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EFFECT OF CROP RESIDUES FILLED MOLES ON SOME PROPERTIES AND PRODUCTIVITY OF SOILS

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ABSTRACT

This field investigation was undertaken to evaluate the effect of crop residues on some soil properties as well as the productivity of crops, and to get rid of crop residues causative the black cloud covered the sky of Egypt. The experiment was conducted at El-Gemmeiza Agricultural Research Station, El-Gharbia Governorate, during three successive growing seasons from 2005 to 2007. Cultivated crops comprised wheat, rice, and onion in a consecutive sequence. El-Gemmeiza soil is silty clay loam in texture with low content of $CaCO_3$ (less than 4 %). The organic matter ranges between 2.41 and 1.86 %, the soil pH between 7.85 and 7.91 and the EC between 5.26 and 5.83 dSm^{-1} . Cotton stalks, rice straw, and corn stalks as a complete structure (without grinding) were placed in moles 30 and 60 cm deep, arranged in parallel orientations with respect to one another and spaced at 3, 5, and 7 m apart. The moles were constructed by a special ditcher.

The obtained results could be summarized as follows :-

1- The rate of fuel consumption increased 19.51 % by increasing mole depth, and the power consumption reached to 51.54 kW, as the mole depth increased to 60 cm. The slip ratio also increased reaching maximum values 6.22 and 11.53 % at operating forward speed of 3.92 Km/h for the mole depths of 30 and 60 cm, respectively.

2- The crop residues and all mole treatments slightly decrease the soil pH and progressive decreased soil salinity (EC).

3- The residues enhanced the nutrient status of the soil either macro or micronutrients and increased organic carbon and the C/N ratio of the surface and subsurface soil.

4- The yield and yield components positively responded to the added residues. Increases in the wheat grains and straw ranged between 11.44 and 40.77 % and between 8.67 and 37.03 %, respectively. The rice grain increases ranged between 7.42 and 37.98 % over the control (untreated soil). The highest yield of onion reached 20.900 ton/fed.

5- According to the economic evaluation, the 60 cm mole depth with corn stalks at 3m spacing was the most valuable compared to other treatments since the highest net revenue was obtained by this treatment.

Therefore, it is concluded that crop residues in moles could markedly improve the soil properties as well as its nutrients status, which reflect on higher crop yields incorporated with high net revenue.

Keywords : Crop residues, cotton stalks, rice straw, corn stalks, mole depth and space, fuel and power consumption.

INTRODUCTION

Application of organic materials on agricultural land has received considerable attention in recent years because they are considered as organic fertilizer and soil conditioners and because of the cost and environmental problems associated with alternative disposal methods (Warman, 1986).

The fast development of agriculture in Egypt lead to an enormous increase in the amount of fertilizers used. However, in recent years there has been growing concern about the adverse effects of excessive inorganic or chemical fertilization on the human and animal health and environments.

There are 7.5 million feddans under cultivation in Egypt would require 170 million tons of farmyard manure annually, much more than is available, other sources of organic matter must be identified and exploited. Also, the organic matter content in Egyptian soils gradually decreased and in order to increase it, the use of different sources of organic residues became necessary (El-Maddah ,2000).

In Egypt, Hamdi and Alaa El-Din (1982) stated that about 11 MT of agricultural residues per year are produced by different crops. Most of these residues are rice and wheat straws and cotton, maize and sorghum stalks. The utilization of these residues at present is largely for burning, industry or as animal feed. Little is composted as organic manure. Also, it is beneficial to use organic materials on a large scale in agriculture especially with the recent rises in prices of the chemical fertilizers which have affected the agricultural production throughout the world and had a violent impact on Egypt.

Recently, the world trend goes toward using the agricultural nature materials to minimize the pollution which affect the environment and public health and improve soil physical, chemical and biological properties.

The addition of organic materials such as, crop residues to soil plays an important role in the recycling of nutrients (IAEA, 2003). Plant residues are essential for maintaining soil productivity acting as a source of nutrients (Kumar and Goh, 2000).

In respect to the effect of organic materials which play an important role in availability of macro and micronutrients through its active groups fulvic and humic acids which have the ability to retain such metals in complex and chelate form.

The organic acids are produced during the decomposition of organic matter in soils, influence the pH and consequently increased the availability of macro and micronutrients for plant.

Abou-El-Soud *et al.* (1996) reported that installation of sandy moles at 2, 4 and 6m spacings decreased ECe values by 40.5, 41.1 and 33% respectively comparing to the control.

Kaloosh *et al.* (1989) found that addition of organic materials having wide C/N ratio such as cotton stalks and garbage favored N-immobilization and decreased the concentration of the mineral nitrogen. While, adding organic materials having narrow C/N ratio such as faba bean straw and orange residues favored mineralization and increased the concentration of the mineral nitrogen. Janssen (1996) reported that N-mineralization of organic products strongly depends on the decomposability and the C/N ratio of organic matter in the product. Phongpan and Mosier (2002) indicated that combined use of organic residues (rice straw) with urea did not decrease total N losses or increase crop yield, uptake of N compared to urea alone. El-Sherbieny et al. (2004) showed that the organic C and C/N ratio decreased with time up to 10 weeks period of incubation at the rate of 50 and 100 mg N Kg^{-1} soil added as plant residues, but N content increased at any given time until the end of incubation.

From the horticultural point of view, the yield of any plant is the most important target for any plantation. The role of various organic materials has been associated with significant increases in the plant growth which reflect on the yield and its components. Dunker *et al.* (1995) recorded that crop yields of maize (Zea maize) and soybean (Glycine max) were significantly increased with increasing tillage depth. El-Abaseri *et al.* (1996) found that most mole treatments at 2, 4 and 6 m spacing, obviously increased the relative yield for clover, rice and clover in the first, second and third seasons, respectively. El-Fayoumy *et al.* (2000) observed that grains and straw yield and 1000-seed weight of wheat and maize increased with increasing the rate of organic matter.

The aim of this work is to evaluate the effect and residual effect of using crop residues (cotton stalks, rice straw and corn stalks) as a complete structure (without grinding) placed in moles at 30 and 60 cm depths arranged in parallel orientations with respect to one anothers at 3, 5 and 7 m spacing on some soil properties and the productivity of crops and to get rid of crop residues especially rice straw causative the black cloud covered the sky of Egypt.

MATERIALS AND METHODS

Field experiments were conducted at El-Gemmeiza Agricultural Research Station, El-Gharbia Governorate, during three consecutive growing seasons from 2005 to 2007. Cultivated crops comprised wheat, rice and onion in consecutive sequence. Cotton stalks, rice straw and corn stalks as a complete structure (without grinding) were placed in moles 30 and 60cm deep arranged in parallel orientations with respect to one anothers and spaced at 3, 5 and 7m apart as well as the control (untreated soil) to evaluate the effect and residual effects of these treatment on improving some soil properties and productivity of crops as well as to get rid of crop residues causative the black cloud covered the sky of Egypt. Soil properties of the experimental soil are presented in Table (1a) and analysis results of the used organic residues are shown in Table (1b).

Water table of the studied soil is shallow (80cm from the soil surface) causing lower hydraulic conductivity and permeability raising the values of EC which ranged between 5.26 and 5.83 dSm^{-1} in saturated paste extract with pH between 7.85 and 7.91 in 1 : 2.5 soil water suspension.

The plot area of the experiment was 300 m^2 (15 m in width and 20 m in length) with three replicates where the area of the experiment was divided into 54 plots using a randomized complete block design. The used organic plant residues are : cotton stalks, rice straw and corn stalks. The rates of plant residues were 140, 84 and 60 m^3/fed. at 30 cm depth, while at 60 cm depth were 350, 210 and 150 m^3/fed. at 3, 5 and 7 m spacings, respectively.

These residues were added into the moles before sowing, and covered with depth by soil.

The moles were constructed at 30 and 60 cm depths by ditcher. To carry out this moles, the following equipments were used, a 90 kW tractor (120.0 hp) model Ford-Tw10 was used to perform mole treatments. The technical specifications of the used ditcher are shown in Fig. (1).

Slippage percentage (S%) was calculated by using the following formula :-

$$S\ \% = \frac{L_1 - L_2}{L_2} \times 100$$

where : L_1 = the advance per 10 wheel revolutions under no load, m.

L_2 = the advance per 10 wheel revolutions under load, m.

Fuel consumption was determined by measuring the volume of fuel required refilling the tank after operation time per each treatment. The rate of fuel consumption was calculated using the following formula:

$$Fuel\ consumption = \frac{Amount\ of\ fuel\ consumption, L}{Time, h}, L/h$$

Table (1a) : Some physical and chemical properties of the used soil.

Properties	Values	
Soil depth, cm	0 - 30	30 - 60
pH, 1:2.5 (susp.)	7.85	7.91
EC, dSm^{-1}	5.26	5.83
Soluble cations, meq l^{-1}		
Ca^{2+}	12.17	13.11
Mg^{2+}	13.48	14.25
Na^{+}	26.58	30.60
K^{+}	0.37	0.34
Soluble anions, meq l^{-1}		
CO_3^{2-}	0.00	0.00
HCO^{3-}	5.43	6.32
Cl^{-}	32.92	35.57
SO_4^{2-}	14.25	16.41
Particle size distribution		
Sand, %	14.32	16.54
Silt, %	48.58	43.95
Clay, %	37.10	39.51
Texture class	* Si.C.L	* Si.C.L
Bulk density (Db, g cm^{-3})	1.32	1.37
Total porosity (E), %	50.19	48.30
Void ratio (e)	1.01	0.93
Hydraulic conductivity (Kh, cm h^{-1})	0.52	0.46
$CaCO_3$, %	3.35	3.21
Organic matter (O.M, %)	2.41	1.86
Organic carbon (O.C, %)	1.40	1.08
Total nitrogen (T.N, %)	0.136	0.114
C/N ratio	10.29	9.47
Available N, ppm	31.27	28.15
Available P, ppm	11.45	8.79
Available K, ppm	353.00	348.00

*** Si.C.L = Silty clay loam**

Table (1b) : Some characteristics of the different used organic residues.

Organic residues	Θw, %	Ash, %	O.M, %	O.C, %	Total N, %	C/N ratio
Cotton stalks	8.84	13.29	75.87	44.01	0.478	92
Rice straw	9.00	17.79	73.21	42.46	0.482	88
Corn stalks	7.08	14.42	77.51	44.96	1.096	41

The power requirement (Er) was calculated using the following equation (Embaby, 1985)

$$Er = (Fc \times \frac{1}{3600}) \times \rho_r \times L.c.v. \times 427 \times \eta_{th} \times \eta_m \times \frac{1}{75} \times \frac{1}{1.36} \quad , kW$$

where : Fc = Fuel consumption rate, L/h

ρ_r = Density of the fuel Kg/l (for solar fuel= 0.85 Kg/l)

L.c.v.= Lower calorific value of fuel K cal/kg; (average L.c.v. of solar fuel is 10000 K cal/kg).

427 = Therme-Mechanical equivalent, Kg m/K cal.

η_{th} = Thermal efficiency of the engine (considered to be about 40 % for diesel engine).

η_m = The mechanical efficiency of the engine (considered to be about 80 % for diesel engine).

The experimental field was treated after adding the residues and prior to planting and the recommended agricultural processes were practiced. Also, an activated dose of nitrogen fertilizer (12 Kg of ammonium nitrate/ton of crop residues) was added before sowing by about one month to correct C/N ratio of the added residues.

Wheat seeds (Sakha 69 variety) were planted in the first season (winter 2005/2006) at the rate of 60 Kg/fed. during the third week of November, rice seeds (Sakha 101 variety) were planted in the second season (summer 2006) at the rate of 60 Kg/fed. where sown in a nursery, after 30 days seedlings were transplanted in June 2006, and onion seeds (Behairy red) were planted in the third season (winter 2006/2007), sowing in the nursery during October 2006 and transplanting at December 2006.

