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EFFECT OF TILLAGE SYSTEMS AND ORGANIC FERTILIZERS ON MAIZE (*ZEA MAYS*, L.) PRODUCTIVITY IN ALKALINE SOILS

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Field experiments were conducted in alkaline soil at the Desert Research Center, Agricultural Experiment Station at El-Kharga Oasis, New Valley Governorate, Southwestern Egypt during the two growing seasons of 2021 and 2022 to study the effect of some tillage systems and some types of organic fertilizers on the maize yield and some alkaline soil properties. Results indicated that all studied parameters were significantly affected by tillage systems and organic fertilizers sources in both seasons. The highest values were obtained when the soil was treated with a disc plough and when adding organic fertilizers in the form of sheep fertilizer, as the grain yield increased by 61.59 and 62.23% in the first and second seasons, respectively.

Keywords: alkaline soil, maize, organic fertilizers, tillage systems, yield, chemical composition

INTRODUCTION

Maize (*Zea mays* L.) is one of the most important grain crops in Egypt. It ranks second among the strategic crops after wheat, and the need is increasing globally to produce this crop with the increasing need to expand the production of biofuels, as it is one of the crops used in its production. As well as human bread industry and mimimal production, especially under the food crises conditions that swept the world from one time to onother caused negative effects on Egypt. Maize is also used in many other food industries such as starch, oil, fructose, paper, and others. Maize can be used in the manufacture loaf of bread or by mixing it with 20% wheat to narrow the gap between production and consumption of wheat and reduce the quantity of wheat imports. Although Egypt's productivity of maize represents about 80% of the production of the Arab world, there is a large gap between production and consumption estimated at about 45% (FAO, 2021). It is very important to increase production of maize to shrink the gap between production and consumption.

Alkaline soils are very common in arid and semiarid climates which cover more than 25% of the earth's surface and are formed as a result of an increase in the exchangeable sodium percentage (ESP) to higher than 15% and soil pH higher than 8.5, which leads to poor natural properties and weak production capacity (Singh, 2015). Therefore, poor soil structure and nutrients as well as high sodium levels in the soil profile, caused by soil alkalinity, have become the key limiting factors for maize production in New Valley Governorate. Organic fertilizer application is a traditional method for the improvement of alkaline soils. Many field experiments indicated that organic manure application can improve soil fertility conditions, such as soil organic matter and soil structure, and enhance the capacity to crop salt-tolerant species and increase crop yields (Ci and Yang 2010 and Chen et al., 2022).

Reclamation of alkaline soil with organic fertilizers can increase soil nutrient content, improve soil structure, increase soil macro aggregates and can significantly reduce exchangeable sodium ions, reduce soil salinity, increase soil nutrients and organic matter, and improve plant growth (Zhang et al., 2022). In addition, organic fertilizer is widely used to improve alkaline soils due to their low pH, abundant organic functional groups, favorable soil aggregate formation, and enhanced crop root uptake (Chen et al., 2022). Manasa et al. (2020) showed that organic fertilizer can reduce the pH value, soil bulk density, soil sodium content and increase soil porosity, soil potassium content, improve soil microbial and enzymatic activities. The application of organic amendments increases microbial diversity in saline–alkali soils and enriches microbial communities towards microbial species responsible for soil aggregate stability (Chang et al., 2022). Soil structure improvement increases the hydraulic conductivity of saturated saline-alkaline soils, which reduces EC and accelerates Na^+ leaching, resulting in lower pH (Song et al., 2020). Yield and its components of maize with organic treatments were significantly higher than control of alkaline soils because the soil conditions in the root zone were improved by the organic material before sowing, which was beneficial to the emergence and growth of maize (Fouladidorhani et al., 2020).

