Effect of the organic and inorganic fertilizer on some soil properties and corn (*Zea mays* L.) growth parameters

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Abstract

A field experiment was carried out in silty loam soil at Agricultural Research Station of Garmat Ali in Basrah-Iraq. The aim of study was to determine the effect of different fertilization treatments on some soil properties (soil mean weight diameter, total soil porosity and soil penetration resistance at different soil depths), corn growth parameters (plant height, leaves area per plant, number of ears per plant and biological yield at maturity stage of plant) and N,P,K concentration in corn leaves at seedling, tasselling and maturity stages. The fertilization treatments were control, without any fertilization (T_0), chemical fertilization (200,130,100 kg N,P,K ha^{-1}) (T_1) and combined fertilization (manure at level 40 ton ha^{-1} + N,P,K (200,130,100 kg ha^{-1})) (T_2). The results showed that, the mean weight diameter and total soil porosity significantly increased, while, the soil penetration resistance decreased with T_2 treatment as compared with T_1 and T_0 treatments. While, there was no significant effect between T_1 and T_0 treatment on all soil properties studied. The mean weight diameter and total soil porosity significantly decreased, while, the soil penetration resistance increased with increasing the soil depth for all fertilization treatments. Plant height, leave area, number of ears per plant and biological yield significantly increased by 19.20, 18.27, 31.29 and 65.05% with T_2 treatment compared with T_1 treatment, respectively, and by 40.71, 51.40, 70.80 and 151.33% compared with T_0 treatment, respectively. N, P and K concentration of corn leaves significantly increased with T_2 treatment in

progressing of growing season compared with T_1 and T_0 treatment, while, there was decreased with increasing plant growth for all fertilization treatments.

Key words : manure, chemical fertilizer, physical properties of soil, corn growth parameters.

Introduction

Iraqi soils of southern region are very poor in organic matter content (less than 1%) due to low vegetation cover and arid climatic conditions, resulting in a decline in plant productivity due to the degradation of soil properties and the lack in essential nutrients for plant growth (Al-Hadithi and Abdul-Hamza, 2010). Therefore, use of organic inputs such as crop residues, manures or compost has great potential for improving soil health and crop yield through improvement of the physical, chemical and microbiological properties as well as enhance soil fertility (Stone and Elioff, 1998). The available data indicates that the combined application of organic and inorganic fertilizers is the best method and more conducive to increase crop yields and improve soil physical and chemical properties rather than using them individually (Efthimiadou *et al*., 2010; Bandyopadhyay *et al*., 2010 and Jinwei and Lianren, 2011).

Soil physical properties such as mean weight diameter, total porosity and penetration resistance are important components of soil quality and structure and they affect plant growth. Such properties are affected by organic input in soil and methods of fertilization eg. organic, inorganic and combination (Xin *et al*., 2016). Haynes and Naidu (1998) reviewed that addition of organic manures into soil resulted higher water holding capacity, porosity and water stable aggregation compared with untreated soil. Bandyopadhyay *et al*. (2010) reported that the application of organic manure with N,P,K fertilizers lead to increase soil organic carbon, total porosity, mean weight diameter and hydraulic conductivity, while decrease bulk density compared with N,P,K fertilizers alone or control.

Corn (*Zea mays* L.) is considered as one of the most important and popular weeds which used as a source of food for humans as well as animal feeds (Ayeni *et al*., 2012). Organic and inorganic fertilizers play an important role in improving corn productivity (Bedada *et al*., 2014). Akongwubel *et al*. (2012) found that the corn growth parameters such as plant height, number of leaves per plant, leaf dry weight, stem dry weight and grain yield were increased by 68.00, 58.57, 18.88, 30.92 and 244.44%, respectively, with addition of poultry manure at level of 10 ton ha^{-1} compared with control. Ayeni and Adetunji (2010) showed that the combined application of manure (10 ton ha^{-1}) with mineral fertilizer (200 kg N,P,K ha^{-1}) for corn, the plant height, grain yield, N, P and K concentration in plant increased by 10.98, 85.78, 20.15, 16.13 and 8.59% respectively, compared with mineral fertilizer alone, and by 21.83, 221.64, 22.00, 44.00 and 39.37% respectively, compared with control treatment.

The objective of this study is to determine the effect of cattle manure with chemical fertilizer on some soil properties and corn growth parameters.

Materials and methods

The study was carried out in silty loam soil of Agricultural Research Station, College of Agriculture, University of Basrah in order to study the effect of fertilization treatments on some soil properties, some corn growth parameters and N,P and K concentration of corn leaves. The treatments were (1) without fertilization (T_0); (2) chemical fertilization of 200,130,100 kg N,P,K ha^{-1} (T_1); (3) manure at level of 40 ton ha^{-1} + N,P,K at level of 200,130,100 kg ha^{-1}, respectively (T_2).

The manure was added and mixed with soil at 0-20 cm depth by using a ditch opener and manure laying machine which was manufactured in the Agriculture Machines Department, College of Agriculture, University of Basrah at the time of sowing. While, the chemical fertilizers (N, P and K) was added to soil at 7 cm depth as urea (46% N), triple super phosphate (20.21% P) and potassium sulfate (43% K) , respectively.

The field was plowed perpendicularly at 30 cm depth using moldboard plow, then was added the manure as rows of 10 m length, the distance between the rows was 0.75 m. After that, the corn seeds variety (FAO 700) were sown on manure rows under drip irrigation system. The different treatments were arranged in a randomized complete block design (RCBD) with three replications. All the obtained data were subjected to analysis of variance (ANOVA) using GenStat 14 statistics program. The means of the treatments were compared using Least Significance Difference (LSD) at 5% level of probability.

The initial properties of soil at depths of 0-10, 10-20 and 20-30 cm and the chemical properties of manure used were analyzed according to Black *et al*. (1965), Page *et al*. (1982) and Richards (1954) and presented in tables (1) and (2).

Table (1): Some properties of the soil used.

