OPEN ACCESS
Pakistan Journal of Agricultural Research

Research Article

Improve the Soil Properties under Two Different Methods (i.e., Tillage Practices and Organic Manuring) of the Wheat Crop

Manzoor Ali Magsi[1*], Naimatullah Laghari[1], Ahmed Ali Tagar[1], and Habibullah Magsi[2]

[1]*Department of Farm Power Machinery, Faculty of Agricultural Engineering, Sindh Agriculture University Tandojam, 70060;* [2]*Department of Agricultural Economics, Faculty of Agricultural Social Sciences, Sindh Agriculture University Tandojam, 70060.*

Abstract | The present study was conducted on different tillage on soil depths (i.e., 0-15 cm, 16 to 30 cm, and 31 to 45 cm) and showed significant influence on pH, electrical conductivity of soil (ECe), soil aggregates, organic matter (OM), calcium, magnesium, chloride, carbonate, and bicarbonate. The tillage practices were shallow and deep tillage-assisted with compost, poultry residuals, NPK, and FM (farmyard manure) in the study area for the wheat crop. It was found that the most effective tillage practices were Deep + NPK and Deep + FM in the study area for the crop. The maximum values of micro, macro, and stability aggregates ranged from 10.86 to 21.41, 73.32 to 82.95, and 13.63 to 28.71 g/m^3 while treated with different shallow and deep manure in the wheat experiment during cropping years 2019-20 and 2020-21 respectively. Similarly, the OM ranges from 0.60 to 1.48 in the wheat experiment during 2019-20. The present experiment found that the most efficient tillage methods for the wheat crop were shallow tillage + compost and deep tillage + NPK respectively. On the other hand, the highest calcium (Deep + FM), magnesium (Deep + Poultry, Shallow + FM), chloride (Deep + NPK and compost), and carbonate and bicarbonate (Deep + FM and Compost) treatments were found during the cropping year 2019-20 and 2020-21 experiments. Based on experimental results under wheat crop, application of reduced tillage treatment is recommended that would increase the greater marginal rate of return as compared to conventional and no-tillage treatments. Comparable investigations need to be carried out in other ecological zones of Pakistan on different types of soils to introduce appropriate tillage practices that perform better and are site-specific not only for wheat rotation but for other crops. Further experiments should be conducted to analyze the impact of deep tillage treatments on the tillage practices and organic fertilizers on soil properties, growth, and yield of the wheat crop.

Received | May 01, 2022; **Accepted** | September 01, 2022; **Published** | December 22, 2022
***Correspondence** | Manzoor Ali Magsi, Department of Farm Power Machinery, Faculty of Agricultural Engineering, Sindh Agriculture University Tandojam, 70060; **Email:** manzoorsau75@gmail.com
Citation | Magsi, M.A., N. Laghari, A.A. Tagar and H. Magsi. 2022. Improve the soil properties under two different methods (i.e., tillage practices and organic manuring) of the wheat crop. *Pakistan Journal of Agricultural Research,* 35(4): 578-588.
DOI | https://dx.doi.org/10.17582/journal.pjar/2022/35.4.578.588
Keywords | Tillage practices, Organic manure, Soil characteristics, Soil porosity, Soil aggregates

Introduction

Wheat (*Triticum aestivum* L.) is among the largest and most significant cereal grains. It is a member of the Graminae family, which includes several species such as rice, barley, and maize. Wheat is the world's leading crop in terms of both area and output. Wheat is a Pakistan's most important crop, with output increasing by 2.5 percent to 24.946 million tonnes (GoP, 2020). Wheat has a great nutritive level. It is made up of 14.7 percent protein, 2.1 percent fat, 2.1 percent mineral content, and 78.11 percent starch (Shewry and Hey, 2015). It plays an important role in physical nourishment as well as industrial applications. Pakistan is an overcrowded nation, and its populace is growing day by day. To satisfy rising requirements, wheat may be an excellent complement to rice, Pakistan's staple grain, and can play an essential role in feeding the country's people. Furthermore, the wheat harvest was planted on 8,734 thousand hectares, a 2.6 percent decrease from the previous year's crop of 8 thousand hectares (GoP, 2019; 2020).

Wheat crop productivity and output are influenced by climate conditions, cultivar, tillage techniques, and other factors. Tillage seems to be the ancient and most essential farm operation, as well as the initial stage in crop production. Tillage is described as physical, chemical, or biological soil modification to maximize conditions for germinating seeds, emergence, and seedlings development reported by De-Vita *et al.* (2007) and Lal and Kimble (1997), Lal (2018). Tillage processes thwart weeds, provide an appropriate seedbed for crop plants, and infuse organic matter into the growing medium, improving the physical soil conditions and bringing out improved nutrient and water relations. Tillage also plays an important role in root expansion and advancement by controlling air and water progression to some extent and nutritional supply to the root system of growing plants. Different tillage operations can affect soil physical qualities such as bulk density, moisture, and porosity (Salem *et al.*, 2015). Agricultural residues have such a high carbon/nitrogen C/N ratio, as well as significant lignin and polyphenol levels, and the breakdown and release of nutrients gradually, whereas other organic inputs (such as animal manure, biofertilizer, slurries, and so on) may be a preferable choice since they disintegrate quickly and are accessible for plant uptake (Javeed *et al.*, 2013). Another study, Puerta *et al.* (2018), found that integrating organic crop monitoring with decreased tillage improves soil structure during continuous cultivation. Organic fertilizers and limited tillage, according to Maltas *et al.* (2018), are efficient ways to preserve land fertility and cereal output in the examined soil. According to Jiao *et al.* (2006), the conjunction of organic manures and no-tillage (NT) improved the soil organic matters (SOM) content in the top 10 cm of sandy loam soil compared to the conventional tillage with mineral fertilization.