During the three seasons, the basal doses of N, P and K were applied according to the recommendations for each crop, the other usual agricultural practices were carried out as usual for each crop according to the recommendations of El-Gemmeiza Research Station.

At harvesting time of each crop, total yield of wheat, rice and onion for each plot was separately harvested, weighed and related to ton/fed., also wheat and rice straw ton/fed. were weighed. The yield relative to control was computed for each treatment as follow: (yield of the treatment - yield of the control)/(yield of the control) X100. Also, 1000 wheat or rice seed weight were determined for each treatment. Ten random plants per plot were sampled at the harvest of each crop to determine the following growth characters.

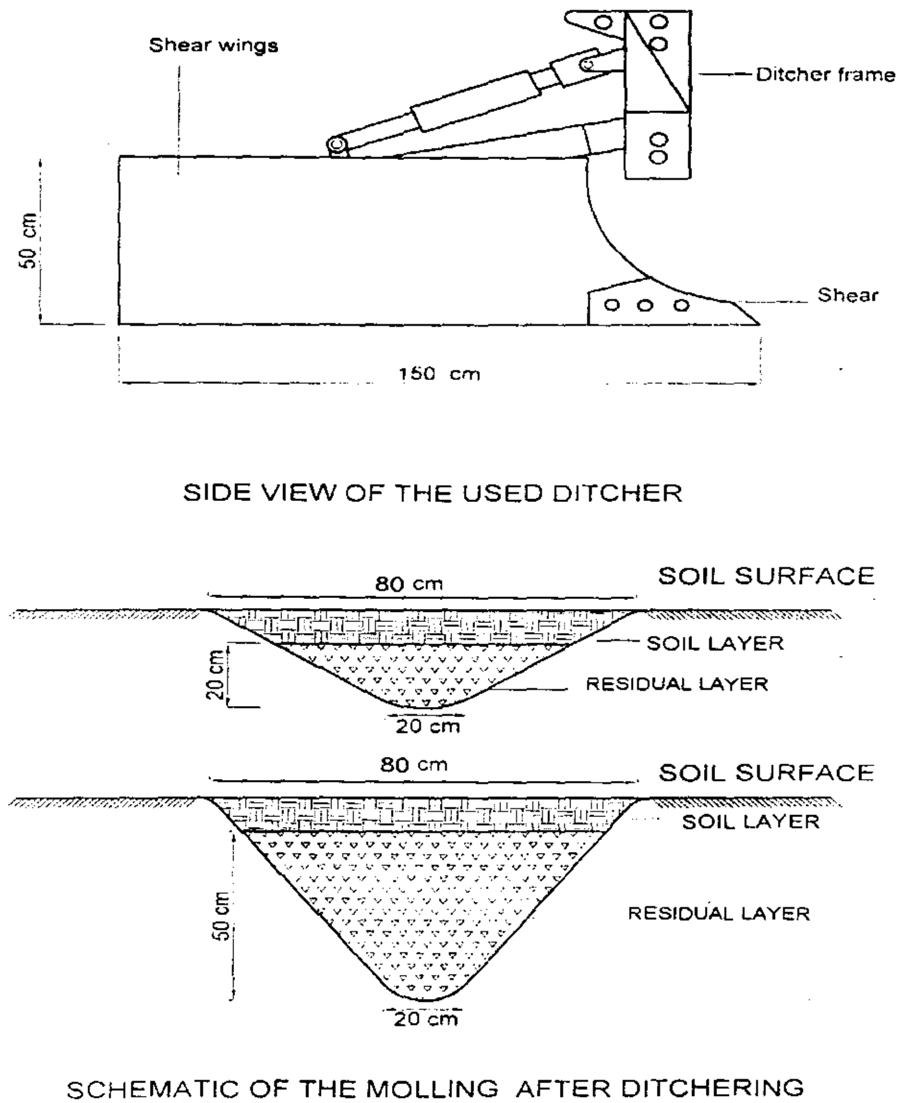

Fig. (1)

a- Wheat growth characters.
1- Plant height, cm 2- Spike length, cm
3- Dry matter after 90 days of sowing, g/10 plants
b- Rice growth characters.
1- Plant height, cm 2- Spike length, cm
c- Onion growth characters.
1- Plant height, cm 2- Average bulb weight, g
3- Marketable and culls yields, ton/fed.

After harvesting of each growing season, soil samples (0-30 and 30-60 cm depths) were collected from each plot. The collected soil samples were air-dried, ground in a ceramic mortar and passed through 2 mm sieve and stored for chemical analysis. Soil chemical analysis were done according to the standard methods reported by Black (1965), Hesse (1971) and Page *et al.* (1982).

Soil pH in soil water suspension (1:2.5) and Soil electrical conductivity (EC, dSm^{-1}) in soil paste extract were measured. Organic matter was determined by Walkely and Black method according to Black (1965).

Total NPK of the two soil depths (0-30 and 30-60 cm) were determined according to Hesse (1971). Nitrogen by macro-Kjeldahel method, phosphorus by ascorbic acid molybdenum blue method and potassium by flame photometer method.

The concentrations of micronutrients (Fe, Mn, Zn and Cu) of soil were determined by DTPA-method as described by Lindsay and Norvell (1978) measured by an Atomic Absorption Spectrophotometer (AAS).

The collected data were statistically analyzed according to procedure out lined by Snedecor and Cochran (1981). The mean values were compared at 0.05 level using L.S.D.

Economic evaluation was done to compare between different treatments to state which one is more valuable. The test was executed according to the price of the yield (1100 L.E./ton grain of wheat and 250 L.E./ton straw of wheat in the first season and 1100 L.E./ton seeds of rice in the second one and 600 L.E./ton of marketable and 60 L.E./ton of culls onion in the third season) as well as the cost of different treatments including the price of moles construction and the price of labor they added residues, which was calculated considering conventional method of estimating both fixed and variable costs.

Total per fed. cost was calculated by multiplying the hourly cost by the actual time required by the machine to cover one feddan.

RESULTS AND DISCUSSION

I- Evaluation of power requirements and slip performances:

Data presented in Figs. (2 to 4) show that the rate of fuel consumption increased 19.51% by increasing mole depth from 30 to 60cm. This may be due to soil draft. Also, it is clear that power requirements increased by increasing mole depth, where it increased from 43.28 to 51.54 kW by increasing mole depth from 30 to 60cm. As for the slip ratio, it is clear that it tended to increase for all mole spaces and increasing mole depths. The maximum values were 6.22 and 44.53% at operating forward speed of 3.92 Km/h for 30 and 60cm mole depth, respectively.

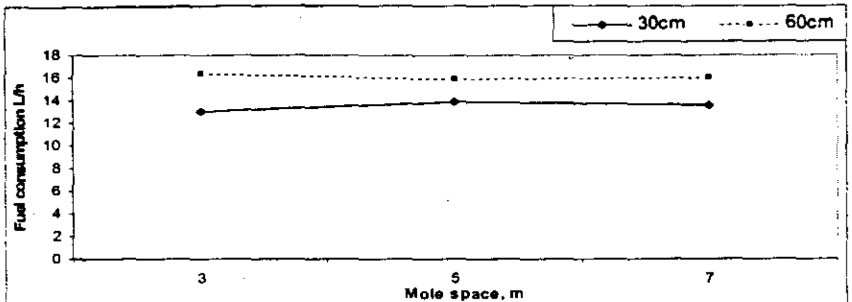

Fig. (2): Effect of different treatments on fuel consumption

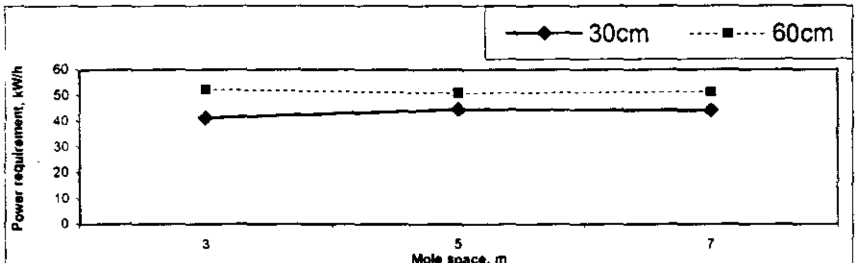

Fig. (3): Effect of different treatments on power requirement

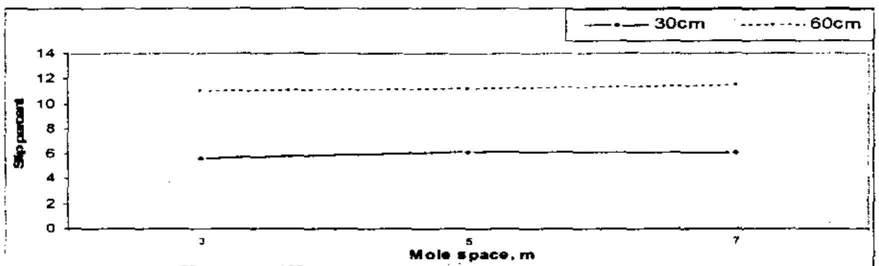

Fig. (4): Effect of different treatments on slip percent

II- Effect of different treatments on some soil chemical properties:

1- Soil reaction (pH) and soil salinity (EC)

Results in Tables (2 to 4) show that all mole treatments and kinds of crop residues lead to a favorable decrease in soil reaction (pH) of the two sequence soil depths (0-30 and 30-60 cm) at the end of the three seasons comparing to the control (untreated soil). By increasing mole depth the soil pH decrease, where the 60 cm mole depth slightly decrease it more than the 30 cm, with the exception of the first season.

On the other hand it is obvious that organic residues kinds also affect soil pH where the corn stalks treatment was more effective on decreasing soil pH of the two sequence soil depths at the end of the first season, while rice straw and corn stalks treatments were equale in their effects at the end of the second season. As for the third season the cotton stalks was the more effective where it recorded the lowest values of pH in both the two sequence soil depths.

The effect of different mole spacing on decreasing soil pH during the three seasons at the two soil depths can be arranged in the following descending order : 3m > 5m >7m > the control.

Concerning the combined effect of different treatments on soil pH, it could be observed that all different treatments decrease soil pH comparing to the control. The best treatment was found to be 60 cm mole depth with corn stalks at 3m spacing during the first and the second seasons and was 60 cm mole depth with cotton stalks at 3 m spacing during the third season, since it recorded the lowest values of soil pH 7.61 and 7.64, respectively for the two layer depths in the first season and 7.50 and 7.55, respectively in the second one and 7.37 and 7.41, respectively in the third season. While the control gave the highest values 7.85 and 7.91, respectively in the first season and 7.76 and 7.87, respectively in the second one and 7.68 and 7.78, respectively in the third season at the two layer depths.

These results reveal that there is no wide variation between the different treatments on soil pH values. Similar results were obtained by Chen and Avnimelech (1986), they reported that the magnitude of pH change depends on many soil properties, including buffering capacity and length of time after the application plant residues.

Concerning the effect of different treatments on soil salinity (EC), mean values indicate that all these treatments induced progressive decrease in soil salinity comparing to the control, as a results of the decomposition of the organic plant residues and mole treatments. The mole treatments in this study differed in their effects on electrical conductivity of soil paste extract dSm^{-1} (EC) with the different crops. From data in Tables (2 to 4) and Fig. (5) it could be concluded that a significant reduction in electrical conductivity (EC) can be obtained by increasing mole depth from 30 to 60 cm and by increasing the number of mole drains per unit area. This reduction may be due to the fact that the mole drains allow water percolated and down ward moved taking with high amount of soluble salts. It can be noticed also that the effect of mole treatments on reducing (EC) was more pronounced after cultivation of onion plants in the third season (winter 2006/2007) which enhancing the leaching processes. Thus, it could be arranged the mean values of (EC) in the following order : the first season > the second one > the third season. These results are in harmony with those obtained by El-Sabry *et al.* (1992), Abo El-Soud *et al.* (1996), El-Maddah and El-Sodany (2003) and El-Sodany et al. (2007).