Property	**Soil depth (cm)**		
	0-10	**10-20**	**20-30**
pH	8.14	8.13	8.12
EC (dS m^{-1})	7.21	7.52	8.10
O.M (g kg^{-1})	6.56	6.14	5.73
$CaCO_3$ (g kg^{-1})	369.28	321.85	314.17
N (mg kg^{-1})	19.13	18.71	18.32
P (mg kg^{-1})	16.42	16.15	15.79
K (mg kg^{-1})	98.73	96.65	90.64
CEC (Cmol kg^{-1})	26.01	24.98	24.76
Clay (g kg^{-1})	212.24	223.59	226.18
Sand (g kg^{-1})	204.81	190.16	171.64
Silt (g kg^{-1})	582.95	586.25	602.18
Soil texture	silty loam	silty loam	silty loam

Table (2): Some properties of manure used in the study.

pH	**EC** dS m^{-1}	**N** g kg^{-1}	**P** g kg^{-1}	**K** g kg^{-1}	**OM** g kg^{-1}	**OC** g kg^{-1}	**C/N**
6.42	13.25	17.37	7.16	10.44	363.22	210.69	12.13

The properties of soil were determined at the end growing season (at full maturity stage of plant) of three depths (0-10, 10-20 and 20-30 cm) as following:-

Soil mean weight diameter (MWD) (mm): The soil mean weight diameter was determined according to Black *et al*. (1965) by the following equation:

$$MWD = \sum_{i=1}^{n} XiWi \quad \dots\dots\dots\dots (1)$$

Where:

MWD = Soil mean weight diameter (mm).

Xi = Average clod diameter in a particular sieve (mm).

Wi = Weight of clods in the size range i as a proportion of total dry weight of sample analyzed.

n = Number of sieves.

Total soil porosity (*f*) (%): The total soil porosity was determined according to Black *et al*. (1965) by using the following equation:

$$f = (1 - \frac{\rho_b}{\rho_s}) \times 100 \quad \dots\dots\dots\dots \ (2)$$

Where:

f = Total soil porosity (%).

P_b = Bulk density of soil (g cm^{-3}).

ρ_s = Density of solid soil substance, it was assumed to be constant (2.65 g cm^{-3}).

Soil penetration resistance (CI) (kN m^{-2}): The soil penetration resistance (cone index) was measured by using a penetrometer (0.02815 m cone diameter and 35^{o} cone angle). It was determined according to Roozbeh *et al*. (2010) by the following equation:

$$CI = \frac{F}{A} \quad \dots\dots\dots\dots \ (3)$$

Where:

CI = Cone index (kN m^{-2}).

F = Penetration force (kN).

A= Cone base area (m^2).

For the measurement of growth parameters, a set of five plants in the center of rows was randomly selected at the end growing season of corn (full maturity stage of plant). The following growth parameters were recorded: plant height (cm), this was taken from soil surface to the apical tip of the plant; leaves area (cm^2) per plant, this was estimated as its length multiplied by its maximum width multiplied by 0.75 (maize leaf calibration factor) according to Elings (2000); number of ears per plant; biological yield (g $plant^{-1}$), this was determined by weight the total plant (ears and straw) after drying at 13-14% moisture content according to Elsahookie (1990) and N, P and K concentration in leaves (g kg^{-1}), samples of leaves were taken to assay the N, P and K concentrations at three growth stages of plant (seedling, tasselling and maturity) according to page *et al*. (1982) method after wet digestion according to Cresser and Parsons (1979).

Results and Discussion

Soil properties:

Mean weight diameter of soil (MWD): The soil mean weight diameter is an important indicator of soil structure. The results showed that the soil mean weight diameter was significantly affected ($p \leq 0.05$) by different fertilization treatments (table 3). The highest value of soil mean weight diameter (0.65 mm) recorded with the combined fertilization treatment (T_2), with significantly differences among other treatments. While, the lowest value of soil mean weight diameter (0.46 mm) recorded with the control treatment (T_0). This results were in agreement with Selvi *et al*. (2005). This results explained that incorporating organic manure into soil increase mean weight diameter of soil as compared with chemical fertilizer alone or control treatment results. This may be due to increasing the concentration of organic matter in soil and soil microbial activity, and get produce positive effects on mean weight diameter and soil structure (Karami *et al*., 2012). Baohuna and Harvey (1993) indicated that the increasing in mean weight diameter of soil with the application of organic waste may be due to after addition organic matter release of some organic acids by microbial activity which helps to increase the stability of soil aggregates, as well as increasing the concentration of some organic compounds such as Fulvic acid and polysaccharides, which play an important role together along with ions of Na^{+2} and Ca^{+2} in increase the stability of soil and thus increase the mean weight diameter of soil. Rasool *et al*. (2008) found that the soil mean weight diameter increased by 65% with application of manure compared with control at the end caused a maize growth. While, Sarkar *et al*. (2003) reported that application of inorganic fertilizers alone decreased the stability of macro-aggregates due to low organic matter in soil. This was confirmed by Biswas *et al*. (2009), where he obtained a high coefficient of correlation ($r = 0.85$) between the organic carbon in the soil and mean weight diameter of soil.

The results of the effect soil depth on soil mean weight diameter showed that the mean weight diameter of soil significantly decreased ($p \leq 0.05$) by 11.11 and 15.79% at the soil depth of 20-30 cm compared with 10-20 and 0-10 cm depths, respectively (table 3). This may be due to the presence of manure in the surface depths causing increasing improvement of soil mean weight diameter. While, the presence of a manure-free layer at the depth of 20-30 cm may reduce the effect of organic matter on improving soil mean weight diameter at this depth. Rasool *et al*. (2008) found that the soil mean weight diameter decreased by 47.61% at the soil depth of 15-30 cm compared with 0-15 cm. This was attributed to increase organic carbon in the upper layers of soil compared to the lower layers. This results also were in agreement with some previous studies whose indicated that the soil mean weight diameter decreased with increasing the soil depth (Huang *et al*., 2015).