Soil organic matter is an important determinant in long-term land fertility and crop yield. Organic additives reduced soil bulk density while increasing overall porosity, moisture content, and organic matter content (Bot and Benites, 2005). This essential component of soil is dwindling because of intense cultivation, high temperatures, and heavy rains. The value of farmyard manure, particularly chicken, cow, sheep, and goat manures, for long-term soil fertility and crop efficiency, has long been known. Mineralization occurs in the manure, resulting in the emission of significant amounts of N, P, K, S, and a lower number of micronutrients. Manure has a significant impact on soil in terms of improving its physical, chemical, and biological qualities. Thus, manure can function as a buffer medium to create a conducive soil environment for increased crop output. Manure application to light soil improves overall porosity and moisture content, nutritional profile, and organic matter content. It makes thick soil more friable and facilitates tillage. The application of manure reduces the cohesiveness and elasticity of heavy soils (He and Zhang, 2014). Furthermore, it enhances soil structure while decreasing bulk density, surface runoff, and eroding losses. Soil restoration with farmyard manure considerably boosts SOM and minimizes the demand for fertilizers by offering a supply of nutrients for crops (Khan *et al.*, 2012). Nutrient-rich organic fertilizers have been demonstrated in several studies to increase soil's physical, chemical, and biological qualities, as well as crop output (Hasnain *et al.*, 2020). Sayara *et al.* (2020) proved that compost was a better alternative to synthetic fertilizers for improving soil quality, fertility, and crop yields.

An appropriate mix of organic and inorganic nutrients is required for improved soil conditions and rising agricultural output. The usage of organic manure in conjunction with chemical fertilizers increases output consistency and preserves soil fertility (Graham *et al.*, 2017). Tillage with organic additions would enhance soil physicochemical qualities, resulting in improved crop growth and production. Soil physical qualities that are beneficial to farmers must be addressed for sustained and better crop yields. Thus, research into the effects of tillage techniques and organic fertilizers on soil characteristics, growth, and yield of wheat crops is required.

Materials and Methods

Experimental site and design

The current study was conducted to assess the effect of tillage practices and organic fertilizers on the soil properties of the wheat crop at the farmers' field in Districts Sanghar of Sindh province of Pakistan. There were eight (08) different treatments shown in following Table 1.

Table 1: *Details of the experiment as described in treatments.*

Treatments	Details
T_1	Shallow Tillage + Compost (no organic fertilizer)
T_2	Shallow Tillage + Poultry Manure
T_3	Shallow Tillage + NPK
T_4	Shallow Tillage + Farmyard Manure
T_5	Deep Tillage + Compost (no organic fertilizer)
T_6	Deep tillage + Poultry Manure
T_7	Deep tillage + NPK
T_8	Deep tillage + Farmyard Manure

The treatments were laid up in a three-replication randomized complete block design (RCBD). The experimental field (32 m 80 m) was divided into 24 plots (each 10 m 10 m).

The field method

The field method was defined as a qualitative method of data collection that aims to observe two different types of tillage systems, (i.e., shallow tillage, and deep tillage systems).

Shallow tillage

Shallow tillage was incorporated, consisting of two-disc harrow passes (to a depth of, 0.10 m), whereas deep tillage consisted of a moldboard plough accompanied by two-disc harrow passes (to a depth of 0.30 m) and (to a depth of, 0.10 m).

Deep tillage systems

The systems of tillage were a set of activities employed to alter soil in order to raise a plant. Deep tilling the land, planting the seed, fertilizing the crop, pesticide treatment for pest control, harvesting, and cutting the residues or shredding were all done. The methods employed to carry out these procedures affect the chemical and physical qualities of the soil, which in turn affect plant growth. Understanding the activities associated with each tillage scheme is the first step in making fertilizer management decisions.

Preparation and application of manure and compost

Manure (i.e., poultry, cattle, sheep, and goat) were obtained from the different Livestock farms surrounding the study area. Manures were stored in storage units at room temperature and were thoroughly mixed and overturned weekly for one month. Compost was prepared with poultry manure, cattle manure, sheep, and goat manure in a 1 × 1-meter pit. It was thoroughly mixed and inverted weekly until it was converted into humus form (i.e., dark brown in color, odorless and friable). Before sowing the crops, the manure and compost were distributed manually at a dosage of 10 Mg ha^{-1} on selected treatment plots and were promptly integrated into the soil using shallow and deep tillage procedures. The control plots received no manure or compost but were exposed to the identical tillage procedures as the experimental plots.

Physicochemical properties of soil

The physicochemical properties of soils, along with associated interrelationships, were examined in this research. Soil quality is directly associated with soil moisture content, soil texture, bulk density, soil porosity, field capacity, soil fertility, fertilizer usage efficiency, pH value, ECe (dS/m), calcium (mg/kg), magnesium (mg/kg), chloride (mg/kg) and carbonates and bicarbonates.

Soil sampling method

By the use of a soil auger for soil sampling, soil sampling was acquired at the depths of 0–15 cm, 16–30 cm, and 31–45 cm across four randomly chosen places in each plot to assess soil moisture content, soil texture, and organic matter. The dry bulk density of the soil was evaluated using a core sampler.

Soil moisture content

The amount of water in the soil is indicated by the soil moisture content. It is generally expressed as the volume of water present (in mm of water depth) in one meter of soil. The soil's moisture content was calculated using the gravimetric technique (Blake and Hartge, 1986) by using the subsequent formula:

$$M.C\ (\%) = \frac{Weight\ of\ water}{Weight\ of\ dry\ soil} \times 100 \quad \ldots.(1)$$

Soil texture

Soil texture was analyzed by pipette method, the soil texture (such as loam, sandy loam, or clay) refers to the proportion of sand, silt, and clay-sized particles that make up the mineral fraction of the soil. The texture of the soil is an essential soil feature that influences crop yield and field management (Greve Fehrenbach, 2012). Soil grains can be organic or mineral, however in the majority of the soils, the mass of particles is mineral, hence these soils are referred to as mineral soils.

Dry bulk density

The dry bulk density was calculated using the gravimetric technique (Blake and Hartge, 1986) and the following relationship:

$$Dry\ bulk\ density\ (g/cm^3) = \frac{Dry\ weight\ of\ soil}{Total\ volume\ of\ soil} \quad \ldots(2)$$

Soil porosity

The percentage of total soil volume occupied by pore space is referred to as soil porosity (Nimmo, 2004). The following relationship was used to calculate soil porosity.

$$n = 1 - \frac{\rho_d}{\rho_s} \times 100 \quad \ldots(3)$$

Where; n= soil porosity (%), and ρ_s = particle density (g/cm^3).