Tillage has been an important aspect of technological development in the evolution of agriculture, particularly in food production. The objectives of soil tillage include seedbed preparation, water and soil conservation, creating a suitable seedbed and helping to increase the root system growth which leads to increase the vegetative growth due to fracture of layers under soil surface and weed control (Muhammad et al., 2018). Araya et al. (2010) indicated that alkaline soil could be tilled by special ploughs, which reduces soil pH and electrical conductivity (EC). However, previous research only focused on improvements in soil properties and increases in crop yield, while lacked further discussions of relationship between crop yield and soil properties under tillage management in alkaline soil. Shahid et al. (2016) stated that all yield and its components of maize were significantly affected when using different tillage systems through various types of ploughs compared to the lack of tillage or traditional tillage. Maximum values of studied traits may be due to well pulverized and smooth soil condition created by various types of ploughs that caused better root expansion, availability of nutrients and soil moisture which improved plant growth and development. Shahid et al. (2022) found that tillage practices significantly affected number of grains ear^{-1}, grains weight, thousand grains weight and grain yield of maize, and they reported that the maximum values of all yield components were produced by deep tillage, particularly with chisel plough which may be attributed to the well pulverized soil and good seed bed prepared by the tillage operation, chisel plough that resulted in better crop growth, development and dry matter accumulation. The treatment of chisel plough improved soil physical properties and plants were facilitated in terms of efficient utilization of nutrients and soil moisture.

This study aimed to assess the effects of organic fertilizers application combined with deep tillage management on soil properties and maize productivity in the alkaline soil. Furthermore, how organic fertilizers application and tillage management influenced the relationship between maize yield and parameters of soil properties under alkalinity conditions were also determined.

MATERIALS AND METHODS

1. Location and Soil Properties of The Experimental Site

A field experiment was carried out in alkaline soil at the Agricultural Experiment Station at El-Kharga Oasis (27°47.7 42 N, 30°24.7 63 E), Desert Research Center, New Valley Governorate, during the two growing seasons of 2021 and 2022. The physical and chemical soil characteristics of the study site were determined according to Klute (1986), as recorded in Table (1). Also, the chemical analysis of irrigation water was carried out using the standard method of Page et al. (1982) and presented in Table (2). The analysis of organic fertilizer types is presented in Table (3).

2. Experimental Treatments

The experiment included 16 treatments which were combinations of four tillage soil systems (TSS) and four types of organic fertilizers (TOF):

2.1. Tillage soil systems (TSS)

Three types of ploughs were applied versus control treatment (no tillage), three TSS were chisel plouph (CP), disc plouph (DP) and moldboard plouph (MP). Where, the tillage depth for all tillage systems used was set to be 70-80 cm through the hydraulic control attached to the agricultural tractor.

2.2. Types of organic fertilizers (TOF)

Different types of organic fertilizers were added based on nitrogen percentage for each of them at a rate of 60 nitrogen units after the first tillage. Organic fertilizer treatments included poultry fertilizer, sheep fertilizer and

Table (1). Physical and chemical properties of the experimental soil sites.

Season	Particles (%)			Texture	EC (ppm)	pH	P (ppm)	Available aions (meq/l)							
	Sand	Silt	Clay					K	Na	Ca	Mg	$CO_3^{=}$	HCO_3^{-}	Cl^{-}	SO_4^{--}
2021	26.2	39.6	34.2	Clay	2351	9.4	0.56	2.16	149.9	2.85	0	8.11	16.6	127.6	2.16
2022	24.5	36.7	38.8	loamy	1984	8.8	0.60	2.96	138.2	2.53	0	6.97	14.82	119.9	1.96

Table (2). Analysis of irrigation water.

Season	pH	E.C. (ds/m)	S.A.R.	Soluble cations (meq/l)				Soluble anions (meq/l)			
				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO_3^{=}$	HCO_{3-}	$SO4^{=}$	Cl^{-}
2021	7.84	1.17	6.86	13.68	2.74	14.82	0.41	-	5.43	4.37	9.47
2022	7.79	1.12	6.14	15.32	2.93	14.51	0.45	-	5.69	4.76	10.24

Table (3). Analysis of organic fertilizers.

Organic fertilizer	E.C. (ds/m)	pH	C %	N %	C/N ratio	OM %	P %	K %	Fe (ppm)	Zn (ppm)	Mn (ppm)	Cu (ppm)
Poultry fertilizer	0.64	8.49	31.15	1.77	17.60	51.11	60.33	1.60	3341	249	118	19.3
Sheep fertilizer	0.62	8.41	32.81	1.80	18.23	54.90	63.47	1.65	3564	162	130	22.4
Vegetable compost	0.52	8.05	26.20	1.31	20.00	41.63	42.08	1.25	1606	53	111	14.5

vegetable compost, in addition to the control treatment (without adding organic fertilizer).