The interaction between the fertilization treatment and soil depth had significant effect ($p \leq 0.05$) on soil mean weight diameter (tab. 3). The lowest value of soil mean weight diameter associated with soil depth of 20-30 cm and control treatment (T_0), while, the highest value of soil mean weight diameter associated with soil depth of 0-10 cm and the combined fertilization treatment (T_2). This is due to the synergistic effect of soil depth and the addition of organic waste to increased soil mean weight diameter.

Table (3): Effect of fertilization treatment and soil depth on soil mean weight diameter (MWD)(mm)

***Treatment** (T)*	***Soil depth (cm)**(D)*			
	0-10	**10-20**	**20-30**	***Mean***
T_0	0.50	0.46	0.42	**0.46**
T_1	0.51	0.48	0.43	**0.47**
T_2	0.69	0.68	0.58	**0.65**
Mean	**0.57**	**0.54**	**0.48**	
LSD	**T (0.018)**	**D (0.018)**	**T × D (0.031)**	

Total soil porosity (%): The results in table (4) indicated that the different fertilization treatments had significant effect ($p \leq 0.05$) on the soil porosity. The lowest porosity of the soil was in the control treatment (T_0) which was 52.06% and significantly differs with the other treatments except at the chemical fertilization treatment (52.57%). While, the highest soil porosity was found in the combined fertilization treatment (T_2) which was 57.57% and significantly differs of the other treatments. The results were consistent with some previous research results where the addition of manure to the soil along with chemical fertilizers may turn out to have real impact on soil porosity (Agbede *et al*., 2008 and Javed *et al*., 2013). The increasing of soil porosity may occurs because the organic materials may stimulate the formation of soil aggregates as it is indicated by a decrease in soil bulk density. The increasing of soil aggregate stability due to the addition of manure (table 3) lead to increasing soil porosity (Rasoulzadeh and Yaghoubi, 2010). Mandal *et al*. (2013) stated that the organic materials may act as a cementing agent between soil particles that may improve soil aggregate stability, thereby improve soil porosity. Also, the organic materials have low bulk density and high porosity when it was added to the soil causing significant increasing in soil porosity (Shirani *et al*., 2002). While. Al-Mohammedi (2009) reported that the organic materials influence microbial activity since, they provide the soil with carbon and essential nutrients for microbial growth which bonding soil particles by hyphens and different exudates resulting in increase soil porosity.

The results showed that increasing the soil depth from 0-10 to 10-20 and 20-30 cm, decreasing the soil porosity significantly ($p \leq 0.05$) from 55.91 to 54.19 and 52.30 %, respectively (tab. 4). The presence of manure in the surface depths may increased the concentration of organic matter in those depths, resulting in an improvement of the bulk density and porosity of soil. While, the presence of a manure-free layer under the surface of the soil at depth of 20-30 cm may reduce the effect of organic matter on improving porosity at this depth. Agbede (2006) observed that increasing soil depth reduced soil porosity as a result of lack of organic matter and increasing compaction potential. This results were in agreement with Rasool *et al*.(2008).

The interaction between the fertilization treatment and soil depth had significant effect ($p \leq 0.05$) on soil porosity (tab. 4). The lowest value of soil porosity (50.86 %) was recorded at soil depth of 20-30 cm and control treatment (T_0), and the highest value of soil porosity (59.37 %) was recorded at soil depth of 0-10 cm and the combined fertilization treatment (T_2). This is definitely due to the synergistic effect of soil depth and the addition of organic waste to increase soil porosity.

Table (4): Effect of fertilization treatment and soil depth on soil porosity (%)

Treatment (T)	*Soil depth (cm)(D)*			
	0-10	**10-20**	**20-30**	***Mean***
T_0	53.53	51.78	50.86	**52.06**
T_1	54.21	51.79	51.70	**52.57**
T_2	59.37	58.99	54.34	**57.57**
Mean	**55.91**	**54.19**	**52.30**	
LSD	**T (1.022)**	**D (1.022)**	**T × D (1.770)**	

Soil penetration resistance (kN m^{-2}): The results in table (5) showed that the soil penetration resistance significantly decreased ($p \leq 0.05$) at the combined fertilization treatment (T_2) compared with chemical fertilization treatment (T_1) or control (T_0). The values were 1247.68, 1532.76 and 1571.17 kN m^{-2} for T_2, T_1 and T_0, respectively. This results were in agreement with many previous studies which indicated that the application of organic manure can decrease soil penetration resistance (Stock and Downes, 2008 and Bandyopadhyay *et al*., 2010). This finding could be attributed to the role of organic manure of treatment (T_2) in increasing the stability of soil aggregates and total soil porosity (tables 3 and 4), which was reflected at reducing soil penetration resistance compared with T_0 and T_1 treatments. Xin *et al*. (2016) reported that the organic manure can increase soil organic carbon content directly and then improve penetration resistance of soil as a result of improved aggregation, moisture content, bulk density and soil porosity. Similarly, Celik *et al*. (2010) found the soil penetration resistance significantly decreased between (17.83 and 29.80 %) with manure application compared with mineral fertilizers alone and control, respectively.

The effect of soil depth on soil penetration resistance was presented in table (5). The results showed that the mean soil penetration resistance significantly increased ($p \leq 0.05$) with increasing the soil depth. They were 1329.13, 1442.65

and 1579.83 kN m^{-2} at the soil depth of (0-10, 10-20 and 20-30) cm, respectively. This may be due to reduce the organic matter with lower depths resulting in higher bulk density and lower total porosity (table 4) as well as reducing the soil mean weight diameter (table 3) resulting in increased soil penetration resistance (Mujeci *et al*., 2017). Xin *et al*. (2016) found that the soil penetration resistance increased amount 228.57% with increasing soil depth from 0-5 to 15-20 cm. Who attributed that to increasing bulk density and decreasing porosity due to reduce the organic matter with lower depth of soil. This results also agree with those of Bandyopadhyay *et al*. (2010) who indicated that the soil penetration resistance increase with increasing the soil depth.