Regarding to the effect of plant residues kinds on decreasing (EC) values, data in Tables (2 to 4) show that all kinds of residues decreased the values of (EC), where corn stalks treatment recorded the lowest values of (EC) followed by rice straw and cotton stalks treatments in both first and second seasons. The cotton stalks treatment has the lowest values followed by rice straw and later corn stalks treatments in the third season. These results may be due to the rate of residues additions and the rate of its decompositions.

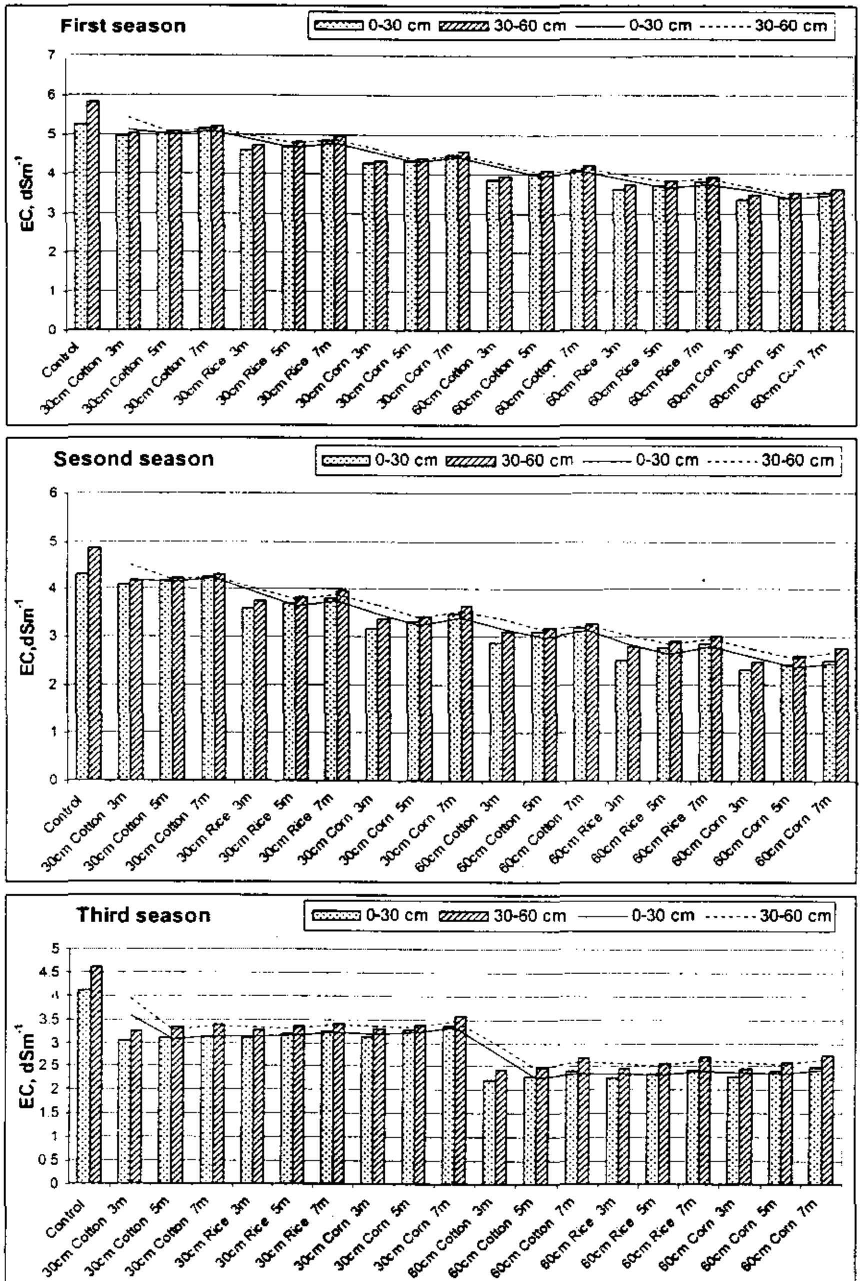

Fig. (5): Effect of different treatments on soil salinity (EC, dSm^{-1})in the three seasons

The effect of mole spacing on decreasing (EC) values during the three seasons can be arranged in the following descending order : 3m > 5m > 7m. This trend is somewhat appropriate with the infiltration characteristic results, since the higher basic infiltration rate, the lower is the (EC) values. These results are consistent with El-Sabry *et al.* (1992).

Regarding the combined effect of different treatments on (EC), it could be observed that all different treatments decreased the mean values comparing to the control at the two layer depths in the three seasons. The best treatment was found to be 60 cm mole depth with corn stalks at 3m spacing in both first and second seasons since it recorded the lowest values of (EC) 3.35, 3.47 and 2.32, 2.48 dSm^{-1} respectively for the two soil depths, while the same treatment with cotton stalks was the best one in the third season where the lowest values were 2.21 and 2.42 dSm^{-1} respectively at the same depths.

2- Soil macronutrients:

Tables (2 to 4) indicate that soil total N, P and K values were increased with all mole treatments and all kinds of the added residues for the two sequence soil depths (0-30 and 30-60 cm) at the end of the three seasons compared with the control (untreated soil). With increasing mole depth from 30 to 60 cm total N increased from 0.152 % to 0.157 % and from 0.128 to 0.164 % respectively for the two soil depths in the first season, also from 0.155 to 0.160 % and from 0.130 to 0.168 % respectively for the same depths in the second one, while it increased from 0.157 to 0.162 % and from 0.132 to 0.170 % respectively for the same depths in the third season. Phosphorus take the same trend as nitrogen where it increased by increasing mole depth from 30 to 60 cm. The mean values were increased from 0.029 to 0.035 % and from 0.027 to 0.034 % respectively for the two soil depths in the first season, and from 0.033 to 0.034 % and from 0.035 to 0.037 % respectively for the same depths in the second one. While it increased from 0.034 to 0.036 % and from 0.027 to 0.038 % respectively for the same depths in the third season. Potassium take also the same trend where the values were increased by increasing mole depth from 30 to 60 cm. The values were increased from 0.488 and 0.477 % to 0.556 and 0.549 % respectively for the two soil depths in the first season, and from 0.554 and 0.545 % to 0.566 and 0.575 % respectively for the same depths in the second one. While it increased from 0.566 and 0.552 % to 0.583 and 0.594 % for the same depths in the third season.

Regarding to the residues kinds, data in Tables (2 to 4) show that all added residues kinds significantly increased the values of total macronutrients (NPK) at the two layer depths in the three growing seasons. The best treatment was corn stalks in the first and second seasons where the increases were 21.32, 35.09 % and 95.00, 116.67 % and 58.38, 59.89 % respectively for NPK at the two layer depths in the first seasons over the control (untreated soil) and 20.14, 35.35 % and 90.90, 115.00 % and 67.54 and 71.58 % respectively for the same macronutrients at the same depths in the second one. Thus the residues can be arranged in the following order : corn stalks > rice straw > cotton stalks. In the third season, the best residues was cotton stalks where the increases were 20.57, 33.61 % and 91.30, 76.19

% and 54.16, 56.17 % respectively over the control for NPK at the same depths. Also, the residues can be arranged in the following order : cotton stalks > rice straw > corn stalks.

Concerning the mole spacing, data show that by decreasing the distance between the moles, the values of macronutrients were increased where the 3 m spacings increased it by 15.44, 30.70 % and 65.00, 77.78 % and 43.78, 45.68 % respectively for NPK at the two layer depths in the first season, and by 14.39, 30.17 and 59.09, 90.00 % and 50.00, 53.35 % for the same NPK at the same depths in the second one, while it increased by 14.18, 29.41 % and 60.87, 61.90 % and 39.43, 41.40 % for NPK at the same depths in the third season over the control.

As for the combined effects, data show that the 60 cm mole depth with corn stalks at 3 m spacing was the best treatment in the first and second seasons since it gave the highest values of each NPK where the values were 0.170, 0.177 % and 0.042, 0.043 % and 0.653, 0.644 % for NPK in the first season and were 0.172, 0.178 % and 0.045, 0.046 % and 0.664, 0.667 % for NPK in the second one. In the third season, the best treatment was the 60 cm mole depth with cotton stalks at 3m spacing since it recorded the highest values of NPK in this season. While the control (untreated soil) recorded the lowest values of NPK at the two depths during the three growing seasons.

These results suggest that it may practical apply organic plant residues with constructed different moles to soils to increase NPK concentrations in the soils and thereby enhance its availability to crops.

3- Organic carbon (O.C.) and C/N ratio of the soil.

Data in Tables (2 to 4) show that all applied treatments including all mole treatments and all kinds of residues led to an increase in O.C.% of the two layer depths (0-30 and 30-60 cm) at the end of the three growing seasons compared with the control (untreated soil). By increasing mole depth, the O.C. % high significantly increased, where the 60 cm mole depth gave the highest values of O.C. % especially in sub surface layer (30-60 cm), where the increases were 194.29, 304.63 % and 147.52, 244.04 % and 107.75, 182.88 %, respectively for the two soil layers at the end of the three growing seasons compared with the control. While 30 cm mole depth take the same trend but with lowest values, especially in sub surface layer which had the lowest values. This may be due to the addition rate of plant residues in 60 cm mole depth equal 2.5 once of 30 cm mole depth as mentioned before.

Regarding to the plant residue kinds, data in Tables (2 to 4) show that all added residues high significantly increased O.C. % in the soil at the two soil depths at the end of the three sequence seasons. Cotton stalks had the highest values of O.C. % at the two layer depths in the three growing seasons, where the values were 5.34 and 3.81 % in the first season and 4.61 and 3.36 % in the second one, also they were 3.69 and 2.86 % in the third season, respectively for the previous parameter. Thus the residues can be arranged in the following order : cotton stalks > rice straw > corn stalks. Thus the decomposition of the added plant residues will be decreased O.C. % values and increased total N % values. Similar results were obtained by Biswas and Khosla (1971) and Kladivok and Nelson (1979), they reported that the application of organic amendments to soil increase the carbon content of the soil, and El-Sodany *et al.* (2007).

Concerning the mole spacings, data show that by decreasing the distance between moles the values of O.C, % were increased where the 3 m spacings gave the highest values. The mean values were 4.06 and 3.08 % at the two soil depths in the first season and 3.43 and 2.72 % for the same depths in the second one, while they were 2.92 and 2.40 % at the same depths in the third season. Thus the effect of mole spacings on increasing O.C. % values during the three seasons can be arranged in the descending order : 3m > 5m > 7m.

Regarding the combined effect of different treatments on O.C. %, it could be noticed that all treatments increased the mean values comparing to the control at the two layer depths in the three seasons. The best treatment was found to be 60 cm mole depth with corn stalks at 7 m spacing in the three growing seasons since it recorded the lowest values of O.C. % 2.36, 1.34 % and 1.92, 1.33 % and 1.72, 1.32 % respectively for the two soil depths. These results may be due to the addition rate of plant residues in this treatment is lower and its decomposition is higher than the other treatments. These results are in agreement with El-Sodany *et al.* (2007).

C/N ratio of the soil is one of the useful characters which can be used as an indicator for improving physical and hydrophysical properties of the soil, where the application of the used residues to soil increase the carbon content of the soil, which decreases bulk density, increases aggregation and hydraulic conductivity (Biswas and Khosla, 1971, El-Maddah, 2000 and El-Maddah and Badr, 2005).

Results in Tables (2 to 4) and Fig. (6) reveal that the C/N ratio was increased for all mole treatments and all applied residues plants in the surface and sub surface layers of the soil compared with the control. While C/N ratio were decreased in the third season than the second and the first one, where the decomposition of organic residues in the third season was greater than its decomposition in the second and first seasons. Similar results were obtained by Chanyasak and Kubota (1981), they reported that the C/N ratio of sufficiently well composted materials vary widely from 5–20 depending on the type of raw materials.

