to be the lowest value for the electrical conductivity of the soil (1.101, 1.060) sequentially.

Table 2: Effect of Mycorrhiza fungi, organic fertilizer and their interaction of EC on soil.

Fertilizer treatments	With mycorrhiza (M_1)	Without mycorrhiza (M_0)	Mean of fertilizer treatments
Absolute control (T_1)	1.101	1.060	1.080
FYM (T_2)	1.410	1.250	1.330
Sheep manure (T_3)	1.331	1.320	1.325
Poultry manure (T_4)	1.357	1.392	1.374
Chemical (T_5)	1.365	1.376	1.370
FYM+½chemical (T_6)	1.320	1.325	1.322
Sheep manure+½chemical (T_7)	1.425	1.420	1.422
Poultry Manure+½chemical(T_8)	1.548	1.592	1.570
Mean Mycorrhiza	1.345	1.341	1.343
LSD 0.05	M= 0.0663	T= 0.1286	M T=0.1949

The values EC and its pH can be explained by the role of organic matter in reducing the value of pH which has an effect on the values of electrical conductivity. There is also an inverse relationship between the values of the two brands (EC, PH), due to the role of degradation products of organic matter (humic and fulvic acids) (Al Obeidi, 2002) [5].

3. Soil Available N

In table 3 showed the treatment of fertilization with poultry manure + half of the fertilizer recommendation T_8 was significantly higher than all fertilizer treatments as well as the T_1 available N in soil (98.75, 71.55 $kgha^{-1}$) respectively. From the same table, the treatment of Mycorrhiza fungi was significantly higher than the control treatment on available N in soil (90.25, 88.57 $kgha^{-1}$) respectively. The interaction M_1T_8 treatment (98.99 $kgha^{-1}$) was significantly higher than most treatments including M0T1 treatment (71.02 $kgha^{-1}$).

Table 3: Effect of Mycorrhiza fungi, organic fertilizer and their interaction on available N (kg ha^1) in soil.

Fertilizer Treatments	With mycorrhiza (M_1)	Without mycorrhiza (M_0)	Mean of fertilizer treatments
Absolute control (T_1)	72.08	71.02	71.55
FYM (T_2)	84.74	82.44	83.59
Sheep manure (T_3)	91.62	88.28	89.95
Poultry manure (T_4)	89.66	87.06	88.36
Chemical (T_5)	92.08	91.32	91.70
FYM+½chemical (T_6)	95.64	93.14	94.39
Sheep manure+½chemical (T_7)	96.99	96.82	96.90
Poultry Manure+½chemical (T_8)	98.99	98.52	98.75
Mean Mycorrhiza	90.25	88.57	89.41
LSD 0.05	M= 0.585	T= 1.356	M T=1.941

4. Soil Available P

Table (4) shows that there are significant differences between the fertilization treatments available of phosphorus in soil, the fertilization treatment of Poultry manure ½chemical (T_8) was significantly higher on all fertilizer transactions, including T_1 (22.53, 9.94 kgha^{-1}) respectively. The treatment of Mycorrhiza fungi (M_1) was significantly higher than the control treatment (M_0) on available of P in soil (15.80, 14.73 kgha^{-1}) respectively. The interaction M_1T_8 treatment (23.06kgha^{-1}) was significantly higher than most treatments including M_0T_1 treatment (9.80 kgha^{-1}).

Table 4: Effect of Mycorrhiza fungi, organic fertilizer and their interaction on available P (kgha^{-1}) in soil.

Fertilizer Treatments	With mycorrhiza (M_1)	Without mycorrhiza (M_0)	Mean of fertilizer treatments
Absolute control (T_1)	10.08	9.80	9.94
FYM (T_2)	14.81	12.75	13.78
Sheep manure (T_3)	15.63	13.84	14.73
Poultry manure (T_4)	18.26	18.18	18.22
Chemical (T_5)	11.58	10.99	11.28
FYM+½chemical (T_6)	14.89	14.13	14.51
Sheep manure+½chemical (T_7)	18.16	16.17	17.16
Poultry Manure+½chemical(T_8)	23.06	22.01	22.53
Mean Mycorrhiza	15.80	14.73	15.26
LSD 0.05	M= 0.7330	T= 1.296	M T=2.029

5. Soil Available K

In table 5 showed The treatment T_8 (Poultry manure + ½chemical) was significantly higher than the comparison treatment, the fertilizer recommendation and the treatment of fertilization of Poultry manure T_1, T_5, T_4 (200.34, 241.55 and 294.13 kgha^{-1}) respectively, while not significantly different from the rest of the treatments. The treatment of Mycorrhiza fungi was significantly higher than the control treatment on available K in soil (267.08, 263.97 kgha^{-1}) respectively. The interaction M_1T_8 treatment (302.35 kgha^{-1}) was significantly higher than most treatments including treatment of comparison with or without adding Mycorrhiza fungi M_0T_1 (199.08kgha^{-1}), M_1T_1 (201.60 kgha^{-1}).

Table 5: Effect of Mycorrhiza fungi, organic fertilizer and their interaction on available K (kgha^{-1}) in soil.

