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Effect of organic and conventional cultivation practices on soil nutrient status in selected crops of Northern Telangana zone

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Abstract
The study in relation to "Nutrient forms under organic and conventional cultivation practices in selected crops of Northern Telangana Zone" was carried out during *kharif* season of 2022 at the farmer's field in sorghum, redgram and tumeric crops of Northern Telangana Zone. The survey was carried out to know the soil nutrient status under organic and conventional cultivation practices in selected crops. 60 soil samples of 0-15 cm depth were collected randomly after the harvest of sorghum, red gram and turmeric crops representing organic and conventional farming systems, 10 samples per each crop from both the practices. The soil samples collected were analysed for bulk density, pH, EC, organic carbon (%), CEC, available macronutrients (N, P, K and S) and micronutrients (Zn, Cu, Fe and Mn). The results revealed regarding physical properties of soil that, the bulk density in organic farming with a mean value of 1.32 Mg m^{-3} and in conventional system with a mean value of 1.54 Mg m^{-3}. Due to application of organic sources resulted a 16% decrease in soil bulk density over conventional farming. Regarding physico-chemical properties of soil the results revealed that soil pH was reduced, electrical conductivity of soil slightly remained unchanged, the soil organic carbon and CEC increased due to incorporation of organic sources. soil pH was neutal to slightly alkaline in nature (6.94-8.02) and electrical conductivity of soil was rated as non-saline (0.16-0.49 ds m-^{1}). The soil organic carbon varied from 0.33 to 0.77% and comes under the categories of low to medium. The status of available N, P, K and S was high in organic farming with a mean values of 218, 42.3, 349 and 37.6 kg ha^{-1} respectively and in conventional system with a mean values of 206, 36.9, 329 and 32.2 kg ha^{-1} respectively. The DTPA extractable micronutrients Zn, Fe, Mn and Cu was high in organic farming with a mean values of 0.66, 9.33, 13.40 and 3.47 mg kg^{-1} and in conventional system with a mean values of 0.50, 7.84, 10.62 and 2.38 mg kg^{-1} respectively. The results revealed that organic farming practices build up the chemical composition of soil, suppliment the availability of macro and micronutrients, and enchance the soil's organic carbon status all of which are cruial for sustainable crop yields.

Keywords: Organic farming, conventional farming, soil organic carbon, CEC, available macronutrients and available micronutrients

Introduction
Different cropping systems with input of fresh organic matter can trigger changes in the physical and chemical properties of soils and consequently affect their biological composition (Powlson and Brookes, 1987) [32]. In recent years, great attention is being paid to organic production as an alternative form of agriculture to obtain high quality food in an environment friendly manner. Organic production methods avoid the use of synthetic fertilizers and pesticides and relay on ecological processes and biological cycles to maintain or improve soil fertility, minimize environmental pollution and produce good quality food in sufficient amount (Benbi *et al.*, 2016) [4]. Conventional soil management practices consist of applications of synthetic fertilizers and the use of herbicides for weed control while the integrated production system includes elements of both organic and conventional practices (Glover *et al.*, 2000) [16]. The input of organic matter through organic amendments the organic system of agriculture can bring about quantitative and qualitative changes in soil organic matter (SOM) and its ecological functions.

Soil organic matter (SOM) is "the most complex and least understood component of soils". Any soil substance derived from the tissues of living or extinct organisms is known as soil organic matter. Soil Organic matter makes up around 50% of the carbon (C) in soil health and is rich in nutrients such micronutrients, phosphorus (P), sulphur (S), and nitrogen (N). Increased nutrient and micronutrient availability is facilitated by soil that is rich in organic matter. Soil organic matter is important key component because it effects the soil physical, chemical and biological properties that defined soil productivity and quality (Doran and Parkin, 1994) [12].

Material and Methods

With support from the Department of Agriculture, KVKs, and Extension Workers, a survey was conducted in the Northern Telangana Zone to identify the farmers engage in organic farming. We selected farmers who had been practicing this method for over five years, and collected information on the type and amount of organic resources they used in their primary farming systems.