Results shown also that increasing mole depth led to significant increases in C/N ratio especially in sub surface layer of the soil where 60 cm mole depth was increased C/N ratio by 154.03 and 185.64% in the first season and by 116.17 and 139.68 % in the second one and by 75.27 and 95.93 % in the third season for the two soil layers over the control (untreated soil). Thus sub surface layer had the highest values of C/N ratio, this may be due to the addition rate in 60 cm mole depth is higher than 30 cm mole depth as explained before.

Table (2): Effect of different treatments on some soil chemical properties in the first season (winter 2005/2006)

Mole depth, cm	Residual kind	Mole space, m	pH, 1:2.5 (susp.)		EC, dSm^{-1}		Total macronutrients, %						Organic carbon, %		C / N ratio	
							N		P		K					
			0-30 cm	30-60 cm	0-30 cm	30-60 cm	0-30 cm	30-60 cm	0-30 cm	30-60 cm	0-30 cm	30-60 cm	0-30 cm	30-60 cm	0-30 cm	30-60 cm
30	Cotton stalks	3	7.76	7.82	4.97	5.05	0.144	0.123	0.024	0.023	0.463	0.454	5.18	1.73	35.97	14.07
		5	7.77	7.84	5.04	5.11	0.142	0.120	0.023	0.022	0.458	0.447	4.98	1.64	35.07	13.67
		7	7.79	7.85	5.15	5.22	0.140	0.118	0.022	0.020	0.447	0.438	4.82	1.59	34.43	13.48
	Rice straw	3	7.68	7.72	4.61	4.75	0.154	0.131	0.028	0.026	0.492	0.485	3.83	1.56	24.87	11.91
		5	7.69	7.73	4.72	4.83	0.153	0.128	0.026	0.025	0.483	0.476	3.63	1.51	23.73	11.80
		7	7.71	7.75	4.85	4.97	0.151	0.126	0.025	0.024	0.469	0.462	3.49	1.46	23.11	11.59
	Corn stalks	3	7.64	7.68	4.27	4.35	0.165	0.137	0.039	0.037	0.537	0.525	2.80	1.42	16.97	10.36
		5	7.65	7.70	4.35	4.41	0.162	0.135	0.037	0.035	0.523	0.510	2.66	1.38	16.42	10.22
		7	7.67	7.71	4.50	4.59	0.160	0.132	0.036	0.034	0.516	0.496	2.59	1.34	16.19	10.15
60	Cotton stalks	3	7.81	7.87	3.87	3.95	0.150	0.158	0.031	0.032	0.470	0.465	5.97	6.35	39.80	40.19
		5	7.82	7.88	4.02	4.11	0.147	0.155	0.030	0.031	0.460	0.454	5.65	5.90	38.30	38.06
		7	7.83	7.90	4.11	4.21	0.145	0.151	0.029	0.030	0.450	0.445	5.44	5.65	37.52	37.42
	Rice straw	3	7.72	7.77	3.61	3.75	0.159	0.167	0.035	0.029	0.574	0.565	4.10	4.37	25.79	26.17
		5	7.73	7.79	3.70	3.84	0.157	0.164	0.033	0.028	0.561	0.553	3.97	4.24	25.29	25.85
		7	7.74	7.80	3.81	3.92	0.155	0.162	0.032	0.027	0.552	0.545	3.90	4.14	25.19	25.56
	Corn stalks	3	7.61	7.64	3.35	3.47	0.170	0.177	0.042	0.043	0.653	0.644	2.50	3.04	14.71	17.18
		5	7.62	7.65	3.42	3.52	0.168	0.173	0.041	0.042	0.646	0.637	2.43	2.92	14.46	16.88
		7	7.63	7.66	3.54	3.63	0.166	0.170	0.041	0.041	0.639	0.630	2.36	2.74	14.22	16.12
Control			7.85	7.91	5.26	5.83	0.136	0.114	0.020	0.018	0.370	0.359	1.40	1.08	10.29	9.47
A Mole depth, cm	30		7.71	7.76	4.72	4.81	0.152	0.128	0.029	0.027	0.488	0.477	3.78	1.51	25.20	11.92
	60		7.72	7.77	3.71	3.82	0.157	0.164	0.035	0.034	0.556	0.549	4.04	4.37	26.14	27.05
	F		5.77^{NS}	28.44*	696.73*	556.49*	6.35^{NS}	881.28*	4.38^{NS}	5.86^{NS}	464.82*	980.42*	48.14*	305.99*	1.8^{NS}	252.89*
	LSD_{05}			0.01	0.16	0.18		0.005			0.013	0.009	0.16	0.70		4.09
B Residual kind	Cotton stalks		7.80	7.86	4.53	4.61	0.145	0.138	0.027	0.026	0.458	0.451	5.34	3.81	36.85	26.15
	Rice straw		7.71	7.76	4.22	4.34	0.155	0.146	0.030	0.027	0.522	0.514	3.82	2.88	24.66	18.81
	Corn stalks		7.64	7.67	3.91	4.00	0.165	0.154	0.039	0.039	0.586	0.574	2.56	2.14	15.49	13.49
	F		67.41*	160.64*	18.03*	241.02*	313.74*	73.88*	33.41*	12.92*	312.18*	277.37*	237.48*	77.88*	307.37*	73.29*
	LSD_{05}		0.03	0.02	0.24	0.06	0.002	0.003	0.004	0.007	0.012	0.012	0.29	0.31	1.99	2.42
C Mole space, m	3		7.70	7.75	4.11	4.22	0.157	0.149	0.033	0.032	0.532	0.523	4.06	3.08	26.35	19.98
	5		7.71	7.77	4.21	4.30	0.155	0.146	0.032	0.031	0.522	0.513	3.89	2.93	25.54	19.41
	7		7.73	7.78	4.33	4.42	0.153	0.143	0.031	0.029	0.512	0.503	3.77	2.82	25.11	19.05
	F		6.04*	4.79*	3.98*	23.59*	2.24^{NS}	6.16*	1.36^{NS}	1.20^{NS}	10.66*	10.75*	2.18^{NS}	5.21*	0.72^{NS}	1.50^{NS}
	LSD_{05}		0.01	0.02	0.16	0.06		0.003			0.009	0.009		0.17		

Table (3): Effect of different treatments on some soil chemical properties in the second season (summer 2006)

Mole depth, cm	Residual kind	Mole space, m	pH, 1:2.5 (susp.)		EC, dSm^{-1}		Total macronutrients, %						Organic carbon, %		C / N ratio	
							N		P		K					
			0-30 cm	30-60 cm	0-30 cm	30-60 cm	0-30 cm	30-60 cm	0-30 cm	30-60 cm	0-30 cm	30-60 cm	0-30 cm	30-60 cm	0-30 cm	30-60 cm
30	Cotton stalks	3	7.67	7.77	4.08	4.17	0.147	0.124	0.029	0.030	0.511	0.503	4.57	1.74	31.09	14.03
		5	7.68	7.79	4.18	4.23	0.145	0.121	0.027	0.029	0.492	0.483	4.42	1.67	30.48	13.80
		7	7.70	7.81	4.25	4.29	0.144	0.120	0.026	0.027	0.486	0.471	4.26	1.61	29.58	13.42
	Rice straw	3	7.54	7.61	3.59	3.74	0.157	0.133	0.032	0.035	0.552	0.543	3.21	1.57	20.45	11.80
		5	7.56	7.63	3.68	3.82	0.155	0.130	0.031	0.034	0.541	0.532	3.11	1.52	20.06	11.69
		7	7.58	7.66	3.79	3.95	0.154	0.128	0.030	0.033	0.528	0.519	3.05	1.48	19.81	11.56
	Corn stalks	3	7.63	7.71	3.17	3.38	0.167	0.139	0.041	0.044	0.638	0.631	2.22	1.41	13.29	10.14
		5	7.65	7.74	3.32	3.42	0.164	0.138	0.040	0.042	0.623	0.619	2.12	1.35	12.93	9.78
		7	7.66	7.76	3.47	3.65	0.162	0.137	0.038	0.040	0.611	0.607	2.07	1.33	12.78	9.71
60	Cotton stalks	3	7.71	7.82	2.86	3.10	0.153	0.163	0.025	0.032	0.478	0.486	4.93	5.18	32.22	31.78
		5	7.73	7.84	3.10	3.19	0.150	0.161	0.024	0.031	0.463	0.475	4.78	5.03	31.87	31.24
		7	7.75	7.86	3.18	3.27	0.148	0.159	0.023	0.030	0.451	0.465	4.68	4.90	31.62	30.82
	Rice straw	3	7.58	7.67	2.50	2.78	0.160	0.170	0.037	0.039	0.594	0.604	3.64	3.95	22.75	23.24
		5	7.59	7.68	2.75	2.89	0.159	0.168	0.035	0.036	0.575	0.587	3.52	3.84	22.14	22.86
		7	7.62	7.70	2.84	3.00	0.158	0.167	0.033	0.034	0.564	0.574	3.45	3.69	21.84	22.10
	Corn stalks	3	7.50	7.55	2.32	2.48	0.172	0.178	0.045	0.046	0.664	0.667	2.03	2.48	11.80	13.93
		5	7.51	7.58	2.41	2.61	0.170	0.175	0.043	0.045	0.657	0.661	1.97	2.40	11.59	13.71
		7	7.53	7.60	2.49	2.75	0.168	0.174	0.042	0.043	0.646	0.653	1.92	2.28	11.43	13.10
Control			7.76	7.87	4.31	4.87	0.139	0.116	0.022	0.020	0.382	0.373	1.41	1.09	10.14	9.40
A Mole depth, cm	30		7.63	7.72	3.73	3.85	0.155	0.130	0.033	0.035	0.554	0.545	3.23	1.52	21.16	11.77
	60		7.61	7.70	2.72	2.90	0.160	0.168	0.034	0.037	0.566	0.575	3.44	3.75	21.92	22.53
	F		2.95^{NS}	0.66^{NS}	2175.36*	845.84*	1.13^{NS}	5329.46*	0.67^{NS}	11.43^{NS}	37.77*	132.35*	1.48^{NS}	1671.85*	0.91^{NS}	1201.28*
	LSD$_{05}$				0.09	0.14		0.002			0.008	0.010		0.23		1.34
B Residual kind	Cotton stalks		7.71	7.82	3.61	3.71	0.148	0.141	0.026	0.030	0.480	0.481	4.61	3.36	31.14	22.52
	Rice straw		7.58	7.66	3.19	3.36	0.157	0.149	0.033	0.035	0.559	0.560	3.33	2.68	21.17	17.21
	Corn stalks		7.58	7.66	2.86	3.05	0.167	0.157	0.042	0.043	0.640	0.640	2.06	1.88	12.30	11.73
	F		14.37*	72.41*	78.17*	140.56*	14.34*	28.23*	100.71*	18.99*	701.81*	455.56*	622.22*	242.73*	190.21*	186.39*
	LSD$_{05}$		0.06	0.03	0.14	0.09	0.008	0.005	0.003	0.005	0.010	0.010	0.17	0.15	2.23	1.29
C Mole space, m	3		7.61	7.69	3.09	3.28	0.159	0.151	0.035	0.038	0.573	0.572	3.43	2.72	21.93	17.49
	5		7.62	7.71	3.24	3.36	0.157	0.149	0.033	0.036	0.559	0.560	3.32	2.64	21.51	17.18
	7		7.64	7.73	3.34	3.49	0.156	0.148	0.032	0.035	0.548	0.548	3.24	2.55	21.17	16.78
	F		0.83^{NS}	3.31^{NS}	14.52*	30.57*	0.83^{NS}	4.81*	2.99^{NS}	2.74^{NS}	29.34*	23.29*	2.28^{NS}	2.53^{NS}	0.79^{NS}	1.14^{NS}
	LSD$_{05}$				0.10	0.06		0.002			0.002	0.008				

Table (4): Effect of different treatments on some soil chemical properties in the third season (winter 2006/2007)