Fertilizer Treatments	With mycorrhiza (M_1)	Without mycorrhiza (M_0)	Mean of fertilizer treatments
Absolute control (T_1)	201.60	199.08	200.34
FYM (T_2)	252.50	248.05	250.27
Sheep manure (T_3)	282.41	276.38	279.39
Poultry manure (T_4)	296.95	291.32	294.13
Chemical (T_5)	242.52	240.58	241.55
FYM+½chemical (T_6)	266.39	264.09	265.24
Sheep manure+½chemical (T_7)	292.01	291.30	291.65
Poultry Manure+½chemical(T_8)	302.35	301.02	301.68
Mean Mycorrhiza	267.08	263.97	265.52
LSD 0.05	M= 18.45	T= 40.85	M T=59.30

6. N (ppm) Uptake in plant

The Mycorrhiza gave the highest N content of 2.98% which differed significantly from 2.82% in absolute control, indicating 4.9% of an increment. The application of poultry manure with half chemical gave the highest N content of 2.90% which differed significantly from ether treatments including absolute control T_1 (1.21%) and Chemical (T_5) (2.43%). Furthermore, significant differences were found in the interactions between fertilizer application and the Mycorrhiza treatments. The combination between poultry residues and Mycorrhiza gave the highest N content of 2.98% compared with absolute control with & without Mycorrhiza application which gave the lowest N content of 1.18% (Table 6).

Table 6: Effect of Mycorrhiza fungi, organic fertilizer and their interaction on available N (%) in plant.

Fertilizer Treatments	With mycorrhiza (M_1)	Without mycorrhiza (M_0)	Mean of fertilizer treatments
Absolute control (T_1)	1.25	1.18	1.21
FYM (T_2)	2.30	2.28	2.29
Sheep manure (T_3)	2.41	2.32	2.36
Poultry manure (T_4)	2.52	2.28	2.40
Chemical (T_5)	2.56	2.30	2.43
FYM+½chemical (T_6)	2.60	2.52	2.56
Sheep manure+½chemical (T_7)	2.95	2.78	2.86
Poultry Manure+½chemical(T_8)	2.98	2.82	2.90
Mean Mycorrhiza	2.44	2.31	2.37
LSD 0.05	M=0.01533	T= 0.02660	M T=0.04193

7. P (ppm) Uptake in Plant

Results indicated significant differences between the Mycorrhiza treatments in P in fruit of the okra. Mycorrhiza gave the highest P of 0.471 ppm which differed significantly from 0.379 ppm in absolute control indicating 24.2% increment. Application of organic substrates indicated that poultry manure with half chemical gave the highest P content (0.585 ppm) compare with the lowest (0.204 ppm) in absolute control, which is an increment of 186.76%. Furthermore, significant differences were found for the interactions between fertilizer application and the use of Mycorrhiza. Results indicated that the use of a mixture of poultry manure with half chemical with Mycorrhiza gave the highest P (0.594 ppm) compared with the absolute control with & without Mycorrhiza application which gave the lowest result (0.183 ppm) of P content in okra. (Table 7).

Table 7: Effect of Mycorrhiza fungi, organic fertilizer and their interaction on available P (PPM) in plant.

Fertilizer Treatments	With mycorrhiza (M_1)	Without mycorrhiza (M_0)	Mean of fertilizer treatments
Absolute control (T_1)	0.226	0.183	0.204
FYM (T_2)	0.453	0.310	0.381
Sheep manure (T_3)	0.450	0.327	0.388
Poultry manure (T_4)	0.484	0.376	0.430
Chemical (T_5)	0.418	0.372	0.395
FYM+½chemical (T_6)	0.581	0.455	0.518
Sheep manure+½chemical (T_7)	0.565	0.528	0.546
Poultry Manure+½chemical(T_8)	0.594	0.576	0.585
Mean Mycorrhiza	0.471	0.379	0.425
LSD 0.05	M=0.01125	T= 0.02545	M T=0.0367

8. K (ppm) Uptake in Plant

Results indicated significant differences between the Mycorrhiza treatments on K in fruit of the okra. Mycorrhiza gave the highest K of 3.29ppm which differed significantly from 2.91 ppm in absolute control indicating 13.05% increment. Application of organic substrates indicated that poultry manure with half chemical (T_8) gave the highest K content (3.47 ppm) compare with the lowest (2.76 ppm) in absolute control, which is an increment of 25.72%. Furthermore, significant differences were found for the interactions between fertilizer application and the use of Mycorrhiza. Results indicated that the use of a mixture of poultry manure with half chemical with Mycorrhiza gave the highest K (3.63ppm) compared with the absolute control with & without Mycorrhiza application which gave the lowest (2.54 ppm) of k content in okara fruit (Table8)

Table 8: Effect of Mycorrhiza fungi, organic fertilizer and their interaction on available k (ppm) in plant.

Fertilizer Treatments	With mycorrhiza (M_1)	Without mycorrhiza (M_0)	Mean of fertilizer treatments
Absolute control (T_1)	2.99	2.54	2.76
FYM (T_2)	3.02	2.75	2.88
Sheep manure (T_3)	3.23	2.65	2.94
Poultry manure (T_4)	3.30	2.76	3.03
Chemical (T_5)	3.17	3.01	3.09
FYM+½chemical (T_6)	3.46	3.11	3.28
Sheep manure+½chemical (T_7)	3.52	3.21	3.36
Poultry Manure+½chemical (T_8)	3.63	3.32	3.47
Mean Mycorrhiza	3.29	2.91	3.10
LSD 0.05	M= 0.0659	T= 0.1245	M T=0.7835

The effect of organic fertilizer may be attributed to its active role in increasing the biological processes of microorganisms in the soil. This increases the readiness of macronutrient elements (Table 3, 4, 5), as well as the addition to the organic fertilizers macro and micro

Elements added to the soil and thus helped the plant absorb it and increase its concentration within the fruit tissue (table 6, 7 and 8), this results agree with (Agaab, 2013 and EL-Kabey, 2014) [1, 10]. Mycorriza increases availability of nutrient elements in soil and helps plant absorption, especially phosphorus by the fungus fungi will reach places far from the growth area of the system of roots and will increase their available in soil and increase absorption by the plant, and these results agree with (Al-Abdullah, 2008; Al-Khafaji, 2014 and Al-Taie, 2016) [3, 4, 8].

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