3. Cultural Practices

Calcium super-phosohate (15.5% P_2O_5) was added during soil plowing at a rate of 150 kg fed.$^{-1}$, while potassium sulphate (48% K_2O) was added at 50% of inflorescence emergence at a rate of 100 kg fed.^{1}, and nitrogen fertilizer was added as ammonium sulphate (20.5%) at a rate of 150 kg fed.$^{-1}$, which was divided into 10 doses with drip irrigation water starting from the completion of germination until the completion of the expulsion of inflorescences.

4. Sampling and Measurements

4.1. Yield and yield components

At harvest, samples of 5 plants plot^{-1} were taken randomly after 117 and 126 days from sowing in 2020 and 2021 growing seasons, respectively from the middle of plot for every treatment to determine the following characters: plant height (cm), 100-grain weight (g), grain yield (ton ha.$^{-1}$), root dry weight (g plant^{-1}) and water use efficiency (WUE) kg m^{-3}. Whereas WUE = Seed yield kg fed^{-1} /actual consumptive use m^{3} fed.$^{-1}$, also at harvest grain yield (kg) of each plot was recorded and then transformed into yield ton ha.$^{-1}$.

4.2. Chemical composition

Some chemical assessments have been made on grains as percentages of protein and oil. Whereas total nitrogen was determined by using the modified micro-Kjeldahl method as described by Peach and Tracey (1956). The crude protein content was calculated by multiplying by 5.7 to obtain the crude protein percentage. As well, oil was determined according to A.O.A.C. (1995) by soxhlet apparatus using petroleum ether as a solvent.

4.3. Soil estimations

After harvest, soil samples were taken from the layer of 20-30 cm depth, to estimate bulk density (mg m^{-3}), moisture content (%), porosity (%), pH and soil penetration resistance (kPa). Whereas bulk density was evaluated by core method, three replications of soil samples were collected per plot from specific depths in this study. Each sample was dried in oven at 105°C and weighed then bulk density was calculated from equation (1) which was noted in Black (1965).

$$Pd = ms/vt \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Where:

Pd: The dry bulk density (mg m^{-3})

ms: The weight of the dried soil sample (mg)

vt: The total volume of the soil sample (m^{3})

The moisture content of the soil was determined on wet weight base where the samples of soil were collected from specific depths with three replications per plot, then samples were dried in an oven at 105°C for 24 hours. Soil moisture content was calculated from equation (2).

$$Mc = w_{wet} - w_{dry} / w_{dry} \times 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (2)$$

Where:
Mc: Moisture content (%)
w_{wet}: The weight of the wet soil sample (g)
w_{dry}: The weight of the dried soil sample (g)

Total porosity was calculated from equation (3) which mentioned in Black (1965). The particle density was equal to 2.65 mg m^{-3}

$$Tp = 1- pd/ps \times 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (3)$$

Where:
Tp: Total soil porosity (%)
pd: The dry bulk density (mg m^{-3})
ps: The particle density (mg m^{-3})

Soil penetration resistance (kPa) was measured by 10 insertions in each plot. A penetrometer (SP 1000) was used with 12.83 mm cone diameter and 30-degree angle based on ASAE standard S313.3 FEB04.

Soil pH was measured using pH sensors for the Vernier LabQuest equipment. Exchangeable sodium percentage was determined according to equation (4)

ESP = Exchangeable sodium ions / Soil cation exchange capacity x 100 ... (4)

5. Experimental Design and Data Analysis

A split plot design with three replicates was used. Where, the main plots were occupied with tillage soil systems and the sub plots allocated with types of organic fertilizers. Each experimental unit area (plot) in the two seasons was 10.5 m^2 (1/400 feddan) which consisted of five lines with a width of 70 cm, a length of 3 m and the distance between plants was 25 cm. All the obtained data for each treatment were subjected to analysis of variance according to the method described by Gomez and Gomez (1985). The least significant difference (LSD) at 5 % level of significance was used.

RESULTS AND DISCUSSION

1. Effect of Tillage Soil Systems (TSS)

Table (4) shows the effect of some tillage systems using three types of ploughs on maize productivity and some soil measurements. The results showed that the use of different types of ploughs had a significant effect on all the studied traits, except for the percentage of oil in grains. The results indicated that the use of disc plough gave the highest values regarding; plant height, weight of 100 grains of grain crop, water use efficiency, root dry weight, grain protein percentage, soil moisture content and soil porosity when compared to the no-tillage treatment (control) in both seasons. While the highest values of bulk density, soil pH, soil penetration resistance and ESP

Table (4). Effect of tillage soil systems on maize (*Zea mays,* L.) productivity during 2021 and 2022 growing seasons under alkaline soils conditions at New Valley.