Mole depth, cm	Residual kind	Mole space, m	pH, 1:2.5 (susp.)		EC, dSm^{-1}		Total macronutrients, % N		P		K		Organic carbon, %		C / N ratio	
			0-30 cm	30-60 cm	0-30 cm	30-60 cm	0-30 cm	30-60 cm	0-30 cm	30-60 cm	0-30 cm	30-60 cm	0-30 cm	30-60 cm	0-30 cm	30-60 cm
30	Cotton stalks	3	7.42	7.49	3.05	3.24	0.170	0.142	0.047	0.032	0.669	0.653	3.68	1.75	21.65	12.32
		5	7.44	7.50	3.10	3.32	0.166	0.139	0.045	0.031	0.661	0.645	3.56	1.70	21.45	12.23
		7	7.47	7.53	3.13	3.39	0.165	0.138	0.044	0.030	0.654	0.638	3.40	1.65	20.61	11.96
	Rice straw	3	7.54	7.59	3.11	3.28	0.158	0.135	0.034	0.029	0.567	0.557	2.91	1.57	18.42	11.63
		5	7.56	7.61	3.18	3.34	0.157	0.133	0.032	0.027	0.556	0.539	2.85	1.52	18.15	11.43
		7	7.59	7.64	3.25	3.42	0.156	0.130	0.031	0.026	0.545	0.531	2.81	1.47	18.01	11.31
	Corn stalks	3	7.64	7.72	3.13	3.30	0.148	0.127	0.026	0.023	0.493	0.482	1.98	1.42	13.38	11.18
		5	7.65	7.74	3.28	3.37	0.146	0.125	0.025	0.022	0.480	0.469	1.92	1.38	13.15	11.04
		7	7.67	7.76	3.35	3.58	0.145	0.122	0.024	0.021	0.467	0.453	1.85	1.32	12.76	10.82
60	Cotton stalks	3	7.37	7.41	2.21	2.42	0.174	0.179	0.043	0.046	0.647	0.652	3.96	4.14	22.76	23.13
		5	7.39	7.44	2.30	2.50	0.172	0.177	0.042	0.043	0.636	0.644	3.80	4.04	22.09	22.82
		7	7.41	7.47	2.41	2.68	0.171	0.176	0.040	0.041	0.628	0.635	3.74	3.89	21.87	22.10
	Rice straw	3	7.48	7.54	2.27	2.45	0.164	0.173	0.039	0.040	0.613	0.619	3.19	3.40	19.45	19.65
		5	7.50	7.56	2.35	2.57	0.161	0.170	0.037	0.039	0.589	0.608	3.08	3.31	19.13	19.47
		7	7.53	7.58	2.43	2.70	0.159	0.169	0.035	0.037	0.571	0.587	3.00	3.23	18.87	19.11
	Corn stalks	3	7.60	7.65	2.30	2.47	0.154	0.165	0.030	0.035	0.532	0.541	1.80	2.14	11.69	12.97
		5	7.61	7.67	2.39	2.59	0.152	0.163	0.028	0.033	0.523	0.534	1.75	2.08	11.51	12.76
		7	7.63	7.70	2.48	2.73	0.150	0.162	0.027	0.031	0.512	0.528	1.72	2.03	11.47	12.53
Control			7.68	7.78	4.10	4.61	0.141	0.119	0.023	0.021	0.421	0.413	1.42	1.11	10.07	9.33
A Mole depth, cm	30		7.55	7.62	3.18	3.36	0.157	0.132	0.034	0.027	0.566	0.552	2.72	1.53	17.51	11.55
	60		7.50	7.56	2.35	2.57	0.162	0.170	0.036	0.038	0.583	0.594	2.95	3.14	17.65	18.28
	F		63.48*	25.85*	4290.98*	25001.99*	12.90^{NS}	37742.19*	4.19^{NS}	39.00*	10.72^{NS}	77.05*	51.53*	61069.13*	0.35^{NS}	2739.55*
	LSD_{05}		0.03	0.05	0.05	0.02		0.001		0.008		0.021	0.07	0.03		0.55
B Residual kind	Cotton stalks		7.42	7.47	2.70	2.93	0.170	0.159	0.044	0.037	0.649	0.645	3.69	2.86	21.74	17.43
	Rice straw		7.53	7.59	2.77	2.96	0.159	0.152	0.035	0.033	0.574	0.574	2.97	2.42	18.67	15.43
	Corn stalks		7.63	7.71	2.82	3.01	0.149	0.144	0.027	0.028	0.501	0.501	1.84	1.73	12.33	11.88
	F		96.82*	112.39*	68.82*	435.12*	217.15*	124.54*	180.87*	59.98*	163.28*	696.88*	4597.65*	2592.36*	474.00*	958.96*
	LSD_{05}		0.04	0.04	0.02	0.01	0.002	0.002	0.002	0.002	0.019	0.009	0.04	0.04	0.72	0.29
C Mole space, m	3		7.51	7.57	2.68	2.86	0.161	0.154	0.037	0.034	0.587	0.584	2.92	2.40	17.89	15.15
	5		7.53	7.59	2.77	2.95	0.159	0.151	0.035	0.033	0.574	0.573	2.83	2.34	17.58	14.96
	7		7.55	7.61	2.84	3.08	0.158	0.150	0.034	0.031	0.563	0.562	2.75	2.27	17.26	14.64
	F		2.08^{NS}	3.81*	57.83*	185.47*	4.45*	11.87*	4.86*	3.86*	4.27*	11.06*	17.06*	43.23*	5.80*	15.73*
	LSD_{05}			0.04	0.03	0.02	0.003	0.002	0.002	0.002	0.017	0.009	0.06	0.03	0.38	0.19

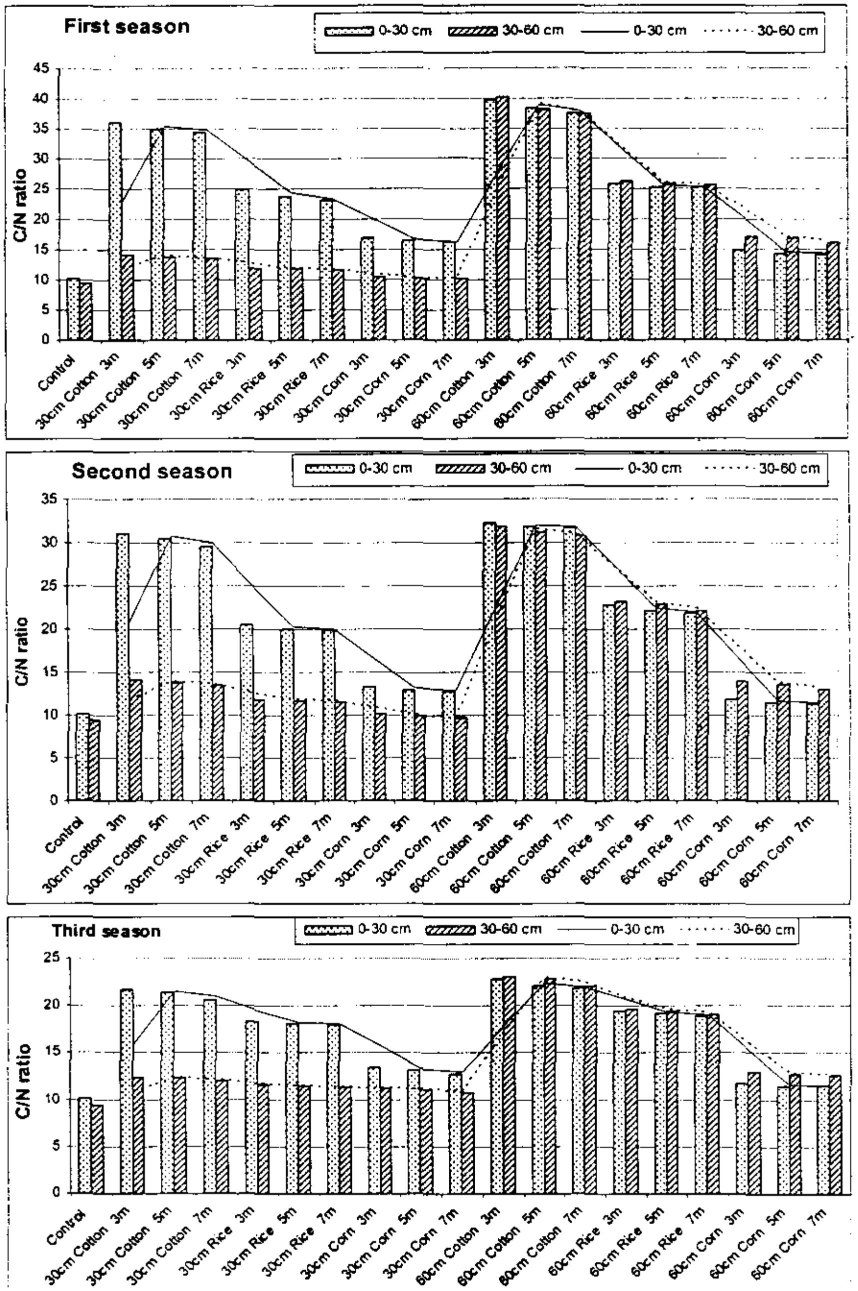

Fig. (6): Effect of different treatments on C/N ratio of the soil in the three seasons

Concerning the plant residues, data show that all added residues high significantly increased C/N ratio in the soil for the two soil layer depths at the end of the three sequence seasons. Cotton stalks had the highest values of C/N ratio at the two layer depths in the three growing seasons, where the values were 36.85 and 26.15 in the first season and 31.14 and 22.52 in the second one, while they were 21.74 and 17.43 in the third season, respectively for cotton stalks treatment. The plant residues can be arranged in the descending order : cotton stalks > rice straw > corn stalks.

As for the mole spacings, data clearly show that with decreasing the distance between moles the values of C/N ratio were slightly increased where the 3 m spacings gave the highest values. The mean values were 26.34 and 19.98, respectively for the two layer depths in the first season, and 21.93 and 17.49, respectively for the same depths in the second one while it reached to 17.88 and 15.15, respectively for the same depths in the third season. In the first and second seasons the increases were insignificant, while it was highly significant in the third one. It was also noticed that the values of subsurface layer were lower than surface one. This may be due to the decomposition of plant residues were fast in this layer.

Concerning the combined effect of different treatments on C/N ratio, it could be noticed that all treatments increased the mean values compared with the control at the two layer depths in the three growing seasons. The best treatment was 60cm mole depth with corn stalks at 7 m spacing in the three growing seasons since it recorded the moderate values of C/N ratio 14.22, 16.12 and 11.43, 13.10 and 11.47, 12.53 respectively for the two soil depths. These results were explained previously in O.C. % and are in line with those of El-Sodany *et al.* (2007).

4- Soil micronutrients:

Data in Tables (5 to 7) show that all mole treatments as well as all kinds of added crop residues led to significant increases in the concentration of soil micronutrients (Fe, Mn, Zn and Cu) of the two sequence soil depths (0-30 and 30-60cm) at the end of the three seasons comparing to the control (untreated soil).

With increasing mole depth from 30 to 60cm iron concentration increased from 4.27 to 5.49 mg Fe/Kg soil and from 3.44 to 5.19 mg Fe/Kg soil, respectively for the two soil depths in the first season, also from 4.72 to 6.05 mg Fe/Kg soil and from 3.87 to 5.71 mg Fe/Kg soil, respectively for the same depths in the second one, while it increased from 5.18 to 6.08 mg/Kg and from 4.23 to 5.78mg/Kg respectively for the same depths in the third season. Mn, Zn and Cu take the same trend as Fe where they increased by increasing mole depth from 30 to 60cm. The mean values were increased from 3.99 to 5.66mg/Kg and from 3.08 to 5.25mg/Kg, also from 4.92 to 5.53 mg/Kg and from 4.02 to 5.07 mg/Kg and from 1.97 to 2.20mg/Kg and from 1.27 to 1.70mg/Kg respectively for Mn, Zn and Cu at the two soil depths in the first season. While they were increased from 4.10, 3.17, 4.99, 4.08, 2.00 and 1.31 to 5.75, 5.33, 5.63, 5.16, 2.26 and 1.76mg/Kg respectively for the same elements at the same depths in the second one.