Description of Survey Location and Survey Work

The field investigation was conducted during *kharif* season of 2022 at the farmer's fields (organic and conventional field) of Northern Telangana Zone. Northern Telangana Zone zone includes Adilabad, Komaram Bheem Asifabad, Nirmal, Mancherial, Nizamabad, Jagtial, Peddapalli, Kamareddy, Rajanna Sircilla and Karimnagar districts. Annual rainfall ranges from 867 mm to 1189 mm, received mostly from the south-west monsoon rainfall. During this season maximum temperatures ranges between 31 and 39^{0}C and minimum ranges between 14 and 25^{0}C. There are 16 types of soils in NTZ. It has shallow black soils (18.4%), deep calcareous soils (16.6%) and red clayey soils (15.2%). However, as a whole, red soils (45%) and is followed by black soils (24%) and calcareous soils (20%). Predominant crops in this zone include rice, maize, soybean, sesame, cotton, redgram, sugarcane and turmeric.

The Survey and study was conducted in the Asifabad and Nizamabad districts of Northern Telangana Zone. Soil samples of 0-15 cm depth were collected randomly after the harvest of sorghum, redgram and turmeric crops from different locations *viz*., Shetpally, Morthad, Armour, Kammarapally, Gummiryal, Velgatoor, Vannel, Domchanda, Kerameri, China sadaka, Pedda sadaka, Token movad, Modi, Jhari, Parda, Chinthakara, Babjipet and Babejhari villages of Asifabad and Nizamabad districts.

Sample collection and Processing

A 60 surface soil (0-15 cm) samples representing organic and conventional farming systems from sorghum, red gram and turmeric crops at 10 samples per each crop from both the practices were collected from farmers field after harvest of the crops.

The sampling design employed a randomized zig-zag pattern, covering the entire field with 4 to 5 sites. Approximately 0.5 kg of soil sample was collected using the quartering method, where sub-samples were taken and combined to obtain a representative sample. Bulk density samples were collected using core samplers to assess the density of the soil. The collected soil samples were shade dried and grounded to a finer consistency and then sieved through a 2 mm sieve and for determination of organic carbon grind soil samples were passed through 0.5 mm sieve, stored in plastic cover, labelled with details and further studied for various physical, physico-chemical and chemical properties.

Laboratory Analysis of Soil Samples

The soil samples were further analysed for bulk density, pH, EC, OC, CEC, available macronutrients (N, P, K and S) and micronutrients (Zn, Cu, Fe and Mn). pH was measured using digital pH meter and EC was determined by digital conductivity meter these methods were proposed by Jackson, 1973 [18]. Bulk density was assessed using core sampler method, given by Blake and Hartge (1986) [7]. Organic carbon was determined by wet oxidation method (Walkley and Black, 1934) [42]. Cation exchange capacity of soil was measured by using sodium acetate method given by Chapman (1965) [9]. Available nitrogen was assessed by using alkaline potassium permanganate method given by Subbiah and Asija (1956) [39]. Available phosphorous was determined by Olsen's method (Olsen *et al*., 1954) [29]. Available potassium was estimated by neutral normal ammonium acetate outlined by Jackson (1973) [18]. Available Sulphur was estimated by turbidimetric method by using Rayleigh UV Visible Spectrophotometer given by Chesnin and Yien (1950) [10]. Micronutrients (Fe and Zn) were determined by Lindsay and Norvell (1978) [22].

Statistical analysis

Survey was conducted according to the Factorial randomized block design (FRBD). The experimental data were statistically analyzed using of variance analysis technique that know as ANOVA (Panse and Suchatme, 1978) [31]. Descriptive statistics (mean, standard deviation, critical difference and coefficient of variation) of soil parameters were computed using the Microsoft Excel. Factorial RBD was used to determine the existence of interaction effect between the nutrient management practices and selected crops. The 5% probability level was regarded as statistically significant.

Results and Discussions

The soil fertility status was evaluated with respect to soil bulk density, pH, EC, organic carbon (%), CEC, available macronutrients (N, P, K and S) and micronutrients (Zn, Cu, Fe and Mn)

Bulk density (Mg m^{-3})