Measurements	Plant							Soil					
TSS \ Char.	Plant height (cm)	100 Grain weight (g)	Grain yield (ton ha.$^{-1}$)	WUE (kg m^{-3})	Root dry weight (g plant^{-1})	Protein %	Oil %	Bulk density (mg m^{-3})	Moisture content %	Porosity %	pH	Soil penetration resistance (kPa)	ESP %
						2021							
Control	157	17.35	4.205	0.84	8.68	8.01	4.61	1.48	15.03	36.56	9.56	1154	17.32
Chisel plough	190	19.47	6.432	1.33	11.32	9.38	5.09	1.40	17.61	45.20	9.10	956	15.19
Disc plough	210	22.54	6.871	1.57	13.57	10.64	5.76	1.22	20.47	52.41	8.03	785	12.54
Moldboard plough	201	20.19	6.648	1.42	12.89	10.40	5.54	1.33	18.36	49.57	8.94	816	13.81
LSD at 5%	8	0.65	0.211	0.08	0.55	0.22	NS	0.06	0.70	2.01	0.14	20	1.22
2022													
Control	162	17.86	4.258	0.91	8.85	8.15	4.69	1.50	15.68	36.94	9.68	1201	17.15
Chisel plough	195	19.93	6.523	1.38	11.66	9.46	5.21	1.41	17.86	46.31	9.25	971	14.96
Disc plough	214	23.03	6.922	1.61	13.81	10.89	5.85	1.20	20.74	53.25	8.19	802	12.17
Moldboard plough	204	20.75	6.710	1.48	12.93	10.63	5.60	1.35	18.82	50.09	9.03	822	13.76
LSD at 5%	9	0.79	0.180	0.07	0.68	0.25	NS	0.05	0.91	2.17	0.12	19	1.14

TSS: Tillage soil systems, control: without tillage, WUE: Water use efficiency, ESP %: Exchangeable sodium percentage and LSD: Least significant difference.

were obtained when the soil was untreated of tillage (control) and the lowest when the disc plough was used in both seasons. When using the soil tillage system by disc plough, the increasing percentage were 33.76 and 32.10% in plant height, 29.91 and 28.95% in 100 grain weight, 63.41 and 62.5% in grain yield, 86.90 and 76.92% in WUE, 56.33 and 56.50% in roots dry weight, 32.83 and 33.62% in grains protein, 36.19 and 32.27% in soil moisture content and 43.35 and 44.85% in soil porosity compared to no tillage soil (control) in both seasons, respectively. In the other hand, the percentage of decrease in soil bulk density was 21.31 and 25.00%, soil pH was 19.05 and 18.19%, soil penetration resistance was 47.55 and 49.75%, and ESP was 38.12 and 40.92% as compared to the control treatment (without tillage) in both seasons, respectively.

The comparative study on tillage system found that disc plough resulted in higher maize yield than the others in alkaline soil; this is due to improving physical seedbed properties and effective role in breaking down soil layers to improve soil bulk density (Abdel-Maksoud et al., 2018). The system of disc plough can improve soil physical properties (Muhsin, 2017). Sadiq et al. (2007) reported that the grain yield of maize increased with the intensity of tillage by disc plough as a result of improved soil properties such as, rise of moisture content and porosity and decrease of bulk density, pH, soil penetration resistance and ESP, which leads to breakdown of soil compaction, increases pore spaces, management of water resources, facilitate drainage and decrease water retention in the root zone and enhance macro pore flow to regulate leaching of agricultural chemical and salts. Appropriate tillage systems can be used to increase the rate of infiltration to improve soil water storage, change porosity and tortuosity to influence soil – water evaporation and improve soil structure through tillage techniques, which can also increase irrigation efficiency in alkaline soil (Araya et al., 2010). In support of these results, Khurshid et al. (2006) indicated that the process of tillage in a way that is appropriate to the type of soil that can contribute about 30% of yield. In addition, applying different tillage systems led to a decrease in the growth of weeds growing with maize by 80% compared to no tillage (Adigun, 2019). Similar results of tillage systems and their effect on the yield and its components of maize in alkalin soil have been reported by Rusinamhodzi et al. (2011), Shahid et al. (2016), Muhammad et al. (2018) and Shahid et al. (2022).

