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EFFECT OF FARMING METHODS AND ORGANIC MANURES ON CALCAREOUS SOIL PROPERTIES AND CROP PRODUCTIVITY

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ABSTRACT: *A field experiment was conducted on a calcareous sandy loam soil at El-Nubaria Agricultural Research Station, El- Behera Governorate using as a test wheat "Triticum spp." CV and broad bean "Vicia faba"CV plants during two seasons of 2007/2008 and 2008 / 2009 to study the effect of two organic manures namely rice straw compost and chicken manure as organic amendments and farming methods which were in row and strew on soil properties and yield of wheat and broad bean.*

The obtained results indicated that, EC values (dS/m^{-1}) and pH values of the studied soil were decreased as a result of using rice straw compost and chicken manure. $CaCO_3$ content (%) was decreased where OM content (%) was increased by using organic manures compared to control treatment. Also, the obtained results indicated that applying rice straw compost had a slight effect on each of soil bulk density and total porosity values as compared to chicken manure and control. The soil structure parameters, i.e., wet stable aggregates (W.S.A. %), aggregation state (A.S.), aggregation degree (A.D.) and aggregation index (A.I.) as well as soil hydraulic conductivity (HC) and moisture contents at both field capacity and available water are increased by using rice straw compost as compared to chicken manure and without manures. Rice straw compost applications gave a highest yield of wheat and broad bean plants. Generally, it is concluded that the different soil properties and crop yield of wheat and broad bean plants grown on calcareous soil are greatly affected by the row cultivation method and the rice straw compost addition compared with other treatments under study.

Key words: *Agricultural method, Calcareous soil, Organic manures, Wheat and broad bean.*

INTRODUCTION

Egypt faces a noticed reduction in fertile cultivated soils in the old Nile Valley and Delta, which represent about 3 - 4% of the total area of Egypt. So, an attention was direct towards to the desert soils, either those characterized calcareous in nature, reclamation and cultivation. The fertility status of these soils are poor, in turn, application of bio-fertilization by using micro-organisms to improve it through their activities and providing most of the

essential nutrients required to plant growth and crop productivity. Organic fertilizers as (chicken manure at 3 ton/fed. with compost at 10 ton /fed) gave almost the same crop production of using the recommended dose of mineral fertilizers as reported by Taalab (1999). Yield of wheat and corn were increased in all manuring treatments (cotton stalks compost, rice straw compost and FYM).Generally, rice straw compost was the best organic manure followed by cotton stalks and FYM enriched with rock phosphate under the conditions of sandy soil was showed by Ali (2001). Medina *et al.* (2004) indicated that, the use of organic amendments to improve symbiotic development is of great importance for legume growth in poor and decertified soils. Illmer *et al.* (2007) showed that, organic matter content, the biomass and height of test plants pointed distinctly to better and faster degradation within the samples treated with compost compared to the untreated samples. Abd El-Moez *et al.* (2002) found that, application of composted materials to the saline calcareous soil decreased both EC and pH values. Abd El-Moez and Saleh (1999) and Abd El-Moez *et al.* (1995) found that, the organic materials have a different effect in modifications of the physical and chemical properties of soil as well as their influence on their nutrition status and soil fertility. Compost reduced soil BD, while increasing water-stable aggregates (Cox *et al.* 2001). Negm *et al.* (2004) compared between sawdust compost (4 and 8 ton/fed) and farmyard manure (FYM). They showed that, there were real increases in soil- water relationships with manuring such as TP, WHC, FC and AW in stead of decreasing in BD. The rate of 8 ton/fed of compost was as the same effect as FYM on TP, WHC and BD. These variables showed better correlations with macro aggregates than other soil parameters. Thus, it is suggested that, the organic matter addition due to residue retention along with tillage reduction accelerates the formation of macro aggregates through an increase in the microbial biomass content in soil, (Kushwaha *et al.* 2001).

MATERIALS AND METHODS

A field experiment was conducted on a calcareous sandy loam soil at El-Nubaria Agricultural Research Station during two successive seasons (2007/2008 and 2008/2009). This experiment included the following treatments:

A) The cultivation methods which were row and strew methods.
B) Organic manures which were used as rice straw compost and chicken manure.
C) Plant type: Wheat crop (*Triticum aestivum L., var.* Giza 168) and broad bean (*Vicia faba L., var.* Egypt 1) were used as a test plants.