Table (5): Effect of different treatments on DTPA - extractable micronutrients concentration (mg/kg) of the soil in the first season (winter 2005/2006)

Mole depth, cm	Residual kind	Mole space, m	DTPA- extractable micronutrients (mg Kg^{-1})							
			Fe		Mn		Zn		Cu	
			0-30 cm	30-60 cm	0-30 cm	30-60 cm	0-30 cm	30-60 cm	0-30 cm	30-60 cm
30	Cotton stalks	3	3.97	2.85	3.76	2.82	4.75	3.85	1.92	1.21
		5	3.84	2.63	3.57	2.63	4.69	3.78	1.89	1.19
		7	3.65	2.45	3.32	2.41	4.60	3.72	1.84	1.16
	Rice straw	3	4.42	3.84	4.10	3.24	4.99	4.11	1.99	1.30
		5	4.29	3.72	3.94	3.10	4.93	3.99	1.96	1.26
		7	4.13	3.43	3.85	2.89	4.89	3.94	1.94	1.23
	Corn stalk	3	4.92	4.14	4.71	3.82	5.21	4.35	2.10	1.40
		5	4.73	3.97	4.42	3.51	5.13	4.27	2.07	1.33
		7	4.51	3.89	4.25	3.32	5.06	4.18	2.03	1.31
60	Cotton stalks	3	5.25	5.12	5.53	5.12	5.42	4.91	2.16	1.61
		5	5.11	4.96	5.47	4.85	5.31	4.84	2.14	1.57
		7	4.97	4.37	5.15	4.74	5.23	4.62	2.11	1.52
	Rice straw	3	5.53	5.32	5.74	5.39	5.62	5.21	2.22	1.76
		5	5.47	5.25	5.67	5.29	5.56	5.10	2.20	1.72
		7	5.32	5.17	5.59	5.23	5.45	4.97	2.17	1.65
	Corn stalk	3	6.13	5.73	6.03	5.71	5.80	5.37	2.31	1.90
		5	5.93	5.44	5.93	5.49	5.72	5.32	2.26	1.82
		7	5.74	5.39	5.82	5.42	5.64	5.25	2.23	1.79
Control			3.32	2.37	3.22	2.33	4.41	3.61	1.79	1.02
A Mole depth cm	30		4.27	3.44	3.99	3.08	4.92	4.02	1.97	1.27
	60		5.49	5.19	5.66	5.25	5.53	5.07	2.20	1.70
	F		136.83*	7774.18*	0511.70	279.88*	974.76*	2002.12*	33.18*	442.88*
	LSD_{05}		0.45	0.09	0.07	0.56	0.08	0.10	0.17	0.09
B Residual kind	Cotton stalks		4.47	3.73	4.47	3.76	5.00	4.29	2.01	1.38
	Rice straw		4.86	4.46	4.82	4.19	5.24	4.55	2.08	1.49
	Corn stalks		5.33	4.76	5.19	4.55	5.43	4.79	2.17	1.59
	F		19.78*	1573.21*	254.43*	16.86*	101.84*	213.46*	30.99*	42.27*
	LSD_{05}		0.32	0.04	0.07	0.31	0.07	0.06	0.05	0.05
C Mole space, m	3		5.04	4.50	4.98	4.35	5.30	4.63	2.12	1.53
	5		4.90	4.33	4.83	4.15	5.22	4.55	2.09	1.48
	7		4.72	4.12	4.66	4.00	5.15	4.45	2.05	1.44
	F		31.18*	100.85*	91.89*	3.15^{NS}	23.36*	48.60*	14.62*	10.98*
	LSD_{05}		0.08	0.06	0.05		0.05	0.04	0.02	0.04

In the third season they were increased also from 4.19, 3.25, 5.03, 4.13, 2.04 and 1.36mg/Kg to 5.83, 5.37, 5.66, 5.14, 2.30 and 1.81mg/Kg respectively for the same micronutrients at the same depths.

Concerning the effect of organic residues kinds, data in Tables (5 to 7) indicate that all added crop residues significantly increased the concentration of soil micronutrients (Fe, Mn, Zn and Cu) of the two sequence soil depths at the end of the three seasons. The corn stalks treatment was the best one in both first and second seasons where it increased Fe concentration by 60.54, 100.84% and 64.89, 88.89% respectively for the two soil depths and for the two seasons over the control. The other micronutrients take the same trend where the increases were 61.18, 95.28% and 59.82, 92.95% for Mn concentration and were 23.13, 32.69% and 22.89, 31.89% for Zn concentration and were 21.23, 55.88% and 21.43, 47.75% for Cu concentration over the control at the same depths and seasons. Thus the crop residues can be arranged in the following order : corn stalks > rice straw > cotton stalks > control. In the third season, the best residual was cotton stalks where the increases were 54.31, 50.14% for Fe and 57.02, 65.69% for Mn and 20.56, 24.22% for Zn and 20.86, 38.52% for Cu concentrations, respectively over the control at the same depths. Also, the residues can be arranged in the following order : cotton stalks > rice straw > corn stalks. These increases may be mainly due to the effect of these residues on lowering soil pH which reflect on increasing the availability of these micronutrients. These results agree with those of El-Fayoumy et al. (2001), who reported that application of organic amendments had a favorable decrease in soil pH and clearly enhanced the nutrients status of soil and its uptake by plants.

Table (6): Effect of different treatments on DTPA - extractable micronutrients concentration (mg/kg) of the soil in the second season (summer 2006)

Mole depth, cm	Residual kind	Mole space, m	DTPA- extractable micronutrients (mg Kg^{-1})							
			Fe		Mn		Zn		Cu	
			0-30 cm	30-60 cm	0-30 cm	30-60 cm	0-30 cm	30-60 cm	0-30 cm	30-60 cm
30	Cotton stalks	3	4.39	3.30	3.86	2.91	4.81	3.90	1.95	1.26
		5	4.25	3.06	3.65	2.72	4.75	3.83	1.91	1.24
		7	4.05	2.87	3.40	2.50	4.65	3.77	1.87	1.20
	Rice straw	3	4.88	4.29	4.21	3.32	5.05	4.19	2.02	1.35
		5	4.72	4.16	4.16	3.19	4.98	4.07	1.98	1.31
		7	4.55	3.84	3.96	2.96	4.94	3.99	1.96	1.27
	Corn stalks	3	5.43	4.58	4.82	3.94	5.32	4.41	2.14	1.45
		5	5.23	4.40	4.54	3.62	5.23	4.34	2.10	1.37
		7	4.99	4.30	4.32	3.41	5.15	4.26	2.06	1.34
60	Cotton stalks	3	5.80	5.54	5.64	5.21	5.51	5.02	2.22	1.66
		5	5.65	5.43	5.59	4.97	5.43	4.94	2.19	1.62
		7	5.48	4.82	5.25	4.82	5.34	4.71	2.17	1.58
	Rice straw	3	6.10	5.86	5.82	5.49	5.72	5.31	2.28	1.82
		5	6.02	5.78	5.76	5.40	5.66	5.19	2.25	1.78
		7	5.86	5.69	5.65	5.21	5.53	5.06	2.23	1.71
	Corn stalks	3	6.73	6.33	6.15	5.81	5.91	5.48	2.36	1.96
		5	6.51	6.02	5.99	5.59	5.81	5.41	2.32	1.87
		7	6.31	5.96	5.89	5.50	5.74	5.35	2.29	1.83
Control			3.56	2.79	3.31	2.41	4.50	3.70	1.82	1.11
A Mole depth, cm	30		4.72	3.87	4.10	3.17	4.99	4.08	2.00	1.31
	60		6.05	5.71	5.75	5.33	5.63	5.16	2.26	1.76
	F		19627.82*	8062.88*	2360.79*	103905.97*	451.53*	4117.19*	460.04*	1133.44*
	LSD_{05}		0.04	0.09	0.15	0.03	0.13	0.07	0.05	0.06
B Residual kind	Cotton stalks		4.94	4.17	4.57	3.86	5.08	4.36	2.05	1.43
	Rice straw		5.36	4.94	4.93	4.26	5.31	4.64	2.12	1.54
	Corn stalks		5.87	5.27	5.29	4.65	5.53	4.88	2.21	1.64
	F		898.88*	1006.98*	678.36*	1092.15*	45.50*	299.99*	31.98*	122.80*
	LSD_{05}		0.05	0.06	0.04	0.04	0.11	0.05	0.05	0.03
C Mole space, m	3		5.56	4.98	5.08	4.45	5.39	4.72	2.16	1.58
	5		5.40	4.81	4.95	4.25	5.31	4.63	2.13	1.53
	7		5.21	4.58	4.75	4.07	5.23	4.52	2.10	1.49
	F		203.41*	132.94*	73.51*	111.89*	29.47*	30.27*	14.67*	24.76*
	LSD_{05}		0.04	0.05	0.06	0.05	0.04	0.05	0.02	0.03

Table (7): Effect of different treatments on DTPA - extractable micronutrients concentration (mg/kg) of the soil in the third season (winter 2006/2007)

Mole depth, cm	Residual kind	Mole space, m	DTPA- extractable micronutrients (mg Kg^{-1})							
			Fe		Mn		Zn		Cu	
			0-30 cm	30-60 cm	0-30 cm	30-60 cm	0-30 cm	30-60 cm	0-30 cm	30-60 cm
30	Cotton stalks	3	5.95	4.46	5.07	3.80	5.38	4.35	2.19	1.52
		5	5.71	4.28	4.59	3.44	5.26	4.26	2.13	1.42
		7	5.42	4.0/	4.36	3.27	5.21	4.22	2.08	1.39
	Rice straw	3	5.27	4.58	4.28	3.33	5.07	4.15	2.07	1.38
		5	5.12	4.45	4.22	3.29	4.99	4.09	2.01	1.34
		7	4.94	4.29	4.06	3.16	4.96	4.03	1.99	1.29
	Corn stalks	3	4.97	4.17	3.94	3.19	4.91	4.12	1.98	1.36
		5	4.71	3.95	3.72	3.00	4.82	4.04	1.96	1.30
		7	4.53	3.81	3.45	2.79	4.69	3.94	1.92	1.25
60	Cotton stalks	3	6.65	6.31	6.19	5.69	5.95	5.47	2.41	1.99
		5	6.43	6.11	6.04	5.55	5.82	5.33	2.38	1.94
		7	6.34	6.02	5.94	5.46	5.77	5.28	2.34	1.89
	Rice straw	3	6.21	5.96	5.91	5.43	5.76	5.25	2.33	1.87
		5	5.97	5.83	5.84	5.38	5.69	5.16	2.29	1.83
		7	5.81	5.58	5.71	5.33	5.55	5.02	2.27	1.74
	Corn stalks	3	5.91	5.55	5.78	5.31	5.54	5.00	2.26	1.73
		5	5.78	5.41	5.67	5.16	5.48	4.91	2.22	1.69
		7	5.62	5.28	5.35	5.04	5.37	4.82	2.17	1.63
Control			3.94	3.47	3.42	2.74	4.62	3.88	1.87	1.22
A Mole depth, cm	30		5.18	4.23	4.19	3.25	5.03	4.13	2.04	1.36
	60		6.08	5.78	5.83	5.37	5.66	5.14	2.30	1.81
	F		1815.77*	5936.38*	570.11*	7124.22*	1236.13*	3188.10*	179.33*	1579.90*
	LSD_{05}		0.09	0.09	0.30	0.11	0.08	0.08	0.08	0.05
B Residual kind	Cotton stalks		6.08	5.21	5.37	4.54	5.57	4.82	2.26	1.69
	Rice straw		5.55	5.12	5.00	4.32	5.34	4.62	2.16	1.58
	Corn stalks		5.25	4.70	4.65	4.08	5.14	4.47	2.09	1.49
	F		1212.48*	246.79*	34.55*	1157.02*	161.86*	104.98*	32.55*	79.29*
	LSD_{05}		0.04	0.06	0.20	0.02	0.06	0.06	0.05	0.04
C Mole space, m	3		5.83	5.17	5.20	4.46	5.44	4.72	2.21	1.64
	5		5.62	5.01	5.01	4.30	5.34	4.63	2.17	1.59
	7		5.44	4.84	4.81	4.18	5.26	4.55	2.13	1.53
	F		82.83*	218.97*	10.21*	91.47*	36.08*	74.83*	9.86*	77.48*
	LSD_{05}		0.06	0.03	0.18	0.04	0.04	0.03	0.04	0.02

Concerning the mole spacing, data clearly show that the superiority was with closer mole space on increasing the values of micronutrient concentrations, where the 3m spacings increased the concentrations of micronutrient by 51.81, 89.87% and 54.66, 86.70% and 20.18, 28.26% and 18.44, 50.00%, respectively for Fe, Mn, Zn and Cu at the two layer depths in the first season, and by 56.18, 78.50% and 53.47, 84.65% and 19.78, 27.57% and 18.68, 42.34%, respectively for the same Fe, Mn, Zn and Cu at the same depths in the second one, while it increased by 47.97, 48.99% and 52.05, 62.77% and 17.75, 21.65% and 18.18, 34.45%, respectively for Fe, Mn, Zn and Cu at the same depths in the third season over the control (untreated soil).