The bulk density is an important soil physical property which indicates soil compaction and it reflects the ability of the soil to function for solute and water movement and soil aeration. Data on soil bulk density under different management practices and different crops was shown in Table. 1. Soil bulk density under different nutrient management practices was significantly varied. On the whole, the range of bulk density was 1.19 to 1.45 Mg m^{-3} in organic farming with a mean value of 1.32 Mg m^{-3} and in conventional system, the range of bulk density was 1.42 to 1.72 Mg m^{-3} with a mean value of 1.54 Mg m^{-3}. Nutrient management practice showed significant variation in bulk density, cultivation of crops under organic farming recorded 16% lower bulk density conventional method of cultivation. The decrease in bulk density in the organic farming might be due to the improvement of the structural status of soil by continuous application of organic manures. Because of the cementing effect of organic acids and polysaccharides produced during the breakdown of organic inputs by greater microbial activities for better aggregation, micropores become macropores. Additionally, this makes the soil more porous. So porosity increased and bulk density reduced. Similar results were also reported by Nandhini *et al*. (2021) [27] and Nagar *et al*. (2016) [25].

Selected crops also showed significant variation in soil bulk density. Among the selected crops, the soil under turmeric crop showed significantly lower bulk density of 1.40 Mg m^{-3} and higher bulk density values of 1.47 Mg m^{-3} was recorded under sorghum crop. Bulk density of 1.42 Mg m^{-3} was recorded under redgram. The variation among the crops may be due to the soil type. In the study area, redgram is mainly grown under medium to heavy soils and due to the more porous nature of soil bulk density recorded as low. Also reported lower bulk densities in heavy soil. The soil collected from sorghum crop has, recorded higher bulk density values. Bulk density of turmeric grown soil was also significantly varied with the bulk density of sorghum grown soil even though turmeric is grown under light soils (sandy loam, clay loam). This may be due to, application of more organic manures during turmeric cultivation and this increased organic matter declines the soil bulk density. The similar also reported by Kumar *et al.* (2016) [25]. On the other hand, while harvesting of turmeric farmers makes the soil loose and more porous which has lower weight per unit volume resulted in declined bulk density. This results aligns with the conclusions drawn by Mekkaoui *et al.* (2023) [23] which demonstrated the bulk density declines by manipulating the soil compared to no disturbance.

Table 1: Bulk density (Mg m^{-3}) as influenced by nutrient management practices and selected crops.

Treatments	Bulk density (Mg m^{-3})
Factor -1: Nutrient management practice	
Organic	1.32
Conventional	1.54
SEm ±	0.02
CD (P = 0.05)	0.05
Factor -2: Selected Crops	
Sorghum	1.42
Red gram	1.47
Turmeric	1.40
SEm ±	0.02
CD (P = 0.05)	0.06
Interaction (N x S)	
SEm ±	0.02
CD (P = 0.05)	NS
CV %	5.46

Soil reaction (pH)

"Soil pH or soil reaction is an indication of the acidity or alkalinity of soil and is measured in pH units and has a dominant effect on availability of plant essential nutrients" (Neina, 2019) [28]. The data concerned to pH as influenced by different nutrien t management practices and selected crops are depicted in Table. 2. The study revealed that soil pH was neutal to slightly alkaline in nature (6.94-8.02). Soil pH was significantly influenced by management practices and more soil pH of 7.56 was recorded under conventional farming system and the low mean pH value of 7.27 was recorded in organic farming system. The pH was considerably lowered by applying organic sources. Since they are naturally organic, incorporation of organic manures releases organic acid into the soil during their decomposition, which also helps to lessen chemical properties like pH. Application of organic sources reduced the soil pH was reported by Bhanuvally *et al.* (2024) [5] and Sihi *et al.* (2017) [38]. The soil pH decreased due to the continuous incorporation of organic sources due to the deactivation of Fe^{3+} and Al^{3+} by chelating effect and release of basic cations through the decomposition of organic manure determined by Gajanana *et al*. (2005) [14].

Electrical conductivity (dS m^{-1})

Electrical conductivity is the measure of soluble salts present in soil. The data concerned to EC as influenced by different nutrient management practices and selected crops are depicted in Table. 2. The study revealed that soil electrical conductivity of soil was rated as non-saline (0.16-0.49). EC under different management practices was found to be significant and the organic management practices showed significantly lower EC of 0.27 dS m^{-1} and the conventional method of cultivation recorded EC of 0.38 dS m^{-1}. Application of the organic sources lowers the EC of soil which were mainly contributed by the production of acids on decomposition. Similar observations were reported by Das and Singh (2014) [11] and Hammad *et al*. (2020) [17]. Panghate *et al*. (2020) [30] revealed that Soil EC of soil remained almost unchanged by the action of organic sources which is under permissible limit (<1 dS m^{-1}).