Two main plots representing method of agriculture treatments. Each main plot contains 6 subplots (3 replicates *2 method of cultivation). Each subplot contains 9 sub-subplots (3 replicates *3 organic manure).The sub-subplot area was 10.5 m^2 (3.5*3 m). Plots replicated three times in Split Split design.

Organic amendments application rates were based on the total N content of the materials and followed the recommendations for mineral fertilization of wheat and bean plants in new reclaimed soils of Egypt as follows: Broad bean was fertilized by ammonium nitrate (33.5 % N) applied at a rate of 15 kg N / fed as soil application in three batches after 15, 30 and 45 days from planting. Ordinary super phosphate (15 % P_2O_5) was applied at rate of 22.5 Kg P_2O_5 / fed. Potassium sulfates (48.5 % K_2O) were applied at rate of 24 Kg K_2O/fed. Phosphate and organic manures were added to the soil before planting, while potassium fertilization was carried out after 25 days from planting. Wheat was fertilized by ammonium nitrate (33.5 % N) applied at a rate of 75 Kg N / fed which added to soil in three batches after 15, 30 and 45 days from planting. Ordinary super phosphate (15 % P_2O_5) was applied at rate of 15 Kg P_2O_5 / fed. Potassium sulfates (48.5 % K_2O) were applied at rate of 24.25 Kg K_2O/fed. Phosphate and organic manures were added to the soil before planting, while potassium fertilization was applied after 25 days from planting.

Soil Sampling:

Before planting surface soil sample (0-30) was taken from experimental field, air-dried, ground, sieved through a 2 mm sieve and analyzed for some physical and chemical properties as recorded in Table (1).

Table (1). Some chemical and physical properties of the studied soil.

Property and unit	Particle size distribution			Soil texture	O.M	$CaCO_3$	EC	pH (1:2.5) (Soil: water sus.)	B.D	R.D	T.P
	Sand %	Silt %	Clay %		%	%	(dSm^{-1})		(g/cm^3)	(g/cm^3)	%
Value	68.91	16.57	14.52	Sandy loam	0.87	18.40	11.33	8.15	1.32	2.22	40.54

Undisturbed and disturbed soil samples were collected from the surface layers (0-30) for all plots after harvest for two seasons. The soil samples were air- dried and analyzed for some physical and chemical characteristics, i.e., soil pH, organic matter and total calcium carbonate according to the methods described by Page *et al.* (1982). The total soluble salts (EC) was determined by using electrical conductivity meter at 25 ° C in soil paste extract as dSm^{-1} (Jackson, 1973). Particle size distribution was carried out by the pipette method described by Gee and Bauder (1986) using sodium hexameta-phosphate as a dispersing agent. Soil bulk density was determined using the undisturbed soil column according to Richards (1954). Real density was determined using kerosene as displacing liquid, as described by Abd El-Aal (1971). Stability of dry aggregates was determined according to the method

of Richards (1954). Stability of water stable aggregates was determined using the wet sieving technique described by Yoder (1936) and modified by Ibrahim (1964). Mean weight diameter was estimated using the values of both dry and water stable aggregates and calculated according to Yonker and McGuiness (1956), then Δ M.W.D was estimated by the difference between mean weight diameters of dry and wet sieving. Also, aggregates state, aggregation degree and aggregation index were calculated according to Richards (1954). Hydraulic conductivity was determined using the undisturbed soil samples according to the method of Richards (1954). Total soil porosity was calculated as percentage from the obtained values of soil real and bulk densities (Richards, 1954). Wilting point was determined according to Stakman and Vanderhast (1962), while field capacity was determined as described by Richards (1954).

Organic manures:

Properties of manures used in this experiment were determined and the obtained data were recorded in Table (2). Manures moisture content was determined by drying at 70 C° for 48h., pH was measured in (1:10) manure-water suspension using electrode pH meter and electrical conductivity (dSm^{-1}) was measured using electrical conductivity bridge, in 1:5 manure - water extraction outlined electrical conductivity according to Jackson (1973). Manures bulk density (BD) and water holding capacity (WHC) were determined according to Klute (1986). Manures content of organic carbon was determined using the method of Walkely and Black (1934).Also, manures content of total nitrogen (%)was determined according to the method as described by Page (1982).