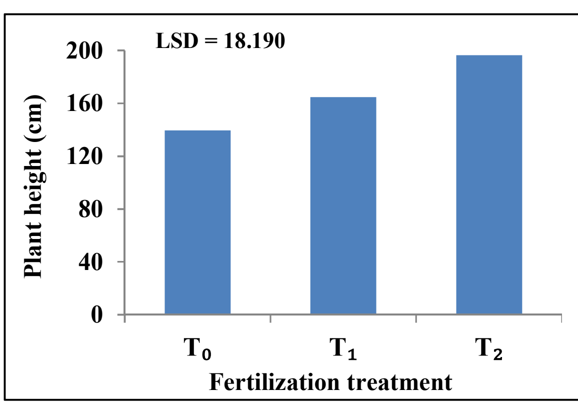
The interaction between the fertilization treatment and soil depth had significant effect ($p \leq 0.05$) on soil penetration resistance (tab. 5). The highest value of soil penetration resistance recorded at soil depth of 20-30 cm and control treatment (T_0), which was 1730.71 kN m^{-2}, while, the lowest value of soil penetration resistance recorded at soil depth of (0-10 cm) and the combined fertilization treatment (T_2), which was 1179.91 kN m^{-2}.

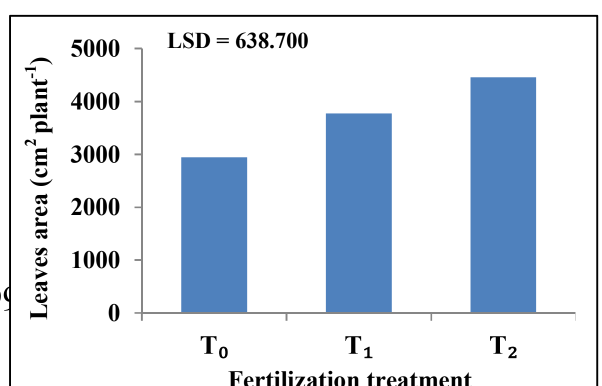
Table (5): Effect of fertilization treatment and soil depth on soil penetration resistance (kN m^{-2})

Treatment (T)	***Soil depth (cm)(D)***			
	0-10	**10-20**	**20-30**	***Mean***
T_0	1416.87	1565.92	1730.71	**1571.17**
T_1	1390.61	1539.44	1668.22	**1532.76**
T_2	1179.91	1222.58	1340.56	**1247.68**
Mean	**1329.13**	**1442.65**	**1579.83**	
LSD	**T (60.700)**	**D (60.700)**	**T × D (105.200)**	

Plant growth parameters:

Plant height (cm) and Leaves area (cm^2 $plant^{-1}$): The results showed that plant height and leave area of corn were significantly ($p \leq 0.05$) affected by different fertilization treatment at maturity stage of plant (figs. 1 and 2). The highest values of plant height and leave area were in the combined fertilization treatment (T_2) which were 196.47 cm and 4462.41 cm^2 $plant^{-1}$, respectively and significantly differs for the other treatments. However, the lowest values of plant height and leave area were in the control treatment (T_0) which were 139.63 cm and 2947.47 cm^2 $plant^{-1}$, respectively and significantly differs for the other treatments. This results were consistent with some previous studied which concluded that the plant height and leave area of corn had a high positive correlation with the addition manure alone or with inorganic fertilizers (Adamu and Leye, 2012 and Uwah *et al*., 2014). The positive effect of the combined fertilization treatment (T_2) on increasing the height and leave area of plant, compared to other treatments (T_0 and T_1) may be due to the role of organic manure with chemical fertilizers in providing the essential nutrient elements necessary for plant growth especially nitrogen which result in the improvement of plant growth parameters (Amanolahi- Baharvand *et al*., 2014). In addition, organic manure has a significant role in improving physical soil properties such as moisture content, bulk density, porosity and aggregation stability (Chakraborty *et al*., 2010), which in turn improve soil conditions and supported better aeration to the plant roots and absorption of water and nutrients (Manivannan *et al*., 2009). This in turn is reflected in increasing plant growth parameters such as plant height and leave area. This is confirmed by the results of the current study, which showed that the plant height (fig. 1) and leave area (fig. 2) under the influence of the addition of organic manure with chemical fertilizers were correlated and improved with improving in the aggregation stability of soil (tab. 3), soil porosity (tab. 4) and soil penetration resistance (tab. 5), which confirms that the role of organic manure in improving the physical soil properties resulting in an enhancement in plant growth.





N, P and K concentration in corn leaves (g kg^{-1}): The results presented in figures 3, 4 and 5 showed that the fertilization treatments and growth stages of plant had significant effect ($p \leq 0.05$) on N, P and K concentrations in corn leaves. The highest mean of N, P and K concentrations (regardless of growth stage) were recorded with the combined fertilization treatment (T_2), which were 31.96, 2.85 and 25.50 g kg^{-1}, respectively, compared with chemical fertilization treatment (T_1) (23.29, 2.05 and 17.56 g kg^{-1}, respectively) and control treatment (T_0) (18.76, 1.78 and 14.74 g kg^{-1}, respectively). This results were in agreement with Balyan *et al*. (2006). The superiority of the combined fertilization treatment in the increased concentrations of N, P and K in plant leaves may be due to the role of organic waste in improving soil fertility by increasing available nutrient concentrations in soil such as nitrogen, phosphorus and potassium (Islam and Munda, 2012), which reflected in the improvement of plant growth and increase its efficiency in the absorption of nutrients and then increase its concentration in the leaves (Uwah and Eyo, 2014). Rosen and Eliason (2002) reported that the addition of one ton of animal residue can provide the soil with 5, 2 and 5 pound $acre^{-1}$ of N, P_2O_5 and K_2O, respectively. In addition, the positive effect of organic waste on physical soil properties (tabs. 3, 4 and 5) may improve ventilation conditions, root growth and increase microorganism activity during the decomposition of organic waste, which is reflected in increase availability of N, P and K elements and their absorption by plants, then increases their concentration in the leaves (Agbede, 2010).