As for the combined effect, data show that the 60cm mole depth with corn stalks at 3m spacings was the best treatment in the first and second seasons since it gave the highest values of micronutrients (Fe, Mn, Zn and Cu) where the values were 6.13, 5.73mg/Kg, and 6.03, 5.71 mg/Kg, and 5.80, 5.37 mg/Kg and 2.31, 1.90 mg/Kg respectively for Fe, Mn, Zn and Cu in the first season and were 6.73, 6.33 mg/Kg and 6.15, 5.81 mg/Kg and 5.91, 5.47

mg/Kg and 2.36, 1.96 mg/Kg for the same elements in the second one. In the third season, the best treatment was the 60cm mole depth with cotton stalks at 3m spacings since it recorded the highest values of Fe, Mn, Zn and Cu in this season where the values were 6.65, 6.31 mg/Kg and 6.19, 5.69 mg/Kg and 5.95, 5.47 mg/Kg and 2.41, 1.99 mg/Kg respectively for the previous micronutrients. While the control (untreated soil) recorded the lowest values at the two layer depths during the three growing seasons.

These results suggest that applied organic crop residues with constructed different moles to soils increase the availability of micronutrients for plants.

III- Effect of different treatments on yield and yield components:

Results in Tables (8 to 10) and Fig. (7) show that most of different treatments exhibited significant differences on yield and yield components at the end of the three studied seasons comparing to the control (untreated soil). Generally, it has been noticed that mole depth led to relative increases in the yield by 21.80 and 26.13 % for wheat grains in the first season and by 14.39 and 28.10 % for rice grains in the second one and by 7.65 and 17.96 % for total yield of onion in the third season for 30 and 60 cm mole depth, respectively over the recorded with the control. Also, the same treatments led to significant increases in plant height, spike length and dry matter for wheat in the first season and in straw yield, plant height and spike length for rice in the second one, also in marketable and culls yield, plant height and average bulb weight for onion in the third season, while straw yield, biological yield and 1000 seed weight were insignificant. These results corresponding with those reported by Meharban *et al.* (1998) and Kaoud (1994), who found that deep tillage treatment increased yields of cotton and clover as compared to conventional tillage. This may be due to the deep tillage breaks up the impediment in the subsoil, and encourage root growth and water extraction more from deeper soil layers. Also, dry matter of wheat was affected by mole depth where increasing mole depth to 60 cm led to increase the dry matter by 6.19 g/10 plants, while 30 cm mole depth increased it by 2.17 g/10 plants. This may be due to the previous reasons mentioned before. These results are in line with that obtained by El-Gohary (1978), who found that dry weight and seed cotton yield were significantly increased by using unfilled moles at 40 cm depth in clayey soil at Kafr El-Sheikh. Also, these results confirmed with those of El-Sodany *et al.* (2007).Concerning the effect of organic plant residues kinds, the mean values of the yield and yield components reveal that all studied characters were significantly increased during the three seasons except spike wheat length in the first season and 1000- seed weight of rice in the second one, and average bulb weight of onion in the third season. The yield obtained by corn stalks treatment was greater than the rice straw and cotton stalks treatments by 0.218 and 0.375 ton wheat grain/fed. respectively in the first season and by 0.123 and 0.272 ton rice grain/fed. in the second season. While in the third season, the yield of cotton stalks treatment was greater than the rice straw and corn stalks treatments by 0.556 and 0.991 ton onion/fed. These results may be due to the rate of residues decomposition which depends on the addition rate and the composition of these residues.

Table (8): Effect of treatments on wheat yield and its components in the first season (winter 2005/2006)

Mole depth, cm	Residual kind	Mole space, m	Biological yield Ton/fed	Grain yield Ton/fed	Straw yield Ton/fed	* R.I.Y., %		1000 Seed weight, g	Plant height, cm	Spike length, cm	Dry matter g/10 plants after 90 days
						Grain	Straw				
30	Cotton stalks	3	6.552	2.577	3.975	16.08	14.09	40.10	96.65	9.12	15.33
		5	6.422	2.539	3.883	14.37	11.45	39.92	96.32	8.99	14.89
		7	6.260	2.474	3.786	11.44	8.67	39.67	96.13	8.87	14.51
	Rice straw	3	6.941	2.735	4.206	23.20	20.72	41.72	97.91	9.75	16.41
		5	6.836	2.667	4.169	20.14	19.66	41.49	97.33	9.62	16.18
		7	6.652	2.623	4.029	18.15	15.64	41.26	96.84	9.24	15.91
	Corn stalks	3	7.514	3.000	4.514	35.14	29.56	42.94	99.21	10.27	17.65
		5	7.311	2.895	4.416	30.41	26.75	42.81	98.75	10.14	16.86
		7	7.209	2.825	4.384	27.25	25.83	42.53	98.24	9.97	16.63
60	Cotton stalks	3	6.811	2.695	4.116	21.40	18.14	40.96	100.25	10.78	18.84
		5	6.668	2.612	4.056	17.66	16.42	40.87	99.82	10.57	18.35
		7	6.551	2.551	4.000	14.91	14.81	40.65	99.44	10.43	18.04
	Rice straw	3	7.221	2.870	4.351	29.28	24.89	42.17	101.72	11.38	20.58
		5	7.041	2.785	4.256	25.45	22.16	41.94	101.45	11.10	19.61
		7	6.908	2.710	4.198	22.07	20.49	41.88	100.87	10.92	19.18
	Corn stalks	3	7.899	3.125	4.774	40.77	37.03	43.67	102.47	11.97	22.80
		5	7.631	2.980	4.651	34.23	33.50	43.35	102.25	11.81	21.76
		7	7.442	2.875	4.567	29.50	31.08	43.13	101.95	11.52	21.37
Control			5.704	2.220	3.484	0.00	0.00	39.10	95.77	8.58	13.87
A Mole depth, cm	30		6.855	2.704	4.151	21.80	19.15	41.38	97.49	9.55	16.04
	60		7.130	2.800	4.330	26.14	24.28	42.07	101.14	11.16	20.06
	F		6.17^{NS}	0.95^{NS}	7.35^{NS}	0.98^{NS}	6.79^{NS}	6.71^{NS}	63.65*	75.10*	136.46*
	LSD_{05}								1.97	0.80	1.48
B Residual kind	Cotton stalks		6.544	2.575	3.969	15.98	13.93	40.36	98.10	9.79	16.66
	Rice straw		6.933	2.732	4.202	23.05	20.59	41.74	99.35	10.34	17.98
	Corn stalks		7.501	2.950	4.551	32.88	30.63	43.07	100.48	10.95	19.51
	F		100.89*	15.68*	49.53*	14.34*	42.79*	17.01*	8.94*	3.56^{NS}	40.17*
	LSD_{05}		0.156	0.155	0.136	7.31	4.19	1.07	1.30		0.73
C Mole space, m	3		7.156	2.834	4.323	27.64	24.07	41.93	99.70	10.55	18.60
	5		6.985	2.746	4.239	23.71	21.66	41.73	99.32	10.37	17.94
	7		6.837	2.676	4.161	20.56	19.42	41.52	98.91	10.16	17.61
	F		4.75*	1.72^{NS}	8.61*	1.70^{NS}	8.99*	0.24^{NS}	2.58^{NS}	1.33^{NS}	3.50*
	LSD_{05}		0.214		0.081		2.27				0.79

* R.I.Y. : Relative increasing yield.

As for the effect of residues kinds on dry matter of wheat in the first season, results in general show a positive effect due to all tested sources of organic plant residues. The values in Table (8) reveal that dry matter of wheat plants responded positively to residues where the highest values were recorded by corn stalks treatment.

The dry matter mean value at this treatment was 19.51 g/10 plants of wheat, followed by rice straw treatment (17.98 g/10 plants) and lastly cotton stalks treatment (16.66 g/10 plants). Such differences could be attributed to the increases in plants tall and spike length. Also, the increases in dry matter may be due to the ability of organic matter in making soil nutrients more available. Thus, the supply of some available nutrients for plants through organic matter decomposition by soil micro organisms is improved.

With respect to the effect of mole spacings, data of the yield indicate that decreasing the mole spacing increased the crop yield in the three growing seasons. This means that 3, 5 and 7 m mole spacings increased the yield by 27.66, 23.69 and 20.54 %, respectively for wheat in the first season and by 25.28, 20.62 and 17.86 % respectively for rice in the second one and by 15.04, 12.20 and 11.18 % respectively for onion in the third season over the recorded with the control. It can also be seen that the superiority of 3 m spacings since it produced the highest crop yield in the three growing seasons. These results may be attributed to that the construction of moles especially at closer spacing improved the infiltration characteristic of the soil and consequently decreased its salinity (Hamideh, 1969). The same treatments led to significant increases in straw yield and biological yield for wheat in the first season and straw yield and 1000 seed weight for rice in the second one and marketable and culls yield, total yield, plant height and average bulb weight for onion in the third season. These results are in agreement with those obtained by El-Sabry et al. (1992), El-Abaseri et al. (1996), Shetawy (2001) and El-Maddah and El-Sodany (2003).