Table (2): Main properties of the organic manures used in this experiment.

Organic materials	EC (1:5) (Soil: water extr.)	pH (1:2.5) (Soil: water sus.)	Bulk density (g/m^3)	Water holding capacity %	O.C %	Total N %	C/N ratio
Rice straw Compost	4.99	7.30	0.32	120	18.83	1.39	13.56
Chicken manure	1.81	6.19	0.55	104	20.76	2.11	9.84

Statistical Analysis:-

The data from this study were statistically analyzed through analysis of variance (ANOVA) and least significant difference (LSD) at 0.05 probability level to make comparison among treatment means according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION:

General view on the experimental soil:-

The experimental soil sites are shown in Table (1) which indicate that, calcareous soil is characterized by medium textural grade (sandy loam), with a relatively high $CaCO_3$ (18.40%). Soil pH value tends to be alkaline side for the studied soil. EC value is 11.33 dS/m^{-1} and tends to be salinity.

Chemical Properties:-

The presented data in Table (3) showed that, EC (dS/m^{-1}) and pH values of the studied soil samples were decreased as a result of using rice straw compost and chicken manure. These results were similar to the findings concluded by Abd El-Moez *et al.* (2002). The contents of $CaCO_3$ were decreased and ranged between 5.00 to 8.20 %. On the other hand, the contents of OM were increased by using rice straw compost compared to chicken manure and without manure treatments.

Table (3). Some chemical properties of the studied soil as affected by the studied treatments (Average of two seasons).

Organic manure	Wheat									
	Row					Strew				
	pH (1:2.5)	EC (dS/m^{-1})	O.M %	$CaCO_3$ %	SP %	pH (1:2.5)	EC (dS/m^{-1})	O.M (%)	$CaCO_3$ %	SP %
Control	7.64	7.61	1.05	7.70	100	7.76	7.83	1.05	5.1	95
Rice straw compost	7.03	4.26	1.92	5.00	92	7.06	5.49	1.40	4.5	90
Chicken manure	7.11	5.14	1.35	6.10	90	7.27	6.71	1.22	4.0	95
	Broad bean									
Control	7.51	7.70	1.13	8.20	90	7.65	7.42	1.10	4.50	100
Rice straw compost	7.06	4.02	1.98	5.80	90	7.14	5.02	1.87	4.70	95
Chicken manure	7.20	5.03	1.67	6.80	95	7.25	6.36	1.77	4.50	100

Physical Properties:-

Soil densities and total porosity:-

Data presented in Table (4) indicated that, the values of soil bulk density under using rice straw compost and chicken manure were relatively lower than those of control. This probably due to the favorable effect of organic matter content on soil structure which was reflected on soil bulk density. This result stand in accordance with Cox *et al.* (2001). It is obvious that, the decreased of soil bulk density associated the treatment of rice straw compost was higher than associated the treatment of chicken manure.

The presented data in Table (4) indicated that, real density was not clearly influenced by organic fertilization. This result can be elucidated to that real density is a special characterizing property of soil because it is related to the nature of parent material which is one of the major soil formation factors. These results were similar to the findings of Aziz *et al.* (1990) and Heggy *et al.* (1999).

As a general pattern, data of total soil porosity was closely followed the opposite trend of soil bulk density regarding the effect of all studied factors, where the lower soil bulk density, the higher total soil porosity was observed. Total soil porosity of rice straw compost and chicken manure treatments were relatively higher than that of control as shown in Table (4). At the same time, the obtained increase in the total porosity associated the treatments of rice straw compost was higher than associated the treatments of chicken manure with different application rates under study. These findings may be attributed to the enhanced effect of organic manuring in soil aggregates formation, which in turn decreased soil bulk density as mentioned above and consequently improves total soil porosity.

Table (4): Soil bulk and real densities, total porosity and hydraulic conductivity (cm^3/h) of the studied soil as affected by the studied treatments (Average of two seasons).