Organic carbon (%)

The data concerned to SOC as influenced by different nutrient management practices and selected crops are depicted in Table. 2. The study revealed that soil organic carbon varied from 0.33 to 0.77% and comes under the categories of low to medium. The soil organic carbon in organic farming with a mean value of 0.57% and in conventional system, the soil organic carbon was with a mean value of 0.45%. Nutrient management practice showed significant variation in soil organic carbon, cultivation of crops under organic farming recorded 26% higher organic carbon compared to conventional method of cultivation. The higher soil organic carbon was because of application of organic inputs, which are source of organic matter when returned to soil increase organic C in soil. Higher soil organic carbon contents of soils under organic management practices are probably due to higher litter production and N fixation by the biomass added through organic manuring. This study showed that continuous application of different organic manures with manure affected SOC in a distinct way (Bharani *et al*. 2018) [6].

Apart from the nutrient management practices, selected crops have shown significant variation in soil organic carbon. Among the selected crops, the soil under turmeric crop showed significantly higher organic carbon of 0.56% and lower organic carbon values of 0.48% was recorded under sorghum crop. The soil organic carbon of 0.51% was recorded under redgram. The soil organic carbon of 0.51% was recorded under redgram. Among the selected crops, in the study area farmers prefer to apply more organics and manures for turmeric cultivation. This continuous application of organic manures and subsequent decomposition of these manures by microbial population which might have resulted to maintain higher organic carbon content in turmeric grown soil as reported by Krishnamurthy *et al.* (2010) [20]. Excess and regular addition of organics increases the organic carbon content in soil also reported by Bhanuvally *et al.* (2024) [5].

Cation exchange capacity

The data concerned to pH as influenced by different nutrient management practices and selected crops are depicted in Table. 2. The study resulted that the cation exchange capacity of soil in organic farming with a mean value of 15.51 cmol (p^+) kg^{-1} and in conventional system, the cation exchange capacity of soil was with a mean value of 12.61 cmol (p^+) kg^{-1}. Nutrient management practice showed significant variation in soil cation exchange capacity, cultivation of crops under organic farming recorded 22% higher cation exchange capacity over conventional method of cultivation. The application of organic sources significantly increased CEC and this may be attributed to the build up of soil humus and higher amount of crop residues. (Gathala *et al*.,

2007) [15]. Similar investigations were analogous with findings of Bulluck *et al*. (2002) [8] and Bhanuvally *et al*. (2024) [5].

Apart from the nutrient management practices, selected crops also showed significant variation in cation exchange capacity. Among the selected crops, the soil under turmeric crop showed significantly higher cation exchange capacity with a mean value of 14.6 cmol (p^+) kg^{-1} and lower cation exchange capacity with a mean value of 13.3 cmol (p^+) kg^{-1} was recorded under sorghum crop. The soil cation exchange capacity with a mean value of 14.3 cmol (p^+) kg^{-1} was recorded under redgram. In the present study area, farmers applying more organics and manures to turmeric crop, which leads to maintain more exchangeable bases in soil results in higher CEC. Presence of more organic matter increases soil CEC was earlier reported by Akhtaruzzman *et al.* (2020) [1]. Whereas, lower CEC values recorded under sorghum crop might be due to low organic carbon and low exchangeable bases. These results are in consistence with the findings of Gafur *et al*. (2000) [13] and Alam *et al*. (1993) [2] who reported that low organic matter and low concentration of exchangeable bases of soil.

Table 2: Soil physico-chemical properties as influenced by nutrient management practices in selected crops.

Treatments	pH	EC (dS m^{-1})	OC %	CEC (cmol (p+) kg^{-1})
Factor -1 : Nutrient management practice				
Organic	7.26	0.27	0.58	15.5
Conventional	7.67	0.38	0.45	12.6
SEm ±	0.03	0.01	0.01	0.15
CD (P = 0.05)	0.08	0.03	0.04	0.45
Factor -2 : Selected Crops				
Sorghum	7.43	0.31	0.48	13.3
Red gram	7.47	0.34	0.51	14.3
Turmeric	7.50	0.32	0.56	14.6
SEm ±	0.03	0.01	0.02	0.19
CD (P = 0.05)	NS	NS	0.05	0.55
Interaction (N x S)				
SEm ±	0.05	0.02	0.02	0.27
CD (P = 0.05)	NS	NS	NS	NS
CV %	2.01	18.71	14.4	6.11