In the present study, the effect of the combined fertilization on improving soil physical properties (tabs. 3, 4 and 5) and increasing plant growth indicators (figs. 1 and 2) associated with increasing the concentration of N, P and K in plant leaves. This confirms that the role of combined fertilization in increasing the concentration of nutrients in leaves due to improved fertility and physical properties of soil as well as improved plant growth.

The effect of the growth stage of plant on N, P and K concentration in corn leaves showed in figures (3, 4 and 5). Values of N, P and K concentration were significantly affected ($p \leq 0.05$) by increasing the growth stage of plant. The highest concentration of N, P and K recorded at seedling stage (regardless of fertilizer treatment) were 30.17, 2.85 and 24.26 g kg^{-1} respectively. While, the lowest values of N, P and K concentration were recorded at maturity stage of plant which were 19.49, 1.63 and 13.42 g kg^{-1} respectively. This may be due to the fact that increasing vegetative growth rate leads to a reduction in nutrients in the leaves, in addition to increasing their movement from leaves to grains, resulting in a decreasing the nutrients concentration in leaves with plant growth progress (Al-Fadlly, 2011 and Mohammed, 2013).

The interaction between the fertilization treatments and growth stages of plant had significant effect ($p \leq 0.05$) on N, P and K concentration in corn leaves (figs. 3, 4 and 5). The highest values of N, P and K concentration were recorded with combined fertilization treatment (T_2) at seedling stage (38.01, 3.47 and 31.10 g kg^{-1}, respectively), while the lowest values were recorded with control treatment (T_0) at maturity stage of plant (14.44, 1.18 and 9.43 g kg^{-1}, respectively).

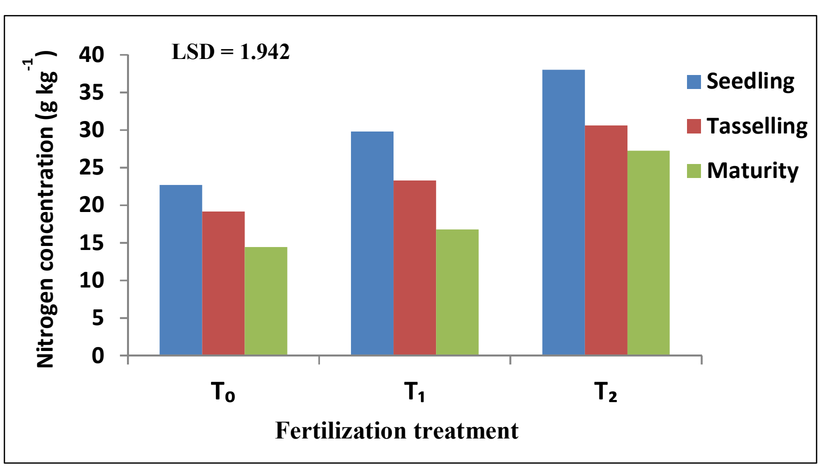


Fig. (3): Effect of fertilization treatment on N concentration of

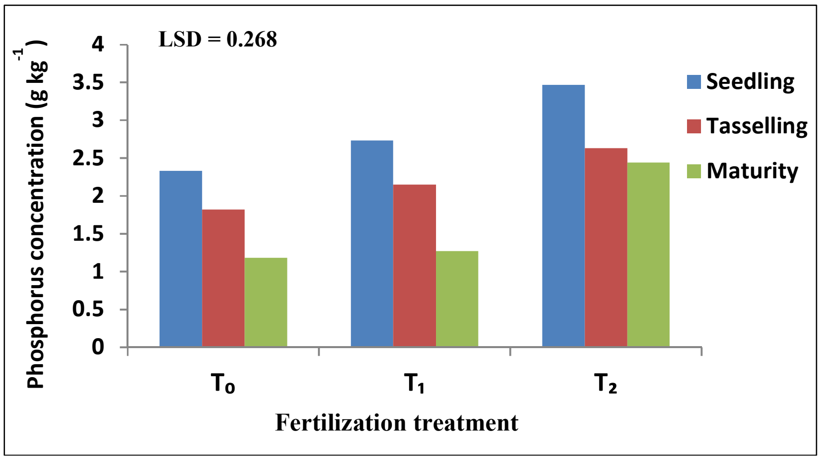


Fig. (4): Effect of fertilization treatment on P concentration of corn leaves during the growing season

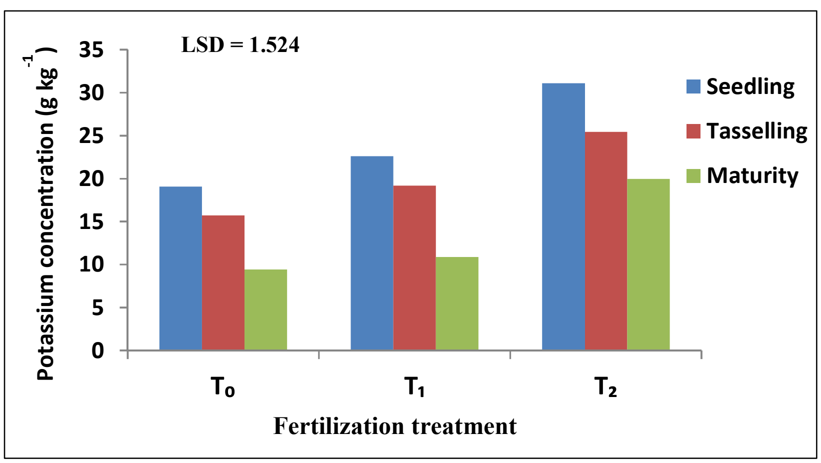


Fig. (5): Effect of fertilization treatment on K concentration of corn leaves during the growing season