Soil aggregation

Soil aggregation is a critical process for SOM stability, particularly in organic soils (Lutzow *et al*., 2006). It has an impact on the physical (aeration), chemical (water infiltration), and biological (microbial) activities of the soil. Soil aggregation was determined by Van Bavel's (1949) method using the following formula:

$$MWD = \sum_{i=1}^{n} x_i w_i \quad \ldots(4)$$

Where; MWD= Mean weight diameter, x_i= mean diameter of adjacent sieves, and w_i= proportion (fraction) of total sample retained on the sieve.

Organic matter content

The organic matter content (OMC) of soils is made up of both live and dead organic components (Stevenson, 1994). The organic carbon content was calculated using the following formula (Walkley and Black, 1934).

$$O.C\ (\%) = \frac{(B - S) \times N \times 0.003 \times 100}{Wt\ of\ soil\ in\ g\,(Oven\ dry)} \ldots (5)$$

Where; B= the amount of 0.5 N ferrous ammonium sulphate necessary to titrate the blank, S= is the amount of standard 0.5 N ferrous ammonium sulphate necessary for the soil sample, and the normality of standard ferrous ammonium sulphate (0.5N).

Statistical analysis

The data was statistically analyzed using the statistics-8.1 (Analytical Software, 2005) tool. Where required, the differences between treatments were compared using the least significant difference (LSD) test.

Results and Discussion

The Figure 1 and Table 2 consisted of two components (i.e., soil characteristics and physiochemical properties) of the experimental site area. The morphological parameters are sand %, silt %, clay %, bulk density (g/cc), porosity %, and field capacity % of study area are revealed that 32.30, 41.32, 33.98, 1.54, 37.97, and 23.43, respectively. On the other hand, the clay loam soil texture class was determined.

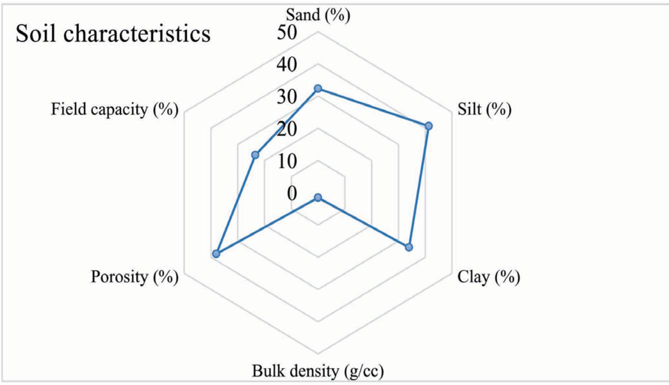

Figure 1: *Soil characteristics of experimental site area.*

The soil physiochemical characteristics of the experimental field, the soil were examined at various depths (i.e., 0-15, 16-30, and 31-45 cm) before beginning the experiment, and the physical and chemical characteristics of the materials were investigated as shown in Table 2. The present result showed that the pH ranged from 7.67 to 8.13 in the study area field, respectively. Similarly, the ECe ranged between 0.73 to 0.79 dS/m, organic matter ranged between 0.83 to 0.85, calcium ranged between 8.53 to 9.04, magnesium ranged between 8.53 to 9.04, chloride ranged between 0.77 to 0.83 and carbonate and bicarbonate ranged between 0.70 to 0.72 in the study area before the study.

Table 2: *Morphological, physical, and chemical properties of experimental site.*

Properties	Unit (cm)	Physiochemical characteristics
pH	0-15	7.67
	16-30	8.09
	31-45	8.13
ECe (dS/m)	0-15	0.73
	16-30	0.78
	31-45	0.79
Organic matter	0-15	0.83
	16-30	0.83
	31-45	0.85
Calcium	0-15	8.53
	16-30	8.69
	31-45	9.04
Magnesium	0-15	8.53
	16-30	8.69
	31-45	9.04
Chloride	0-15	0.83
	16-30	0.79
	31-45	0.77
Carbonate & Bicarbonates	0-15	0.72
	16-30	0.71
	31-45	0.7

The rainfall and temperature data monthly minimum and maximum temperatures were recorded during both growing seasons (i.e., 2019-20 to 2020-21). The detailed rainfall and temperature data are shown in Figure 2.

The pH of the soil is crucial because it impacts the availability of vital nutrients. Figure 3 concluded that the pH of the soil was not dramatically altered by tillage intensity, poultry manure, and NPK during both experiments during 2019-20 and 2020-21. The results of different depths of soil i.e., 0-15 cm, 16 to 30 cm, and 31 to 45 cm reveal that the soil's highest average value of pH was 8.63, 8.47, and 8.47 in found Deep + NPK treatments, while the lowest value of pH were 7.53, 7.67 in Shallow + Compost, Shallow + FM, and 7.53 in Deep + Compost treatments followed by Shallow + Compost treatment, respectively, the all-treatments data were founded significant during the 2019-20 experiment were showed in Figure 3A.