Available macronutrients (kg ha^{-1})

The soil available N, P, K and S as influenced by different nutrient management practices and selected crops are depicted in Table. 3. The available N, P, K and S in organic farming with a mean values of 218, 42.3, 349 and 37.6 kg ha^{-1} respectively and in conventional system, the available nitrogen of soil was with a mean values of 206, 36.9, 329 and 32.2 kg ha^{-1} respectively. Nutrient management practice showed significant variation in soil available N, P, K and S, cultivation of crops under organic farming recorded higher available N, P, K and S and conventional method of cultivation recorded lower available N, P, K and S. The available nitrogen increase in organic farming might be caused due to organic matter application which helps in the multiplication of greater soil microbes caused by the addition of organic sources, which mineralize organically bound N into inorganic form. Due to application of organic sources they contributes P to the soil available pool and coating of organic material on sesquioxides, which reduces the phosphate fixing capacity of soil which ultimately helps in release of sufficient quantity of plant available phosphorous (Sharma and Subehia, 2014) [36]. The increase in available potassium in the soils of organic farming could be attributed to the direct addition of potassium to the available pool of soil from addition of organic sources like FYM and vermicomposts. The beneficial effect of organics on the available potassium might also attributed to the reduction of potassium fixation and release of K due to interaction of organic material with clays besides the direct K addition in the soil (Subehia and Sepehya, 2012) [40]. Similar observations were also determined by Gajanana *et al*. (2005) [14] and Bhanuvally *et al*. (2024) [5]. The higher amount of available S was recorded due to application of organic source alone than the use of inorganic fertilizer and may be due to incorporation of organic carbon content in soil. Similar observations were also determined by Panghate *et al*. (2020) [30].

Among the selected crops, the soil under turmeric crop showed significantly higher available N, P, K and S with a mean values of 226, 41.4, 348 and 36.1 kg ha^{-1}, available N, P, K and S with a mean values of 198, 38.2, 340 and 32.78 kg ha^{-1} respectively was recorded under sorghum and available N, P, K and S with a mean values of 211, 39.2, 328 and 35.8 kg ha^{-1} respectively was recorded under redgram. The maximum available N was observed with the application of organic inputs in turmeric was recorded by Kadam and Kamble (2020) [43]. Increase in availability of N in soil with incorporation of organic manure might be due to increase in nodulation, release of higher amount of N compounds by root nodules at early stage of crop growth and their subsequent decomposition at later stage. Similar result was found by Walia and Kler (2006) [41]. Nagar *et al*. (2016) [25] who reported that application of organic manure significantly increased available nitrogen in redgram. The maximum available P and K was observed in turmeric grown soil might be due to the application of more fertilizers to turmeric crop (172-60-112 kg N-P_2O_5-K_2O ha^{-1}) in the study area compared to other two crops selected. The sequence of available nitrogen and phosphorus in soils collected from different crops followed the order turmeric > redgram > sorghum. Whereas, for the available potassium the order turmeric > sorghum > redgram. This might be due to no/less application of potassic fertilizers to redgram in the study area. Application of organic inputs and more fertilizers to turmeric could be the reason to maintain maximum available nutrients in soil was also reported by Kadam and Kamble (2020) [43]. Significance difference was not observed in available sulphur between redgram and turmeric grown soils and these two quantities are significantly superior over the available sulphur recorded in sorghum grown soil. This might be due to, application of phosphorus through SSP was practiced in turmeric and redgram, whereas, farmers prefer DAP for sorghum. Application of SSP supplies sufficient quantity of sulphur, thus maintained sufficient quantity in the soils collected from turmeric and redgram. Nagesh Yadav *et al.* (2017) [26] documented that application SSP to groundnut could maintained the higher sulphur in soil during cultivation of groundnut. Musa *et al*. (2015) [24] also reported that application of SSP increased the plant available sulphur in soil

Table 3: Macronutrient status in soil as influenced by nutrient management practices and selected crops.