Number of ears and Biological yield (g plant^{-1}): The results showed that fertilization treatments significantly affected ($p \leq 0.05$) on the number of ears and biological yield of corn (figs. 6 and 7). The highest values of the ears number and biological yield of corn were achieved in the treatment include application of manure and NPK fertilizer (T_2), they were 1.93 ear plant^{-1} and 312.45 g plant^{-1}, respectively. While, the lowest values of the ears number and biological yield of corn were recorded with control treatment (T_0) which were 1.13 ear plant^{-1} and 124.32 g plant^{-1}, respectively. This result is consistent with some previous studied which the refers to a positive correlation between the addition of manure alone or in combination with chemical fertilizer with yield of corn (Adamu and Leye, 2012 and Zhang *et al*., 2016). Increasing the number of ears and biological yield of plant with using combined fertilization compared to chemical fertilizers alone or control may be due to the role of manure in improving plant growth and increase the concentration of nutrients in the plant (Uwah *et al*., 2014). This was confirmed by the obtained results, where it was observed that the changes in the number of ears and biological yield under the effect of combined fertilization were consequences with the changes in plant growth parameters eg. height plant (fig. 1) and leave area (fig. 2) and concentration of N, P and K in leaves (figs. 3, 4 and 5). This result was in agreement with Dhadli *et al*. (2016) who found that the grain and straw yield for maize increased by 28.76 and 41.42 respectively with the combined application of manure and NPK fertilizers compared with NPK fertilizers alone, and by 162.67 and 139.79% compared with control.

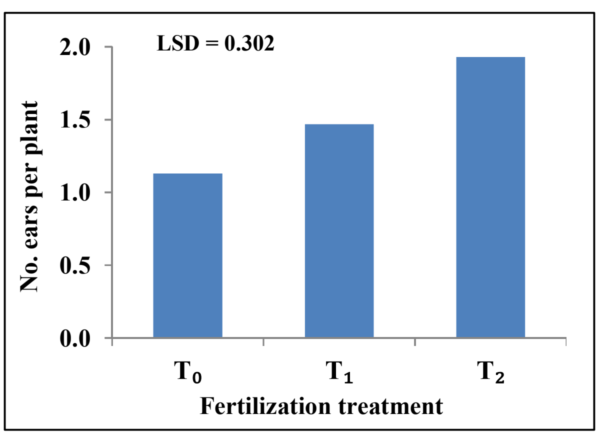


Fig. (6): Effect of fertilization treatment on No. ears per plant

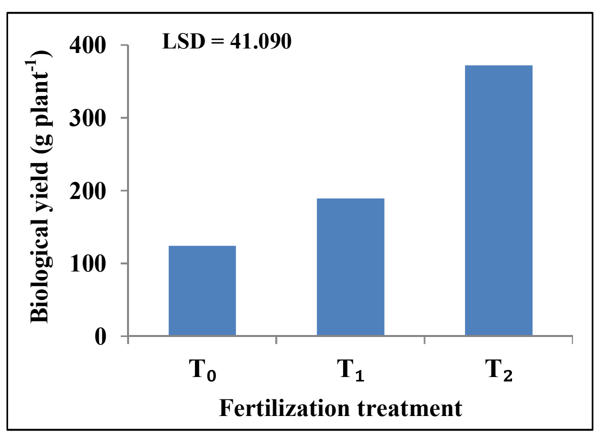


Fig. (7): Effect of fertilization treatments on biological yield of corn

Conclusions:

In conclusion, our research determined that physical characteristics of soil sown with corn, could be improved significantly by addition of cattle manure at level of 40 ton ha^{-1} in combination with chemical fertilizers (N,P,K) as compared with N,P,K alone. Cattle manure incorporated into soil increased the organic matter content, made a more porosity and better aggregation of soil and penetration resistance. These enhancements in soil physical properties in addition to the role of manure to provide and/or protect the essential elements in soil can play a role to improve the plant media resulting in an increasing plant growth and nutrient uptake.

References

Adamu, S. and B.O. Leye (2012). Performance of maize (Zea mays L.) as influenced by complementary use of organic and inorganic fertilizers. Int. J. of Sci. and Nature, 3(4): 753-757.

Agbede, T.M. (2006). Effect of tillage on soil properties and yam yield on an Alfisol in Southwestern Nigeria. Soil and Till. Res., 86: 1-8.

Agbede, T.M. (2010). Tillage and fertilizer effects on some soil properties, leaf nutrient concentrations, growth and sweet potato yield on an Alfisol in southwestern Nigeria. Soil and Till. Res., 110: 25-32.

Agbede, T.M.; S.O. Ojeniyi and A.J. Adeyemo (2008). Effect of poultry manure on soil physical and chemical properties, growth and grain yield of sorghum in southwest Nigeria. Am.-Eurasian J. Sustain. Agric., 2(1): 72-77.

Akongwubel, A. O.; U. B. Ewa; A. prince; O. Jude; A. Martins; O. Simon and O. Nicholas (2012). Evaluation of agronomic performance of maize (Zea mays L.) under different rates of poultry manure application in an Ultisol of Obubra, Cross river state, Nigeria. Int. J. Agric. and forestry, 2(4): 138-144.

Al-Fadlly, J.T.M. (2011). Effect of organic and mineral fertilization on growth and yield of potato crop. M. Sc. Thesis. Coll. Agric. Univ. Baghdad, Iraq. (in Arabic).

Al-Hadithi, J.I. and J.S. Abdul-Hamza (2010). Effect of sources and levels of organic matter on some soil physical properties and corn yield (*Zea mays* L.). J. Al-Qadisiyah, Pure Sci., 15(13): 1-9. (in Arabic).

Al-Mohammedi, O.H.M. (2009). Use of manure and whey as a way of organic agriculture and their impact in growth and production of potatoes. Ph. D. Thesis. Coll. Agric. Univ. Baghdad. Iraq. (in Arabic).