Organic fertilizer	Wheat							
	Row				Strew			
	Bulk density (g/cm^3)	Real density (g/cm^3)	Total porosity (%)	H.C (cm^3/h)	Bulk density (g/cm^3)	Real density (g/cm^3)	Total porosity (%)	H.C (cm^3/h)
Control	1.29	2.35	45.11	0.90	1.20	2.30	47.80	0.90
Rice straw compost	1.23	2.34	47.44	1.23	1.15	2.29	49.78	1.22
Chicken manure	1.25	2.33	46.35	1.12	1.18	2.28	48.25	1.09
	Broad bean							
Control	1.30	2.26	42.48	1.0	1.22	2.28	46.49	0.91
Rice straw compost	1.22	2.27	46.26	1.21	1.19	2.31	48.48	1.23
Chicken manure	1.25	2.28	45.18	1.11	1.21	2.32	47.85	1.15

*HC = Hydraulic conductivity.

Similar results were obtained by Kushwaha *et al.* (2001) and Negm *et al.* (2004).

Soil hydraulic conductivity (HC):-

Data recorded in Table (4) indicated that, the values of soil hydraulic conductivity were increased as a result of rice straw compost and chicken manure applications. The values of soil hydraulic conductivity of the plots received rice straw compost were higher than those of chicken manure and control under the row method.

Moisture constants:-

Field capacity, wilting point and the calculated available water are considered the main soil moisture constants. Field capacity highly increased with added rice straw compost under the row method as compared to the found increase with chicken manure under strew method and control, (Table, 5). Similar results were obtained by Negm et al. (2004).Increased capacity for water retention as a result of adding organic matter is a clear indication of its positive effect in modifying porosity and physical conditions of soil. Application of rice straw compost under the row method increased available water values as compared to chicken manure under strews method and control.

Table (5):- Soil moisture constants (%) of the studied soil as affected by the studied treatments (Average of two seasons).

Organic manure	Wheat					
	Row			Strew		
	F.C %	W.P %	A.W %	F.C %	W.P %	A.W %
Control	38.11	22.11	16.00	40.01	24.99	15.02
Rice straw compost	39.95	21.01	18.94	39.99	22.00	17.99
Chicken manure	36.67	20.20	18.47	42.98	25.05	17.93
	Broad bean					
Control	40.11	24.00	18.11	39.00	21.99	17.01
Rice straw compost	44.45	26.19	18.26	40.21	22.99	17.22
Chicken manure	39.99	20.00	19.99	42.99	24.98	18.01

*FC = Field capacity W.P = Wilting point
A.W = Available water

Dry soil aggregates (D.S.A. %):-

The data of dry sieving stable aggregates as recorded in Table (6) reveals that, the D.S. A (%) which having diameters from 10 to 2 mm were found to be the largest size presented in the different manuring treatments, while the percentages of other sizes of D.S. A (%) decrease as their diameters decrease, especially the aggregates those have diameters less than 0.063 mm which the lowest values were found, (Cox *et al;* 2001). Dry aggregates of large fraction were high relatively in the treatments of rice straw compost under the row method compared to that found with chicken manure treatments under straw method and control, respectively. The positive and favorable effect of compost on soil physical properties is a manifestation of the influence of organic matter in creating soil structure favorable for plant growth.

Table (6): Dry sieving stable aggregates (%) of the studied soil as affected by the studied treatments (Average of two seasons).

Organic manure	Wheat													
	Row							Strew						
	10-2	2 - 1	1 - 0.50	0.50-0.25	0.25-0.125	0.125-0.063	<0.063	10-2	2 - 1	1 - 0.50	0.50-0.25	0.25-0.125	0.125-0.063	<0.063
Control	46.80	10.38	10.89	9.30	14.82	7.51	0.30	36.41	12.69	12.39	18.40	11.87	7.89	0.35
Rice straw compost	32.50	9.85	11.17	13.24	15.63	15.38	2.23	58.23	8.89	9.29	7.68	8.71	7.00	0.20
Chicken manure	29.79	12.51	12.60	13.43	23.67	7.56	0.44	33.30	13.55	15.16	18.11	11.19	8.38	0.31
	Broad bean													
Control	40.46	8.40	10.61	13.97	17.46	8.74	0.36	49.63	9.76	10.44	9.56	9.77	10.23	0.61
Rice straw compost	47.48	10.43	10.93	10.55	14.60	5.35	0.66	38.82	12.00	12.72	11.36	11.87	12.05	1.18
Chicken manure	47.50	11.63	11.08	9.37	14.32	5.85	0.25	40.30	13.61	12.24	11.76	12.63	9.16	0.30

Wet sieving stable aggregates (W.S.A):-

Data in Table (7) revealed that, the values of W.S.A of rice straw compost were higher than those in the treatments of chicken manure and control. Data also revealed that, the row method gave lower values of W.S.A than those in the strew method.