2. Types of Organic Fertilizers (TOF)

Data in Table (5) demonstrate that the different types of organic fertilizers caused a significant increase in all studied parameters of maize plants in both seasons. The highest values of studied parameters were obtained with sheep fertilizer compared with control treatment (without organic fertilizers). Regarding soil properties such as bulk density, pH, soil penetration resistance and ESP, the highest values could be obtained by control treatment

Table (5). Effect of organic fertilizers types on maize (*Zea mays* L.) productivity during 2021 and 2022 growing seasons under alkaline soils conditions at New Valley.

Measurements	Plant							Soil					
TOF \ Char.	Plant height (cm)	100 Grain weight (g)	Grain yield (ton ha.$^{-1}$)	WUE (kg m^{-3})	Root dry weight (g plant^{-1})	Protein %	Oil %	Bulk density (mg m^{-3})	Moisture content %	Porosity %	pH	Soil penetration resistance (kPa)	ESP %
2021													
Control	151	16.30	4.126	0.95	8.79	8.34	4.52	1.46	15.36	38.67	9.71	1023	18.68
Poultry fert.	207	21.01	6.329	1.30	11.72	10.82	5.94	1.31	20.52	47.30	8.34	869	14.21
Sheep fert.	221	22.16	6.624	1.52	12.24	11.06	5.73	1.20	21.47	49.21	7.95	852	12.84
Compost, VC	198	20.44	6.026	0.93	11.06	10.23	5.31	1.37	18.36	43.64	9.02	955	15.39
LSD at 5%	8	0.64	0.214	0.17	0.47	0.22	0.20	0.06	0.94	1.52	0.37	25	1.05
2022													
Control	155	16.62	4.140	0.98	8.90	8.41	4.60	1.44	15.42	39.12	9.66	1009	18.16
Poultry fert.	213	21.52	6.418	1.39	11.96	10.87	6.04	1.30	21.06	48.41	8.31	855	14.02
Sheep fert.	227	22.88	6.701	1.60	12.61	11.22	5.86	1.18	22.00	50.14	7.88	831	12.33
Compost, VC	205	20.71	6.166	0.98	11.21	10.37	5.48	1.35	19.30	44.52	8.93	967	15.20
LSD at 5%	7	0.77	0.221	0.19	0.60	0.31	0.16	0.05	1.02	1.44	0.40	21	1.09

TOF: Types of organic fertilizers, Fert.: Fertilizers, VC: Vegetable compost, WUE: Water use efficiency, ESP %: Exchangeable sodium percentage and LSD: Least significant difference.

(without organic fertilizers) and the lowest when sheep manure was used in both seasons. On the other hand, the highest values for each of the moisture content and porosity of the soil were obtained when using sheep fertilizer and the lowest when using the control treatment (without organic fertilizers) in both seasons.

The increasing percentages of maize yield components and some soil traits attributed with using the sheep fertilizer as compared with control treatment were 45.36 and 46.45 for plant height, 35.95 and 37.66 for 100 grain weight, 60.56 and 61.85 for grain yield, 60.00 and 63.27 for WUE, 39.25 and 41.69 for root dry weight, 32.61 and 33.41 for protein, 39.78 and 42.67 for moisture content and 27.26 and 28.17 for soil porosity in both seasons, respectivily. On the other hand, the percentage decrease due to the use of sheep fertilizer in bulk density were 21.67 and 22.03, pH were 22.14 and 22.59, soil penetration resistance were 20.07 and 21.41 and ESP were 45.96 and 47.28 as compared with control in both seasons, respectivily.

The increase in the values of these traits under this study resulting from the application of sheep fertilizer may be due to that sheep fertilizer when incorporated with soil can retain large quantities of water and nutrients which were released slowly as required by the plant to improve growth under alkaline soil condition. This may also be due to developments like root growth, root length and root volume. Results also showed that the use of sheep fertilizer had a positive effect on the natural and chemical properties of the soil, as it led to an increase in the moisture content of the soil and increased its porosity to a degree that was superior to other types of organic fertilizers. It also led to the reduction of both the bulk density of the soil, soil penetration resistance and ESP, which led to the improvement of the productivity of maize under alkaline soil conditions. Finally, the reclamation of alkaline soil with organic fertilizers can increase soil nutrient content, soil macroaggregates and organic matter content, increase soil microbial richness and improve soil structure, and reduce the soil bulk density, salinity, pH and then promote crop growth and increase crop yield. Similar results of organic fertilizers and their effect on maize yield and properties of alkaline soil have been reported by Komakech et al. (2015), Mahmood et al. (2017), Sekumade (2017), Joseph et al. (2020), Manasa et al. (2020), Chang et al. (2022), Chen et al. (2022) and Zhang et al. (2022).