Amanolahi-Baharvand, Z.; H. Zahedi and M. Rafiee (2014). Effect of vermicompost and chemical fertilizers on growth parameters of three corn cultivars. J. of Appl. Sci. and Agric., 9(9): 22-26.

Ayeni, L.S and M.T. Adetunji (2010). Integrated application of poultry manure and mineral fertilizer on soil chemical properties, nutrient uptake, yield and growth components of maize. Nature and Sci., 8(1): 60-67.

Ayeni, L.S.; E.O. Adeleye and J.O. Adejumo (2012). Comparative effect of organic, organomineral and mineral fertilizers on soil properties, nutrient uptake, growth and yield of maize (Zea mays). Int. Res. J. of Agric. Sci. and Soil Sci., 2(11): 493-497.

Balyan, J.K.; P. Singh; B.S. Kumpawat and L.K. Jain (2006). Effect of integrated nutrient management on maize (*Zea mays* L.) growth and its nutrients uptake. Curr. agric., 30: (1-2): 79-82.

Bandyopadhyay, K.K.; A.K. Misra; P.K. Ghosh and K.M. Hati (2010). Effect of integrated use of farmyard manure and chemical fertilizers on soil physical properties and productivity of soybean. Soil and Till. Res., 110: 115-125.

Baohuna, G.U. and E.D. Harvey (1993). Dispersion and aggregation of soils as influenced by organic and inorganic polymers. Soil Sci. Soc. Am J., 57: 709-716.

Bedada, W.; E. Karltun; M. Lemenih and M. Tolera (2014). Long-term addition of compost and NP fertilizer increases crop yield and improves soil quality in experiments on smallholder farms. Agric. Ecosys. and Environ., 195: 193-201.

Biswas, A.K; M. Mohanty; K.M. Hati and A.K. Misra (2009). Distillery effluents effect on soil organic carbon and aggregate stability of a Vertisol in India. Soil and Till. Res., 104: 241-246.

Black, C.A.; D.D. Evans; J.L. White; L.E. Ensminger and F.E. Clarck (1965). Methods of soil analysis. Part 1. Physical properties. Am. Soc. Agron. Inc. Pub., Madison, Wisconsin, 770pp.

Celik, I.; H. Gunal; M. Budak and C. Akpinar (2010). Effects of long-term organic and mineral fertilizers on bulk density and penetration resistance in semi-arid Mediterranean soil conditions. Geoderma, 160: 236–243.

Chakraborty, D.; R.N. Garg; R.K. Tomar; B.S. Dwivedi; P. Aggarwal; R. Singh; U.K. Behera; A. Thangasamy and D. Singh (2010). Soil physical quality as influenced by long-term application of fertilizers and manure under maize-wheat system. Soil Sci., 175: 128–136.

Cresser, M.S. and J.W. Parsons (1979). Sulphuric perchloric and digestion of plant material for the determination of nitrogen, phosphorus, potassium, calcium and magnesium. Anal. Chem. Acta., 109: 431-436.

Dhadli, S.H.; S.B. Brar and A.T. Black (2016). N2O emissions in a long-term soil fertility experiment under maize–wheat cropping system in Northern India. Geoderma Regional 7: 102–109.

Efthimiadou, A.; D. Bilalis; A. Karkanis and B. Froud-Williams (2010). Combined organic and inorganic fertilization enhance soil quality and increased yield, photosynthesis and sustainability of sweet maize crop. Australian J. of Crop Sci., 4(9): 722-729.

Elings, A. (2000). Estimation of leaf area in tropical maize. Agronomy J., 92: 436-444.

Elsahookie, M. M. (1990). Yellow maize, production and improvement. Univ. of Baghdad, Coll. of agric., 400pp. (in Arabic).

Haynes, R. and R. Naidu (1998). Influence of time, fertilizer and manure application on soil organic matter content and soil physical conditions: a review. Nutrient Cyc. Agroeco., 51: 123-137.

Huang, M.; T. Liang; L. Wang and C. Zhou (2015). Effect of no-tillage system on soil physical properties and carbon sequestration under long-term wheat-maize doumle cropping system. Catena, 128: 195-202.

Islam, M. and G.C. Munda (2012). Effect of organic and inorganic fertilizer on growth, productivity, nutrient uptake and economics of maize (Zea mays L.) and toria (Brassica campestris L.). Agric. Sci. Res. J., 2(8): 470-479.

Javed, H.M.R.; M.S.I. Zamir; A. Tanveer and M. Yaseen (2013). Soil physical properties and spring maize yield as influenced by different tillage practices and integrated use of poultry manure with synthetic fertilizers, J. Agric. Res., 51(3): 277-287.

Jinwei, Z. and Z. Lianren (2011). Combined application of organic and inorganic fertilizers on black soil fertility maize yield. J. of Northeast Agric. Univ., 18(2): 24-29.

Karami, A.; M. Homaee; S. Afzalinia; H. Ruhipour and S. Basirat (2012). Organic resource management: Impacts on soil aggregate stability and other soil physical-chemical properties. Agric. Ecosyst. Environ., 148: 22-28.

Mandal, M.; R.S. Chandran and J.C. Sencindiver (2013). Amending subsoil with composted poultry litter-I: Effects on soil physical and chemical properties. Agronomy, 3: 657-669.

Manivannan, S.; M. Balamurugan; K. Parthasarathi; G. Gunasekharan and R. Ranganathan (2009). Effect of vermicompost on soil fertility and crop productivity beans (Phaseolus vulgaris) J. Environ, 30: 275-281.

Mohammed, E.J. (2013). Evaluation the effect of organic and Mineral Fertilization on some soil properties , growth and yield of snake cucumber (Cucumis melo var.flexuosus Nauds). M. Sc. Thesis. Coll. Agric. Univ. Basrah, Iraq. (in Arabic).

Mujdeci, M.; A. A. Isildar; V. Uygur; P. Alaboz; H. Unlu and H. Senol (2017). Cooperative effects of field traffic and organic matter treatments on some compaction-related soil properties. Solid Earth, 8: 189-198.