The beneficial effect of organic matter resulted from the permanent application of rice straw compost and chicken manure which cause the improvement of soil aggregation. These findings are coincided with those of Haynes and Naidu (1998). The effectiveness of various binding agents at different stages in the structural organization diameter; consequently, macro aggregation is controlled by soil management (i.e. crop rotations), as management influences the growth of plant roots, and the oxidation of organic carbon. The water-stability of micro-aggregates depends on the persistent organic binding agents and appears to be a characteristic of the soil, independent of management as reported by Tisdall (2006).

Structure parameters:-

Data of soil structure parameters, i. e., aggregation state (A.S.), aggregation degree (A.D.), aggregation index (A.I.) and differences in mean weigh diameter (Δ M.W.D) are shown in Table (8). Data revealed that, there is no obvious trend for soil structure parameters with different treatments under study.

Biological, Gain and Strew Yields:-

The crop was harvested at physiological maturity and yields recorded in Table (9) which revealed that, the plant grown under the row method gave higher yield than that under strew method one. The row method proved more efficient for wheat and broad bean than strew method and rice straw compost proved more efficient for wheat and broad bean grain yield (kg/fed), Biological yield and straw yield associated the treatments of rice straw compost was higher than that with treatments of chicken manure .

Table (7): Water stable aggregates (%) of the studied soil as affected by the studied treatments (Average of two seasons).

Organic manure	Wheat													
	Row							Strew						
	10-2	2 - 1	1 - 0.50	0.50-0.25	0.25-0.125	0.125-0.063	Total	10-2	2 - 1	1 - 0.50	0.50-0.25	0.25-0.125	0.125-0.063	Total
Control	8.71	5.58	8.13	7.82	6.82	7.22	44.28	13.08	7.86	9.12	6.75	6.28	1.53	44.62
Rice straw compost	3.12	6.21	8.71	10.09	18.95	7.93	55.01	38.14	6.13	5.12	2.00	1.99	0.65	54.03
Chicken manure	3.22	4.46	8.40	15.43	8.46	9.51	49.48	6.91	8.81	9.34	24.21	3.75	1.47	54.49
	Broad bean													
Control	4.73	4.78	7.22	9.76	9.89	7.57	43.95	25.92	8.57	7.29	13.79	1.54	0.35	57.46
Rice straw compost	11.80	8.17	10.59	9.02	5.14	2.59	47.31	16.78	11.27	10.04	6.65	3.71	1.89	50.34
Chicken manure	6.04	7.90	10.74	10.80	9.81	0.99	46.28	12.04	10.17	9.88	13.16	1.44	3.15	49.84

Table (8): Structure parameters, i. e, aggregation state (A. S), aggregation degree (A.D), aggregation index (A.I) and differences in mean weight diameter (Δ M.W.D) of the studied soil as affected by the studied treatments (Average of two seasons).

Organic manure	Wheat							
	Row				Strew			
	A.S	A.D	A.I	Δ M.W.D	A.S	A.D	A.I	Δ M.W.D
Control	39.3	33.17	0.70	2.41	43.95	50.97	0.54	2.25
Rice straw compost	50.0	55.11	0.52	1.86	44.31	34.19	0.95	2.12
Chicken manure	44.7	45.23	0.51	1.77	46.28	48.57	0.73	2.58
	Broad bean							
Control	44.62	43.32	0.94	1.56	46.41	58.18	0.88	2.34
Rice straw compost	46.03	50.51	0.61	2.61	42.83	36.70	0.75	1.90
Chicken manure	54.43	59.76	0.84	1.69	44.85	38.46	0.89	1.93

Table (9): Wheat and Broad bean biological, straw and grain yields (kg/fed) as affected by the studied treatments (Average of two seasons).