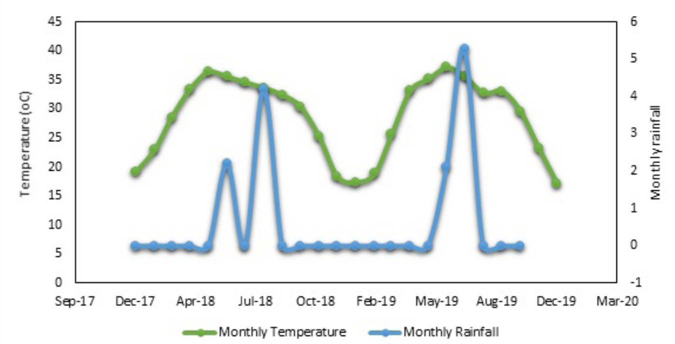

Figure 2: *Monthly metrological data of the experimental site.*

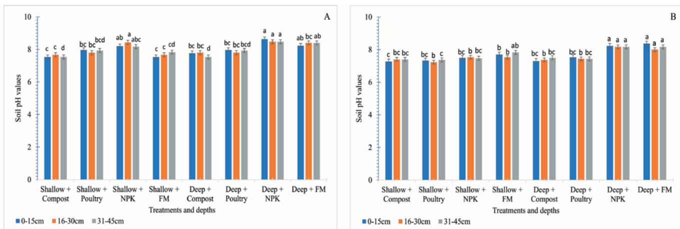

Figure 3: *Effect of tillage intensity, fertilizer and manuring on pH values were determined (A) 2019-20 and (B) 2020-21.*

During 2020-21, the soil pH was not considerably affected by tillage intensity, poultry manure, and NPK treatments. The highest mean of pH was 8.37 found in Deep + FM, 8.17 in Deep + NPK, and 8.17 found in Deep + NPK and Deep + FM treatments, while the lowest mean of pH was 7.27 in Shallow + Compost, 7.23 and 7.37 in Shallow + Poultry. The interaction of different tillage intensity, poultry manure, and NPK was non-significant in the 2020-21 years of experiments were determined in Figure 3B.

The ECe (dS/m) was significantly affected by tillage intensity, poultry manure, and NPK during both experiments during 2019-20 and 2020-21 in Figure 4A and B. The results of different depths of soil i.e., 0-15 cm, 16 to 30 cm, and 31 to 45 cm revealed that the highest average value of ECe was 1.17, 1.18, and 1.25 dS/m found in Deep + Compost treatments, respectively. Moreover, the lowest value of ECe was 0.44, 0.51, and 0.51 in Deep + FM followed by Deep + Poultry treatments during the 2019-20 experiment found in Figure 4A.

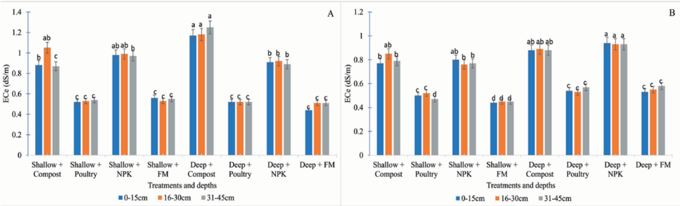

Figure 4: *Effect of tillage intensity, fertilizer and manuring on ECe (dS/m) were determined (A) 2019-20 and (B) 2020-21.*

During 2020-21, the ECe values were slightly deceased in entire treatments. Meanwhile, the soil ECe was not affected by tillage intensity, poultry manure, and NPK treatments. The highest mean of ECe was 0.94, 0.93, and 0.93 found in Deep + NPK treatment, while the lowest mean of ECe was 0.44, 0.45, and 0.45 in Shallow + FM. The interaction of different tillage intensity, poultry manure, and NPK was significant in both years of experiments shown in Figure 4B.

The soil aggregates are essential structures for ideal soil functioning. Figure 5A and B concluded that soil aggregate was not dramatically altered by tillage intensity, poultry manure, and NPK during both experiments during 2019-20 and 2020-21. The results of different types of soil aggregate stability i.e., micro-aggregate, macro-aggregate, and aggregate stability reveal that the soil aggregates highest average value was 21.41, 84.05, and 27.23 found in Deep + NPK, Shallow + Compost, Deep + Poultry treatments, while the lowest value of soil aggregates was Shallow + FM (12.51), Deep + NPK (73.32), and Shallow + NPK (13.93) treatments, respectively, the all-treatments data were founded significant during the 2019-20 experiment were determined in Figure 5A.

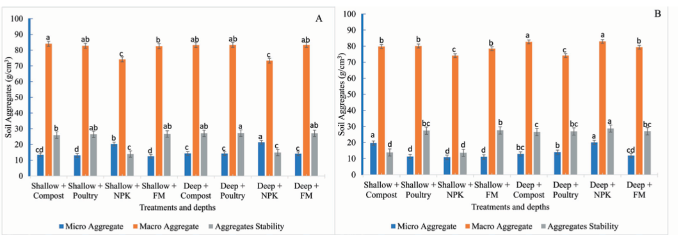

Figure 5: *Effect of tillage intensity, fertilizer and manuring on soil aggregates with wheat crop during 2019-20 (A) and 2020-21 (B).*

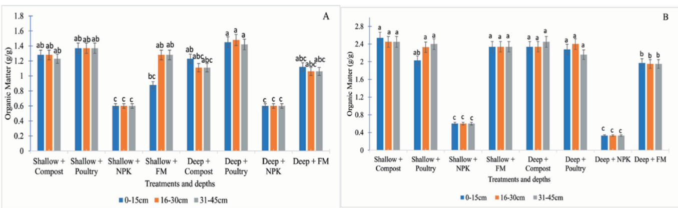

Figure 6: *Effect of tillage intensity, fertilizer and manuring on organic matter during the year 2019-20 (A) and 2020-21 (B).*

During 2020-21, the soil aggregate was not considerably affected by tillage intensity, poultry manure, and NPK treatments. The highest mean of soil aggregates was determined at 20.11, 82.95, and 28.71 in Deep + NPK treatment, while the lowest mean of soil aggregates was 10.86, 74.08, and 13.63 in Shallow + NPK. The interaction of different tillage intensity, poultry manure, and NPK was significant in the 2020-21 years of experiments found in Figure 5B.

The results showed that most treatments greatly improve the organic matter content of the soil in Figure 6A and B. Tillage intensity, chicken manure, and NPK had little effect on soil organic matter content during both experiments during 2019-20 and 2020-21. The results of different depths of soil i.e., 0-15 cm, 16 to 30 cm, and 31 to 45 cm reveal that the highest organic matter content was 1.45, 1.48, and 1.42 found in Deep + Poultry treatments, while the lowest value of organic matter were 0.60, 0.60, and 0.60 in Shallow + NPK and deep + NK during the 2019-2020 experiment were identified in Figure 6A.