3. Effect of The Interaction Between Tillage Soil Systems and Types of Organic Fertilizers

Data presented in Table (6 a and b) show that the effect of interaction between tillage soil systems and types of organic fertilizers on yield of maize and soil properties under alkaline soil conditions were significant. The interaction disc plough X sheep fertilizer (as organic source of nitrogen) had

Table (6 a). Effect of the interaction between tillage soil systems and types of organic fertilizers on maize (*Zea mays* L.) productivity during 2021 growing season under alkaline soils conditions at New Valley.

Measurements		Plant							Soil					
TSS x TOF	Char.	Plant height (cm)	100 Grain weight (g)	Grain yield (ton ha.$^{-1}$)	WUE (kg m^{-3})	Root dry weight (g plant^{-1})	Protein %	Oil %	Bulk density (mg m^{-3})	Moisture content %	Porosity %	pH	Soil penetration resistance (kPa)	ESP %
TSS	**TOF**	2021												
Control	**Control**	154	16.83	4.166	0.80	8.74	8.18	4.57	1.47	14.70	25.46	9.64	1089	18.00
	PF	182	19.18	5.267	1.07	10.20	9.42	5.28	1.40	17.28	29.04	8.95	1012	15.77
	SF	189	19.76	5.415	1.18	10.46	9.54	5.17	1.34	18.75	28.52	8.76	998	14.93
	VC	178	18.90	5.116	0.89	9.87	9.12	4.96	1.43	16.70	27.46	9.29	1055	16.36
Chisel plough	**Control**	171	17.89	5.279	1.04	10.06	8.86	4.81	1.43	15.99	29.78	9.41	990	16.94
	PF	199	20.24	6.381	1.32	11.52	10.10	5.52	1.36	19. 04	33.36	8.72	913	14.70
	SF	206	20.82	6.528	1.43	11.78	10.22	5.41	1.30	19.57	32.84	8.53	899	13.87
	VC	194	19.96	6.229	1.13	11.19	9.81	5.20	1.39	17.99	31.78	9.06	956	15.29
Disc plough	**Control**	181	19.42	5.499	1.16	11.18	9.49	5.14	1.34	17.42	33.39	8.97	904	15.61
	PF	209	21.78	6.600	1.44	12.65	10.73	5.85	1.27	20.00	36.97	8.29	827	13.38
	SF	216	22.35	6.748	1.55	12.91	10.85	5.75	1.21	21.47	36.44	8.09	814	12.54
	VC	204	21.49	6.449	1.25	12.32	10.44	5.54	1.30	19.42	35.39	8.63	870	13.97
Moldboard plough	**Control**	176	18.25	5.387	1.09	10.84	9.37	5.03	1.40	16.36	31.97	9.33	920	16.25
	PF	204	20.60	6.489	1.36	12.31	10.61	5.74	1.32	19.41	35.55	8.64	843	14.01
	SF	211	21.18	6.636	1.47	12.57	10.73	5.64	1.27	19.94	35.02	8.45	829	13.18
	VC	200	20.32	6.337	1.18	11.98	10.32	5.43	1.35	18.36	33.97	8.98	886	14.60
LSD at 5%		4	0. 13	0.046	0.03	0.07	0.10	0.07	0.03	0.36	0.11	0.09	9	0.41

TSS: Tillage soil systems, TOF: types of organic fertilizers, PF: Poultry fertilizer, SF: Sheep fertilizer, VC: Vegetable compost, WUE: Water use efficiency, ESP %: Exchangeable sodium percentage and LSD: Least significant difference.

Table (6 b). Effect of the interaction between tillage soil systems and types of organic fertilizers on maize (*Zea mays,* L.) productivity during 2022 growing season under alkaline soils conditions at New Valley.