Organic manure	Wheat yield (Kg\fed)								
	Biological yield			Straw yield			Seed or grain yield		
	Agriculture methods		Mean	Agriculture methods		Mean	Agriculture methods		Mean
	Row	Strew		Row	Strew		Row	Strew	
Control	2115	2016	2066	1774	1838	1806	341.6	177.8	259.7
Rice straw compost	3367	3031	3199	2639	2303	2471	728.0	728.0	728.0
Chicken manure	3490	3403	3448	2624	2467	2545	866.6	938.0	319.2
Mean	2991	2817	2904	2346	2203	2274	645.4	614.6	280.4
L.S.D at 0.05	A=12.43 O=15.22 A*O=21.53			A=18.61 O=22.79 A*O=32.24			A=10.76 O=13.18 A*O=18.64		
	Broad bean (Kg\fed)								
Control	986	930	958	797	773	785	198.0	156.8	172.9
Rice straw compost	1754	1687	1721	1464	1429	1447	289.8	257.6	273.7
Chicken manure	2188	2172	2157	1826	1804	1817	362.6	319.2	340.9
Mean	1643	1581	1612	1362	1336	1349	280.4	244.5	262.5
L.S.D at 0.05	A=5.36 O=6.56 A*O=ns			A=9.39 O=11.51 A*O=ns			A=7.79	O=9.54	A*O=ns

Conclusion:-

Row cultivation method with rice straw compost resulted in pronounced increase in the yield of wheat and broad bean plants than either strew cultivation method with chicken manure or control .The row method with rice straw compost proved more efficient for wheat and broad bean grain, biological and straw yields than chicken manure and control under strew method.

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تأثير طرق الزراعة و الأسمدة العضوية على خواص الأرض الجيرية وانتاجية المحاصيل

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الملخص العربي

اجريت تجربة حقلية على تربة جيرية بمحطة البحوث الزراعية بالنوبارية – محافظة البحيرة و تم زراعة نباتات القمح (صنف جيزة ١٦٨) و الفول البلدى صنف مصرية ١) والتى تتميز بأنها نباتات اختيارية خلال موسمين زراعيين و متتاليين هما ٢٠٠٧ –٢٠٠٨، ٢٠٠٨– ٢٠٠٩ وذلك لدراسة تأثير استخدام نوعين من التسميد العضوى وهما الكمبوست ومخلفات الدجاج كمصلح عضوي وكذلك الزراعة بطريقتين هما الزراعة على خطوط والزراعة فى نقر على ارض بلاط على كل من خواص التربة ومحصول القمح و الفول البلدى.

أشارت النتائج ان الملوحة و قيم pH قد انخفضت فى حالة اضافة الكمبوست وكذلك الزراعة على خطوط بالمقارنة بمخلفات الدجاج و طريقة النقر, و انخفض المحتوى من كربونات الكالسيوم و كان هناك زيادة واضحة فى المادة العضوية فى حالة اضافة الكمبوست مع الزراعة على خطوط بالمقارنة بمخلفات الدجاج مع الزراعة النقر.

أشارت النتائج أيضا علي تحسين خواص التربه الطبيعيه(الكثافة الظاهرية والمسامية الكلية) في حاله استخدام التسميد العضوى الكمبوست اكثرمن مخلفات الدجاج عند الزراعة باستخدام طريقة الخطوط اكثر من النقر فى كل من الفول والقمح . أما عن معايير البناء والتى تشمل التجمعات الثابتة فى الماء و حالة التجمع و درجة التجمع و كذلك قيم التوصيل الهيدروليكى و ثوابت الرطوبة عند كل من السعة الحقلية و المحتوى من الماء الميسر قد ازدادت جميعها مع اضافة الكمبوست مقارنة بمعاملات مخلفات الدجاج أو الغير معاملة. وكذلك وجد ان طريقة الزراعة على هيئة السطور مع اضافة الكمبوست أعطى أعلى محصول ثم يلية طريقة النقر مع اضافة مخلفات الدجاج. وبصفة عامة توصى الدراسة باستخدام الكمبوست فى التسميد و الزراعة فى خطوط حيث يقلل من ملوحة التربة و يعمل على تحسين خواص التربه الطبيعيه و الكيميائية وزيادة المحصول مقارنة بالمعاملات الأخرى تحت الدراسة.