Figure 6B shows that the organic matter increased in Shallow + FM (10.03), Shallow + Compost (10.50), and Deep + FM (11.03) treatment. Meanwhile, treatments of tillage intensity, poultry manure, and NPK treatments had little effect on the organic matter during 2020-2021. The highest value of organic matter was 11.03 found in Deep + FM treatment, while the lowest value of organic matter was 0.60 in Shallow + NPK, and Deep + NPK treatment. In both years of testing, the interaction of varied tillage intensities, poultry manure, and NPK was significant.

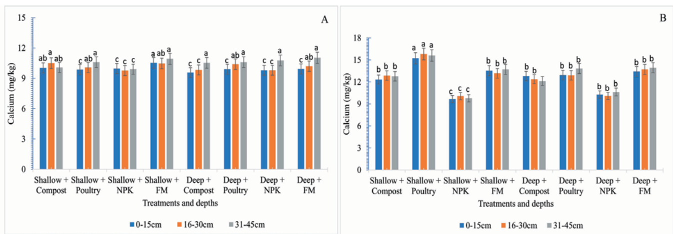

Figure 7: *Effect of tillage intensity, fertilizer and manuring on calcium (mg/kg) were found in 2019-20 (A) and 2020-21 (B).*

Figure 7A and B demonstrates that calcium was changed in 2020-2021 than in the 2019-2020 experiment. Moreover, calcium was not significantly affected by tillage intensity, poultry manure, and NPK during both experiments during 2019-20 and 2021-21. The results of different depths of soil i.e., 0-15 cm, 16 to 30 cm, and 31 to 45 cm reveal that the highest calcium reading was recorded at 10.53, 10.50, and

Links Researchers

11.03 in Shallow + FM, Shallow + Compost, and Deep + FM, while the lowest values of calcium were found 9.57, 9.77, and 9.90 in Deep + Compost, and Shallow + NPK, treatment during the 2019-2020 experiment. The maximum and minimum calcium values found in Shallow + FM, and Deep + Compost were determined in Figure 7A.

During 2020-2021, the calcium increased in the Shallow + Poultry treatment. Meanwhile, the calcium was not considerably influenced by tillage intensity, poultry manure and NPK treatments. The greatest calcium values were 15.23, 15.80, and 15.60 in the Shallow + poultry treatment, whereas the lowest calcium values were 9.67, 10.07, and 9.77 in the Shallow + NPK treatment. In both years of testing, the interaction of varied tillage intensities, poultry manure, and NPK was significant results revealed in Figure 7B.

Figure 8A and B demonstrate that the magnesium was not significantly affected by tillage intensity, poultry manure, and NPK during both experiments during 2019-20 and 2020-21. The results of different depths of soil i.e., 0-15 cm, 16 to 30 cm, and 31 to 45 cm reveal that the highest values of magnesium were 8.10, 8.47, and 8.00 found in Deep + Poultry, while the lowest magnesium was 6.77, 6.70, and 6.50 in Shallow + FM treatment during the 2019-2020 experiment. The maximum and minimum values of magnesium were shown in Deep + Poultry and Shallow + FM were shown in Figure 8A, respectively.

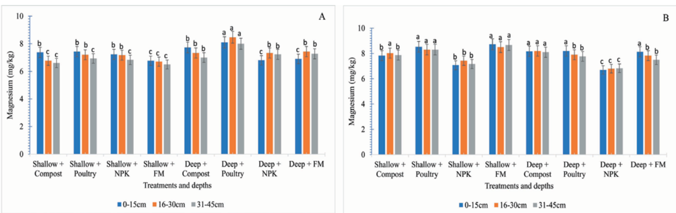

Figure 8: *Effect of tillage intensity, fertilizer and manuring on magnesium (mg/kg) were determined cropping year 2019-20 (A) and 2020-21 (B).*

During 2020-2021, the magnesium was not significantly affected by tillage intensity, poultry manure, and NPK treatments. The highest values of magnesium taken from the different depths of soil were 8.73, 8.50, and 8.67 found in the Shallow + FM treatment, while the lowest values of magnesium taken from the different depths of soil were 6.70, 6.80, and 6.83 in Deep + NPK treatment. The maximum and minimum values were examined from Shallow + FM and Deep + NPK treatments. The interaction of different tillage intensity, poultry manure, and NPK was significant in both years of experiments were determined in Figure 8B.

Figure 9A and B demonstrate that the chloride was not significantly affected by tillage intensity, poultry manure, and NPK throughout both experiments during 2019-20 and 2020-21. The results of different depths of soil samples i.e., 0-15 cm, 16 to 30 cm, and 31 to 45 cm reveal that the highest values of chloride were 1.13, 1.00, and 1.18 found in Deep + NPK, while the lowest values chloride were 0.69, 0.69, and 0.67 in Shallow + NPK, and Shallow + Compost treatment during the 2019-2020 experiment. The maximum and minimum values were examined from Deep + NPK and Shallow + Compost treatments found in Figure 9A.

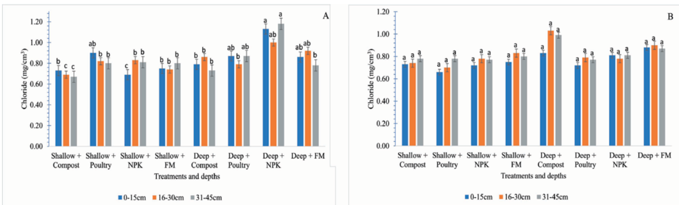

Figure 9: *Effect of tillage intensity, fertilizer and manuring on chloride (mg/cm3) were determined cropping year 2019-20 (A) and 2020-21 (B).*

During 2020-2021, the chloride was not significantly affected by tillage intensity, poultry manure, and NPK treatments. The highest values of chloride were 0.88, 1.03, and 0.99 found in Deep + FM, and Deep + Compost treatment, while the lowest values of chloride were 0.66, 0.70, and 0.77 in Shallow + Poultry, and Shallow + NPK, Deep + Poultry treatments. The maximum and minimum values were examined from Deep + Compost and Shallow + Poultry treatments were shown in Figure 9B. The interaction of different tillage intensity, poultry manure, and NPK was significant in both years of experiments.