Page, A.L.; R.H. Miller and D.R. Keeney (1982). Methods of soil analysis. Part 2. 2nd ed. ASA Inc. Madison, Wisconsin, 1143pp.

Rasool, R.; S.S. Kukal and G.S. Hira (2008). Soil organic carbon and physical properties as affected by long-term application of FYM and inorganic fertilizers in maize-wheat system. Soil and Till. Res., 101:31-36.

Rasoulzadeh, A. and A. Yaghoubi (2010). Effect of cattle manure on soil physical properties on a sandy clay loam soil in north-west Iran. J. of Food Agric. and Environ., 8(2): 976-979.

Richards, L.A. (1954). Diagnosis and improvement of saline and alkali soils. US Department of Agriculture, Agricultural Handbook No 60., Washington. 154pp.

Roozbeh, M.; M. Almasi; A. Hemmat; M. Hedayatizadeh; M. Attashi and M.G. Varnamkhasti (2010). Soil penetration resistance and time required for corn seedbed preparation under four tillage systems. J. Agric. Tech., 6(2): 211-218.

Rosen, C.J. and R. Eliason (2002). Nutrient management for commercial fruit and vegetable crops in Minnesota. Univ. of Minnesota.

Sarkar, S.; S.R. Singh and R.P. Singh (2003). The effect of organic and inorganic fertilizer on soil physical condition and the productivity of rice-lentil cropping sequence in India. J. of Agric. Sci., 140 (4): 419-425.

Selvi, D.; P. Santhy and D. Dhakhinamoorthy (2005). Effect of inorganics alone and in combination with farmyard manure on physical properties and productivity of vertic haplustepts under long-term fertilization. J. of the Indian Soci. of Soil Sci., 53(3): 302-307.

Shirani, H.; M.A. Hajabbasi; M. Afyuni and A. Hemmat (2002). Effects of farmyard manure and tillage systems on soil physical properties and corn yield in central Iran. Soil and Till. Res., 68: 101-108.

Stock, O. and N. Downes (2008). Effects of additions of organic matter on the penetration resistance of glacial till for the entire water tension range. Soil and Till. Res., 99: 191-201.

Stone, D. M. and J. D. Elioff (1998). Soil properties and Aspen development five years after compaction and forest floor removal. Canadian J. of Soil Sci., 78(1): 51-58.

Uwah, D.F. and V.E. Eyo (2014). Effects of number and rate of goat manure application on soil properties, growth and yield of sweet maize (Zea mays L. saccharata Strut). Sustainable Agric. Res., 3(4): 75-83.

Uwah, D.F.; U.L. Undie and N.M. John (2014). Comparative evaluation of animal manures on soil properties, growth and yield of sweet maize (*Zea mays* L. saccharata Strut.) J. of Agric. and Environ. Scie., 3(2): 315-331.

Xin, X.; J. Zhang; A. Zhu and C. Zhang (2016). Effects of long-term (23 years) mineral fertilizer and compost application on physical properties of fluvo-aquic soil in the north China Plain. Soil and Till. Res., 156: 166-172.

Zhang, Y.; C. Li; Y. Wang; Y. Hu; P. Christie; J. Zhang and X. Li (2016). Maize yield and soil fertility with combined use of compost and inorganic fertilizers on a calcareous soil on the North China Plain. Soil and Till. Res., 155: 85-94.

تأثير التسميد العضوي والمعدني في بعض صفات التربة ومفردات نمو الذرة الصفراء (*Zea mays* L.)

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الخلاصة

نفذت تجربة حقلية في تربة مزيجة غرينية تابعة لمحطة البحوث الزراعية في موقع كرمة علي – البصرة وذلك لبيان تأثير معاملات التسميد المختلفة في بعض صفات التربة (معدل القطر الموزون والمسامية الكلية ومقاومة الاختراق عند اعماق تربة مختلفة) ومفردات نمو الذرة الصفراء (ارتفاع النبات والمساحة الورقية وعدد العرانيص والحاصل البايلوجي نهاية موسم النمو) وكذلك تركيز النتروجين والفسفور والبوتاسيوم في اوراق النبات خلال مراحل البادرة والتزهير والنضج. تضمنت معاملات الدراسة: معاملة المقارنة بدون تسميد (T_0) ومعاملة التسميد الكيميائي (100،130،200 كغم N،P ،K هكتار$^{-1}$) (T_1) ومعاملة التسميد المشترك (سماد عضوي بمستوى 40 طن هكتار$^{-1}$ + 200 ،130،100 كغم N،P،K هكتار$^{-1}$) (T_2). اظهرت النتائج زيادة معدل القطر الموزون والمسامية الكلية وانخفاض مقاومة التربة للاختراق عند معاملة التسميد المشترك (T_2) مقارنة مع معاملة التسميد الكيميائي فقط (T_1) او المقارنة (T_0) في حين زادت مقاومة التربة للاختراق وانخفضت قيم معدل القطر الموزون والمسامية الكلية مع زيادة عمق التربة، كما لم يختلف تأثير معاملة التسميد (T_1) معنويا" عن معاملة المقارنة في جميع صفات التربة المدروسة. حققت معاملة التسميد المشترك زيادة في ارتفاع النبات والمساحة الورقية وعدد العرانيص والحاصل البايلوجي بنسبة 19.20 و 18.27 و 31.29 و 65.05 % على التوالي مقارنة مع معاملة التسميد الكيميائي، وبنسبة 40.71 و 51.40 و 70.80 و 151.33 % على التوالي مقارنة مع معاملة بدون تسميد. كما زاد تركيز كل من النتروجين والفسفور

والبوتاسيوم في اوراق النبات معنويا" عند معاملة التسميد المشترك قياسا" مع معاملة التسميد الكيميائي والمقارنة.

كلمات مفتاحية : السماد العضوي ، السماد الكيميائي ، صفات التربة الفيزيائية ، مفردات نمو الذرة الصفراء .