Measurements		Plant							Soil					
TSS x TOF	Char.	Plant height (cm)	100 Grain weight (g)	Grain yield (ton ha.$^{-1}$)	WUE (kg m^{-3})	Root dry weight (g plant^{-1})	Protein %	Oil %	Bulk density (mg m^{-3})	Moisture content %	Porosity %	pH	Soil penetration resistance (kPa)	ESP %
TSS	**TOF**	2022												
Control	**Control**	159	17.24	4.199	0.85	8.88	8.28	4.65	1.47	15.32	38.03	9.67	1105	17.66
	PF	188	19.69	5.338	1.15	10.41	9.51	5.37	1.40	18.37	42.68	9.00	1028	15.59
	SF	195	20.37	5.480	1.26	10.73	9.69	5.28	1.34	18.84	43.54	8.78	1016	14.74
	VC	184	19.29	5.212	0.95	10.03	9.26	5.09	1.43	17.49	40.73	9.31	1084	16.18
Chisel plough	**Control**	175	18.28	5.332	1.08	10.28	8.94	4.91	1.43	16.41	42.72	9.46	990	16.56
	PF	204	20.73	6.471	1.39	11.81	10.17	5.63	1.36	19.46	47.36	8.78	913	14.49
	SF	211	21.41	6.612	1.49	12.14	10.34	5.54	1.30	19.93	48.23	8.57	901	13.65
	VC	200	20.32	6.345	1.18	11.44	9.92	5.35	1.38	18.58	45.42	9.09	969	15.08
Disc plough	**Control**	185	19.83	5.531	1.20	11.36	9.65	5.23	1.32	17.85	46.19	9.03	906	15.17
	PF	214	22.28	6.670	1.50	12.89	10.88	5.95	1.25	20.40	50.83	8.35	829	13.10
	SF	221	22.96	6.812	1.61	13.21	11.06	5.86	1.19	21.87	51.70	8.14	817	12.25
	VC	210	21.87	6.544	1.30	12.51	10.63	5.67	1.28	20.02	48.89	8.66	885	13.69
Moldboard plough	**Control**	180	18.69	5.425	1.13	10.92	9.52	5.10	1.40	16.89	44.61	9.35	916	15.96
	PF	209	21.14	6.564	1.44	12.45	10.75	5.82	1.33	19.44	49.25	8.67	839	13.89
	SF	216	21.82	6.706	1.54	12.77	10.93	5.73	1.27	20.91	50.12	8.46	827	13.05
	VC	205	20.73	6.438	1.23	12.07	10.50	5.54	1.35	19.06	47.31	8.98	895	14.48
LSD at 5%		5	0.11	0.050	0.02	0.06	0.06	0.04	0.02	0.21	0.55	0.14	7	0.32

TSS: Tillage soil systems, TOF: types of organic fertilizers, PF: Poultry fertilizer, SF: Sheep fertilizer, VC: Vegetable compost, WUE: Water use efficiency, ESP %: Exchangeable sodium percentage and LSD: Least significant difference.

superiority in all studied characters compared to other interactions except grains content of oil, which was higher at disc plough X poultry fertilizer. These results are in harmony with those obtained by Shafique et al. (2011) and Javeed et al. (2023).

CONCLUSION

All studied parameters of maize were significantly affected by tillage systems and organic fertilizers sources in both the growing seasons of 2021 and 2022. The highest values were obtained when the alkaline soil was treated with a disc plough and when adding organic fertilizers in the form of sheep fertilizer, as the grain yield increased by 61.59 and 62.23% in the first and second seasons, respectively.

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تأثير نظم الحرث والأسمدة العضوية على إنتاجية الذرة الشامية بالأراضي القلوية

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أجريت التجارب الحقلية على التربة القلوية بالمحطة البحثية التابعة لمركز بحوث الصحراء بواحة الخارجة، محافظة الوادي الجديد، جنوب غرب مصر خلال موسمي ٢٠٢١ و٢٠٢٢ لدراسة تأثير بعض أنواع المحاريث كنظم حراثة وبعض مصادر الأسمدة العضوية على محصول الذرة الشامية وبعض خصائص التربة القلوية. أشارت النتائج إلى أن جميع الصفات المدروسة تأثرت معنويًا بأنظمة الحراثة ومصادر الأسمدة العضوية في كلا الموسمين. تم الحصول على أعلى القيم عند حرث التربة بالمحراث القرصي وإضافة السماد العضوي في صورة سماد مخلفات الأغنام مما أدى إلى زيادة محصول الحبوب بنسبة ٦١.٥٩ و٦٢.٢٣٪ في الموسمين الأول والثاني على التوالي.