Treatments	Nitrogen (kg ha^{-1})	Phosphorus (kg ha^{-1})	Potassium (kg ha^{-1})	Sulphur (kg ha^{-1})
Factor -1 : Nutrient management practice				
Organic	218	42.3	349	37.6
Conventional	206	36.9	329	32.2
SEm ±	2.05	0.59	4.42	0.81
CD (P = 0.05)	5.85	1.68	12.58	2.31
Factor -2 : Selected Crops				
Sorghum	198.	38.2	340	32.8
Red gram	211	39.2	328	35.8
Turmeric	226	41.4	348	36.1
SEm ±	2.51	0.72	5.41	0.99
CD (P = 0.05)	7.16	2.06	15.4	2.83
Interaction (N x S)				
SEm ±	3.56	1.02	7.65	1.40
CD (P = 0.05)	NS	NS	NS	NS
CV %	5.31	8.16	7.14	12.7

Available micronutrients (mg kg^{-1})

The available micronutrients Zn, Cu, Fe and Mn as influenced by different nutrient management practices and selected crops are depicted in Table. 4. The status available Zn, Cu, Fe and Mn in organic farming with a mean values of 0.66, 9.33, 13.40 and 3.47 mg kg^{-1} respectively and in conventional system with a mean values of 0.50, 7.84, 10.62 and 2.38 mg kg^{-1} respectively. Nutrient management practice showed significant variation in soil available micronutrients, cultivation of crops under organic farming recorded higher available micronutrients and conventional method of cultivation recorded lower available micronutrients. Organic farming can be attributed to its higher soil organic matter content and higher micronutrient content because organic matter present in it acts as a chelating agent for these elements and forms stable bonds with them (Sheoran *et al*., 2018) [37]. The application of large quantities of organic manures every year under organic farming practice was the reason of such a marked increase in available micronutrients. The results were agree with findings of Sharma *et al*. (2000) [35], Panghate *et al*. (2020) [30] and Bhanuvally *et al*. (2024) [5]. Kharche (2013) [19] reported that, the application of FYM significantly increased availability of micro-nutrients over chemical fertilizers probably due to decomposition of FYM.

Selected crops also showed significant variation in available Zn, Cu, Fe and Mn. Among the selected crops, the results revealed that status of available Zn, Cu, Fe and Mn with a mean values of 0.60, 3.10, 8.89 and 11.91 mg kg^{-1} in turmeric crop, 0.55, 2.68,7.09 and 11.31 mg kg^{-1} was recorded under sorghum crop and 0.59, 3.00, 9.77 and 12.92 mg kg^{-1} was recorded under redgram respectively. The micronutrient status was high in turmeric crop but however, iron and manganese was high in red gram. Sharma *et al.* (2004) [34] reported favourable influence of vermicompost and organic fertilizers on the availability of all essential plant nutrients during the crop period.

Table 4: Micronutrient status in soil as influenced by nutrient management practices and selected crops.

Treatments	Zn (mg kg^{-1})	Cu (mg kg^{-1})	Fe (mg kg^{-1})	Mn (mg kg^{-1})
Factor -1 : Nutrient management practice				
Organic	0.66	3.47	9.33	13.4
Conventional	0.50	2.38	7.84	10.6
SEm ±	0.01	0.10	0.31	0.37
CD (P = 0.05)	0.03	0.27	0.88	1.05
Factor -2 : Selected Crops				
Sorghum	0.55	2.68	7.09	11.3
Red gram	0.59	3.00	9.77	12.9
Turmeric	0.60	3.10	8.89	11.9
SEm ±	0.01	0.12	0.38	0.44
CD (P = 0.05)	0.03	0.33	1.08	1.25
Interaction (N x S)				
SEm ±	0.02	0.17	0.54	0.62
CD (P = 0.05)	NS	NS	NS	NS
CV %	9.74	17.9	19.7	16.2

Conclusions

The Survey and study was conducted in the Asifabad and Nizamabad districts of Northern Telangana Zone under organic and conventional cultivation practices in sorghum, redgram and tumeric crops. From the study, the study indicated that organic cultivation practices has lower bulk density, higher available nutrient status, high organic carbon and high CEC. The results revealed that organic cultivation practices build up the chemical composition of soil, suppliment the availability of macro and micronutrients and enchance the soil's organic carbon status all of which are cruial for sustainable crop yields. It could be concluded that organic farming practices influenced the soil properties which in turn would enhance soil health.

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