The Figure 10A and B showed that the carbonate and bicarbonate were not significantly affected by tillage intensity, poultry manure, and NPK during both experiments during 2019-20 and 2020-21. The results of different depths of soil i.e., 0-15 cm, 16 to 30 cm, and 31 to 45 cm reveal that the highest values of carbonate and bicarbonate were 0.77, 0.77, and 0.77 found in Deep + FM treatment, respectively, while the lowest values of carbonate and bicarbonate were 0.50 in Shallow + Compost (all depths of soil), Shallow

+ Poultry (0-15 cm) and Shallow + FM (all depths of soil) treatments respectively, during the 2019-2020 experiment. The maximum and minimum values were examined from Deep + FM and Shallow + Compost, Poultry, and FM treatments were shown in Figure 10A.

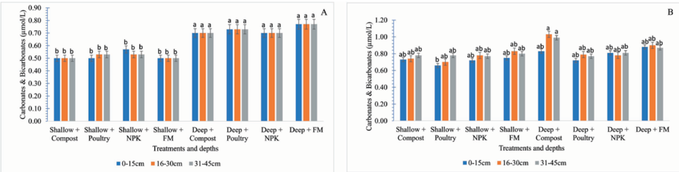

Figure 10: *Effect of tillage intensity, fertilizer and manuring on carbonate and bicarbonate (μmol/L) were determined cropping year 2019-20 (A) and 2020-21 (B).*

During 2020-2021, the carbonate and bicarbonate were not significantly affected by tillage intensity, poultry manure, and NPK treatments. The highest value of carbonates and bicarbonate was 1.03 found in the Deep + Compost treatment, while the lowest value of chloride was 0.66 in the Deep + NPK treatment. The interaction of different tillage intensity, poultry manure, and NPK was non-significant in the 2019-2020 experiment, while in the 2020-21 experiment was found significant in Figure 10B.

Different tillage depths i.e., 0-15 cm, 16 to 30 cm, and 31 to 45 cm showed significant influence on pH, ECe, organic matter, magnesium, and chloride. The pH ranges from 7.51 to 8.63 in the wheat experiment during 2019-20 and 2021-21 and 7.23 to 8.37 during 2020-2021. The application of NPK, poultry, and farmyard manure decreases the effect on the pH of sowing soils. The decreasing effect was more where poultry manure was applied. This might be due to poultry releasing organic acids through decomposition leading to a decrease in the soil pH (Apori *et al*., 2021). In addition, Adeyemo *et al.* (2010) reported that the use of FYM elevated the pH by a rate of 10 ha^{-1} FYM in wheat crops, Neugschwandtner *et al.* (2014) also consisted with our findings that pH increased with different tillage intensities, while during 7 years of tillage system did not affect pH, as reported by Aase and Pikul (1995) that after 12 years of different tillage systems. Nevertheless, López-Fando and Pardo (2009) reported that pH can be decreased in short term in soil properties due to the decomposition of crop residues as well as the production of organic acids.

The ECe ranges from 0.44 to 1.25 in the wheat experiments during 2019-20 and 2020-21 and from 0.44 to 0.94 during 2020-2021. It was found that the most effective tillage practices were Deep + Compost, and Deep + FM in the study area for the wheat crop. It is because increased tillage intensity encourages instant organic matter breakdown and less tillage enhances organic matter status (Balesdent *et al*., 2000). Interestingly, at the maturity phase of wheat cultivars, soil OM was considerably (p≤0.05) enhanced following biochar residues and N input, although the influence of N on soil pH and ECe was not significant (p≤0.05) (Alam, 2018).

Increasing tillage supported faster organic matter breakdown, whereas less tillage enhanced organic matter status. Less soil disruption resulted in a greater accumulation of surface residue. The OM ranges from 0.60 to 1.48 in the wheat experiments during 2019-20 and 2020-21 and 0.33 to 0.45 during 2020-2021. It was found that the most effective tillage practices were Shallow + Compost and Deep + NPK in the study area for the wheat crop. Likewise, Suryanto *et al.* (2022) reported that during the maturity phase of wheat crop soil OM rose considerably (p≤0.05) using biochar residues and N treatments, however, soil pH was solely altered by residual biochar. As a field trial, Noor-us-Sabah *et al.* (2014) investigated the effect of several organic and inorganic substances on wheat yield and yield characteristics. Organic treatments were used once the breakdown process had taken its course. Wheat seeds of the variety Sahar-2006 were planted. Before harvesting, the maximum plant height and number of productive tillers were collected, whereas total biomass and grain yield were collected after harvesting the wheat. All data collected was statistically examined.

Nutritionally rich manures have been widely demonstrated to augment soil physical, biological, and chemical aspects, as well as crop productivity (Hasnain *et al*., 2020). Sayara *et al.* (2020) demonstrated that compost represented a better option than synthetic fertilizers for improving soil quality, soil fertility, and enhancing crop yields. Calcium is also an important to factor in soil, it was found in the study that the calcium was not significantly affected by tillage intensity, poultry manure, and NPK during both experiments during 2019-20 and 2020-21. The highest calcium was 11.03 found in Deep + FM, while the lowest calcium was 9.57 in Deep + Compost treatment during the 2019-2020 experiment. The highest value of calcium was 15.80 found in the Shallow + poultry treatment, while the lowest value of calcium was 9.67 in the Shallow + NPK treatment. On the other hand, the highest value of calcium was 15.70 found in the Shallow + poultry treatment, while the lowest value of calcium was 9.57 in the Shallow + NPK treatment. The results of different depths of soil i.e., 0-15 cm, 16 to 30 cm, and 31 to 45 cm reveal that the highest magnesium was 8.47 found in Deep + Poultry, while the lowest magnesium was 6.50 in Shallow + FM treatment during the 2019-2020 wheat experiment, while the lowest value of magnesium was 6.70 in Deep + NPK treatment. In both years of experimentation, the interaction of varied tillage intensities, poultry manure, and NPK was significant. Moreover, the interaction of different tillage intensity, poultry manure, and NPK was significant in both years of experiments. In respect of the chloride, the highest chloride was 1.18 found in Deep + NPK, 1.03 found in Deep + Compost treatment for both years of wheat experiments. The results of different depths of soil i.e., 0-15 cm, 16 to 30 cm, and 31 to 45 cm reveal that the highest value of chloride was 1.04 found in Deep + Compost treatment, while the lowest value of chloride was 0.67 in Deep + NPK treatment. The interaction of different tillage intensity, poultry manure, and NPK was significant in both years of experiments. The interaction of different tillage intensity, poultry manure, and NPK with carbonate and bicarbonates were non-significant in the 2019-2020 experiment, while in 2020-21 the experiment were found significant. The highest carbonate and bicarbonate were 0.77 found in Deep + FM treatment, respectively, while 1.03 was found in Deep + Compost treatment. Moreover, the highest value of carbonate and bicarbonate was 1.05 found in Deep + Compost treatment, while the lowest value of carbonate and bicarbonate was 0.67 in Deep + NPK treatment. Graham *et al*. (2017) indicated that tillage with organic supplements would enhance soil physicochemical parameters and produce greater crop development and production. Soil physical attributes that are beneficial to farmers must be addressed for sustained and better crop yields. Thus, research into the effects of tillage techniques and organic fertilizers on soil characteristics, growth, and yield of the wheat crops is required.

Conclusions and Recommendations

The present study concluded that the different tillage depths (i.e., 0-15 cm, 16 to 30 cm, and 31 to 45 cm) showed significant influence on pH, ECe, organic matter, magnesium, and chloride. It was found that the most effective tillage practices were Deep + NPK and Deep + FM in the study area for the wheat crop. The micro, macro, and stability aggregates ranged from 10.86 to 21.41, 73.32 to 82.95, and 13.63 to 28.71 while treated with different shallow and deep tillage in the wheat experiment during cropping years 2019-20 and 2020-21. On the other hand, the OM ranges from 0.60 to 1.48 in the wheat experiment during 2019-20. The study found that the most efficient tillage methods for wheat crops were shallow tillage + compost and deep tillage + NPK. Furthermore, the highest calcium (Deep + FM), magnesium (Deep + Poultry, Shallow + FM), chloride (Deep + NPK and compost), and carbonate and bicarbonate (Deep + FM and Compost) treatments were found during the cropping year 2019-20 and 2020-21 experiments. Based on experimental results under wheat crop, application of reduced tillage treatment is recommended that would increase no-tillage treatments. Comparable investigations need to be carried out in other ecological zones of Pakistan on different types of soils. Further experiments should be conducted to analyze the impact of deep tillage treatments on the tillage practices and organic fertilizers on the soil properties, of the wheat crop.

Novelty Statement

It was aimed to use most economical tillage practice with organic fertilizer for improving the physico-chemical properties of soil in order to increase wheat productivity in the country.

Author's Contribution

Manzoor Ali Magsi: Conceived the idea, wrote abstract, methodology, conclusion, technical input at every step, data collection, data entry in SPSS and analysis, result and discussion, introduction, references.
Naimatullah Laghari: Conceived the idea, technical input at every step, overall management of the article, results and discussion.
Ahmed Ali Tagar: Wrote abstract, methodology, conclusion, technical input at every step, introduction, references.
Habibullah Magsi: Did SPSS analysis, technical input at every step, overall management of the article, data collection, data entry in SPSS and analysis.

Conflict of interest

The authors have declared no conflict of interest.

References

Aase, J.K., and J.J. Pikul Jr., 1995. Crop and soil response to long-term tillage practices in the northern Great Plains. Agron. J., 87(4): 652-656. https://doi.org/10.2134/agronj1995.00021962008700040008x

Adeyemo, A., Kumar, R., Linga, P., Ripmeester, J., and P. Englezos. 2010. Capture of carbon dioxide from flue or fuel gas mixtures by clathrate crystallization in a silica gel column. Int. J. Greenh. Gas Contr., 4(3): 478-485. https://doi.org/10.1016/j.ijggc.2009.11.011

Alam, S., 2018. Impact of biochar and nitrogen application on soil physicochemical attributes at various growth stages of maize and subsequent wheat crop. Sarhad J. Agric., 34(2): 368-377. https://doi.org/10.17582/journal.sja/2018/34.2.368.377

Analytical Software, 2005. Statistix 8.1. Analytical Software, Tallahassee, FL, USA.

Apori, S.O., J. Byalebeka, M. Murongo, J. Ssekandi and G.L. Noel. 2021. Effect of co-applied corncob biochar with farmyard manure and NPK fertilizer on tropical soil. Resour. Environ. Sustain., 5: 100034. https://doi.org/10.1016/j.resenv.2021.100034

Balesdent, J., C. Chenu and M. Balabane. 2000. Relationship of soil organic matter dynamics to physical protection and tillage. Soil Tillage Res., 53(3-4): 215-230. https://doi.org/10.1016/S0167-1987(99)00107-5

Blake, G.R., and K.H. Hartge. 1986. Bulk density. Methods of soil analysis: Part 1 Physical and mineralogical methods, 5: 363-375. https://doi.org/10.2136/sssabookser5.1.2ed.c13

Bot, A., and J. Benites. 2005. Drought-resistant soils: Optimization of soil moisture for sustainable plant production: Proceedings of the electronic conference organized by the FAO land and water development division (Vol. 11). Food and Agriculture Org.

De-Vita, P., Di Paolo, E., Fecondo, G., Di Fonzo, N. and Pisante, M. 2007. No-tillage and conventional tillage effects on durum wheat yield, grain quality and soil moisture content in southern Italy. Soil Til. Res., 92 (1-2): 69-78.

GoP, 2020. Economic Survey of Pakistan 2019-2020. Economic Advisor 's Wing, Finance Division, Govt. of Pakistan, Islamabad.

GoP, 2019. Wheat: Economic survey of Pakistan 2018-2019. Department of Food and Agriculture, Bureau of Statistics (Economic Wing), Government of Pakistan, Islamabad.

Graham, R.F., S.E. Wortman and C.M. Pittelkow. 2017. Comparison of organic and integrated nutrient management strategies for reducing soil N2O emissions. Sustainability, 9(4): 510. https://doi.org/10.3390/su9040510

Greve, L., and C. Fehrenbach, 2012. Mechanical testing and macro-mechanical finite element simulation of the deformation, fracture, and short circuit initiation of cylindrical Lithium ion battery cells. J. Power Sour., 214: 377-385. https://doi.org/10.1016/j.jpowsour.2012.04.055

Hasnain, M., J. Chen, N. Ahmed, S. Memon, L. Wang, Y. Wang and P. Wang. 2020. The effects of fertilizer type and application time on soil properties, plant traits, yield and quality of tomato. Sustainability, 12(21): 9065. https://doi.org/10.3390/su12219065

He, Z., and H. Zhang. 2014. Applied manure and nutrient chemistry for sustainable agriculture and environment. Springer Netherlands. https://doi.org/10.1007/978-94-017-8807-6

Javed, M.A., S. Poshtiban, D. Arutyunov, S. Evoy and C.M. Szymanski. 2013. Bacteriophage receptor binding protein based assays for the simultaneous detection of *Campylobacter jejuni* and *Campylobacter coli*. PLoS One, 8(7): e69770. https://doi.org/10.1371/journal.pone.0069770

Jiao, C.J., Q.L. Xu, C.Y. Wang, F.M. Li, Z.X. Li and Y.F. Wang. 2006. Accumulation pattern of toxin β-ODAP during lifespan and effect of nutrient elements on β-ODAP content in (*Lathyrus sativus)* seedlings. J. Agric. Sci., 144(3): 543-549. https://doi.org/10.1017/S0021859606006265

Khan, M.A., Ahmad, M., and H.S. Hashmi, 2012. Review of available knowledge on land degradation in Pakistan. OASIS Country Report 3, ICARDA, Aleppo, Syria.

Lal, R., 2018. Managing agricultural soils of Pakistan for food and climate. Soil Environ., 37(1): 1-10. https://doi.org/10.25252/SE/18/61527

Lal, R., and J.M. Kimble. 1997. Conservation tillage for carbon sequestration. Nutr. Cycl.

Agroecosyst., 49: 243-253. https://doi.org/10.1023/A:1009794514742

López-Fando, C., and M.T. Pardo. 2009. Changes in soil chemical characteristics with different tillage practices in a semi-arid environment. Soil Till. Res., 104(2): 278-284. https://doi.org/10.1016/j.still.2009.03.005

Lützow, M.V., I. Kögel-Knabner, K. Ekschmitt, E. Matzner, G. Guggenberger, B. Marschner and H. Flessa. 2006. Stabilization of organic matter in temperate soils: Mechanisms and their relevance under different soil conditions. A review. Eur. J. Soil Sci., 57(4): 426-445. https://doi.org/10.1111/j.1365-2389.2006.00809.x

Maltas, A., H. Kebli, H.R. Oberholzer, P. Weisskopf and S. Sinaj. 2018. The effects of organic and mineral fertilizers on carbon sequestration, soil properties, and crop yields from a long-term field experiment under a Swiss conventional farming system. Land Degrad. Dev., 29(4): 926-938. https://doi.org/10.1002/ldr.2913

Neugschwandtner, R.W., P. Liebhard, H.P. Kaul and H. Wagentristl. 2014. Soil chemical properties as affected by tillage and crop rotation in a long-term field experiment. Plant, Soil Environ., 60(2): 57-62. https://doi.org/10.17221/879/2013-PSE

Nimmo, J., 2004. Porosity and pore size distribution. In: Encyclopedia of soils in the environment. Elsevier, London. 3: 295–303. https://doi.org/10.1016/B0-12-348530-4/00404-5

Noor-us-Sabah, G., Sarwar and M.A. Tahir. 2014. Role of various nutritional sources for improving the yield of wheat under saline-sodic soil environment. Pak. J. Agric. Sci., 51(4): 963-967.

Puerta, V., P. Engil, W. Raphaël, M. Van der Heijden and J. Six. 2018. Improvement of soil structure through organic crop management, conservation tillage and grass-clover ley. Soil Till. Res., 180: 1-9. https://doi.org/10.1016/j.still.2018.02.007

Salem, H.M., Valero, C., Muñoz, M.Á., Rodríguez, M.G., and L.L. Silva. 2015. Short-term effects of four tillage practices on soil physical properties, soil water potential, and maize yield. Geoderma, 237: 60-70. https://doi.org/10.1016/j.geoderma.2014.08.014

Sayara, T., R. Basheer-Salimia, F. Hawamde and A. Sánchez. 2020. Recycling of organic wastes through composting: Process performance and compost application in agriculture. Agronomy, 10(11): 1838. https://doi.org/10.3390/agronomy10111838

Shewry, P.R., and S.J. Hey. 2015. The contribution of wheat to human diet and health. Food Energy Secur., 4(3): 178–202. https://doi.org/10.1002/fes3.64

Stevenson, F.J., 1994. Humus chemistry: Genesis, composition, reactions. John Wiley and Sons.

Suryanto, P., E. Faridah, H.H., Nurjanto, E.T.S. Putra, D. Kastono, S. Handayani and T. Alam. 2022. Short-term effect of in situ biochar briquettes on nitrogen loss in hybrid rice grown in an agroforestry system for three years. Agronomy, 12(3): 564. https://doi.org/10.3390/agronomy12030564

Van-Bavel, C.H.M. 1950. Mean weight-diameter of soil aggregates as a statistical index of aggregation. Proceed. Soil Sci. Soc. Am., 14: 20-23.

Walkley, A., and I.A. Black. 1934. An examination of the Degtjareff method for determining soil organic matter, and a proposed modification of the chromic acid titration method. Soil Sci., 37(1): 29-38. https://doi.org/10.1097/00010694-193401000-00003