Table (9): Effect of treatments on rice yield and its components in the second season (summer 2006)

Mole depth cm	Residual kind	Mole space, m	Grain yield Ton/fed	Straw yield Ton/fed	R.I.G.Y., %	1000 Seed weight, g	Plant height, cm second season	Panicle length, cm second season
30	Cotton stalks	3	3.842	6.376	14.01	27.74	95.25	15.96
		5	3.700	6.233	9.79	27.43	94.95	15.77
		7	3.620	6.095	7.42	27.35	94.12	15.21
	Rice straw	3	3.974	6.792	17.92	28.21	96.21	16.98
		5	3.830	6.546	13.65	27.92	95.35	16.52
		7	3.760	6.427	11.57	27.79	95.11	16.20
	Corn stalk	3	4.095	6.945	21.51	28.34	97.26	17.95
		5	4.010	6.780	18.99	28.13	96.45	17.28
		7	3.868	6.696	14.78	28.05	96.14	17.11
60	Cotton stalks	3	4.284	7.185	27.12	28.93	98.32	17.96
		5	4.131	6.959	22.58	28.65	97.46	17.84
		7	4.100	6.903	21.66	28.49	97.16	17.14
	Rice straw	3	4.489	7.270	33.20	29.32	99.10	18.92
		5	4.329	7.128	28.46	29.03	98.21	18.22
		7	4.188	7.063	24.27	28.81	97.86	18.16
	Corn stalk	3	4.650	7.502	37.98	29.65	99.85	19.57
		5	4.389	7.339	30.24	29.41	98.92	18.86
		7	4.295	7.262	27.45	29.27	98.71	18.77
Control			3.370	5.577	0.00	27.11	93.84	15.29
A Mole depth cm	30		3.855	6.543	14.40	27.88	95.65	16.55
	60		4.317	7.179	28.11	29.06	98.40	18.38
	F		44.53*	147.30*	46.16*	2.12^{NS}	30.75*	57.95*
	LSD_{05}		0.298	0.225	8.68		2.13	1.03
B Residual kind	Cotton stalks		3.946	6.625	17.10	28.10	96.21	16.65
	Rice straw		4.095	6.871	21.51	28.51	96.97	17.50
	Corn stalks		4.218	7.087	25.16	28.81	97.89	18.26
	F		8.58*	15.49*	9.14*	1.53^{NS}	7.00*	5.66*
	LSD_{05}		0.151	0.192	4.35		1.04	1.10
C Mole space m	3		4.222	7.012	25.29	28.70	97.67	17.89
	5		4.065	6.831	20.62	28.43	96.89	17.42
	7		3.972	6.741	17.86	28.29	96.52	17.10
	F		4.35*	5.87*	4.26*	4.43*	2.76^{NS}	2.87^{NS}
	LSD_{05}		0.177	0.166	5.31	0.29		

*** R.I.G.Y : Relative increasing grain yield.**

Also, these treatments led to significant increases in dry matter of wheat in the first season, where 3 m spacing recorded the highest values (18.60 g/10 plants) followed by 5 m spacing (17.94 g/10 plants) and 7 m spacing (17.61 g/10 plants).

Table (10): Effect of treatments on onion yield and its components in the third season (winter 2006/2007)

Mole depth, cm	Residual kind	Mole space, m	* Marketable yield Ton/fed	** Culls yield Ton/fed	** Total yield Ton/fed	R.I.Y., %	* Plant height, cm	** Av. Bulb weight, g
30	Cotton stalks	3	18.325	0.729	19.054	13.24	60.85	82.17
		5	17.910	0.690	18.600	10.54	59.26	80.85
		7	17.745	0.669	18.414	9.44	59.17	80.42
	Rice straw	3	17.715	0.647	18.362	9.13	59.38	81.11
		5	17.300	0.608	17.908	6.43	58.19	79.87
		7	17.217	0.564	17.781	5.68	57.93	79.34
	Corn stalks	3	17.522	0.523	18.045	7.24	58.42	80.42
		5	17.015	0.504	17.519	4.12	57.15	79.10
		7	16.859	0.477	17.336	3.03	56.82	78.95
60	Cotton stalks	3	19.750	1.150	20.900	24.21	62.61	85.72
		5	19.343	1.079	20.422	21.37	61.40	83.85
		7	19.208	1.057	20.265	20.44	61.11	83.79
	Rice straw	3	19.232	1.038	20.270	20.47	62.35	84.45
		5	18.823	0.981	19.804	17.70	61.15	83.15
		7	18.658	0.945	19.603	16.50	60.95	82.92
	Corn stalks	3	18.625	0.885	19.510	15.95	61.33	83.67
		5	18.207	0.807	19.014	13.00	60.10	82.38
		7	18.111	0.733	18.844	11.99	59.98	81.89
Control			16.381	0.445	16.826	0.00	54.51	78.15
A Mole depth, cm	30		17.512	0.601	18.113	7.65	58.57	80.25
	60		18.884	0.964	19.848	17.96	61.22	83.54
	F		52.51*	316.48*	98.61*	148.70*	21.15*	148.37*
	LSD_{05}		0.815	0.088	0.752	3.64	2.47	1.16
B Residual kind	Cotton stalks		18.714	0.896	19.609	16.54	60.73	82.80
	Rice straw		18.158	0.797	18.955	12.65	59.99	81.81
	Corn stalks		17.723	0.655	18.378	9.22	58.97	81.07
	F		23.63*	33.17*	47.37*	45.11*	7.25*	2.89^{NS}
	LSD_{05}		0.333	0.068	0.292	1.78	1.07	
C Mole space m	3		18.528	0.829	19.357	15.04	60.82	82.92
	5		18.100	0.778	18.878	12.19	59.54	81.53
	7		17.966	0.741	18.707	11.18	59.33	81.22
	F		5.33*	3.82*	6.37*	6.60*	4.41*	5.32*
	LSD_{05}		0.371	0.066	0.389	2.28	1.13	1.15

*** Recorded at 105 days after transplanting**
**** recorded at harvest time**

Regarding the combined effect of different treatments, it can be observed that the highest yield of wheat in the first season (3.125 ton/fed.) and rice in the second season (4.650 ton/fed.) were achieved by 60 cm mole depth with corn stalks at 3 m spacings treatment, while the highest yield of onion in the third season (20.900 ton/fed.) was recorded by 60 cm mole depth with cotton stalks at 3 m spacings treatment and in most of cases, the control gave the lowest yield. Also, the same treatments gave the highest values of straw yield, biological yield, 1000 seed weight, plant height, spike length and dry matter g/10 plants for wheat in the first season and straw yield, 1000 seed weight, plant height and spike length for rice in the second season and marketable and culls yield, plant height and average bulb weight for onion in the third season compared to the control which gave the lowest values. These results trend may be attributed to the distribution of moisture and soil strength magnitudes in root growing zones resulted in a good growth of plants, which reflect on its components. These results are in line with that obtained by El-Gohary (1978). Thus the present study could confirm that adapting deep moles combination with adding organic plant residues (corn stalks, rice straw and cotton stalks) at 3 m spacings is an important practice for improving soil physical, hydrophysical and chemical properties of the soil besides enhanced the nutrient status of the soil and accordingly increasing crop production comparable to untreated soil (control).

IV- Estimation of the net treatments cost :

Cost evaluation was performed for tractor and ditcher considering conventional method of estimating both fixed and variable costs. The ditcher cost was 1.25 LE/h, tractor cost was 34.45 LE/h and total costs were 35.70 LE/h.

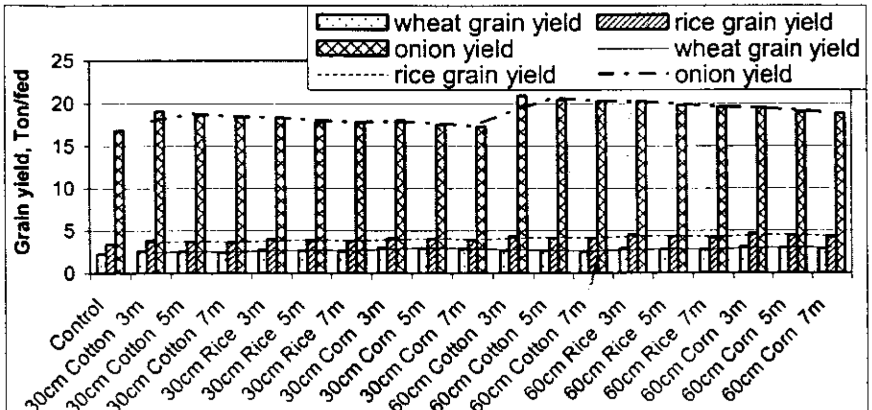

Fig. (7): Effect of different treatments on yield (Ton/fed) in the three seasons

The average of total moling costs and net profit as affected by different treatments are shown in Table (11). It can be concluded that, although, the total costs of moling for 3 m mole space recorded higher values than of the other mole spacings (5 and 7m) 177.25 and 208.56 LE/fed. respectively for 30 and 60cm mole deep, the net profit of this mole space was in general higher than that of the other spaces. Thus, it can be concluded that it is better from the economic view to decrease mole space down to 3m to increase the net returne.

The results indicated also that the net profit of corn stalks treatments were in general higher than those of rice straw and cotton stalks. Thus the added plant residues can be arranged according to high their net returne as follows : corn stalks > rice straw > cotton stalks.

Also, it can be seen that, it is better from the economic view to increase the mole depth up to 60 cm to increase the net profit.

Table (11): The net revenue* (LE/fed) due to different treatments through the three growing seasons under study.

Mole depth cm	Residual kind	Mole space, m	Total moling cost LE/fed	Total yield price, LE/fed					Net return LE/fed
				Wheat grain	Wheat straw	Rice grain	Onion marketable	Onion culls	
30	Cotton stalk	3	177.25	392.70	122.75	519.20	1166.40	17.04	2040.84
		5	121.78	350.90	99.75	363.00	917.40	14.70	1623.97
		7	70.97	279.40	75.50	275.00	818.40	13.44	1390.77
	Rice straw	3	177.25	566.50	180.50	664.40	800.40	12.12	2046.67
		5	121.78	491.70	171.25	506.00	551.40	9.78	1608.35
		7	70.97	443.30	136.25	429.00	501.60	7.14	1446.32
	Corn stalks	3	177.25	858.00	257.50	797.50	684.60	4.68	2425.03
		5	121.78	742.50	233.00	704.00	380.40	3.54	1941.66
		7	70.97	665.50	225.00	547.80	286.80	1.92	1656.05
60	Cotton stalk	3	208.56	522.50	158.00	1005.40	2021.40	42.30	3541.04
		5	151.84	431.20	143.00	837.10	1777.20	38.04	3074.70
		7	101.70	364.10	129.00	803.00	1696.20	36.72	2927.32
	Rice straw	3	208.56	715.00	216.75	1230.90	1710.60	35.58	3700.27
		5	151.84	621.50	193.00	1054.90	1465.20	32.16	3214.92
		7	101.70	539.00	178.50	899.80	1366.20	30.00	2911.80
	Corn stalks	3	208.56	995.50	322.50	1408.00	1346.40	26.40	3890.24
		5	151.84	836.00	291.75	1120.90	1095.60	21.72	3214.13
		7	101.70	720.50	270.75	1017.50	1038.00	17.28	2962.33

*** = (yield of the treatment - control) - the cost of the treatment.**
The price of the yield and the costs of different treatments were calculated as subsidized price of 2006 and 2007

Thus according to the economic evaluation in Table (11) it could be concluded that the combined treatment of 60 cm mole depth with corn stalks at 3m spacings was the best treatment and should be recommended due to a relative high net income (3890.24 LE/fed.) comparing to the other treatments. This may be due to this treatment recorded the highest values of yield in the first and second seasons, consequently high net profit.

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تأثير إضافة مخلفات المحاصيل الحقلية علي بعض خواص وإنتاجية الأرض

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يختص هذا البحث الحقلي بتقييم تأثير إضافة مخلفات المحاصيل علي بعض خواص التربة بالإضافة إلي إنتاجية المحاصيل، وكذلك التخلص من مخلفات المحاصيل المسببة للسحابة السوداء التي تغطي سماء مصر. وقد نفذت التجربة في محطة البحوث الزراعية بالجميزة، محافظة الغربية خلال ثلاث مواسم زراعية متتالية من عام ٢٠٠٥ إلي عام ٢٠٠٧ . المحاصيل المنزرعة المتعاقبة هي القمح والأرز والبصل . أراض الجميزة متوسطة القوام (لومية طينية سلتية) ذات محتوي منخفض من كربونات الكالسيوم (اقل من ٤ %) وتتراوح نسبة المادة العضوية بها ١,٨٦ إلي ٢,٤١% كما يتراوح رقم حموضة التربة بين ٧,٨٥ ، ٧,٩١ والتوصيل الكهربي بين ٥,٢٦ ، ٥,٨٣ ملليموز/سم . وقد وضع حطب القطن وقش الأرز وحطب الذرة بصورتها الكاملة (بدون طحن) في أنفاق متوازية علي عمق ٣٠ ، ٦٠ سم علي أبعاد مختلفة ٣ ، ٥ ، ٧ متر , وقد تم إنشاء الأنفاق بواسطة ديتشر خاص . ويمكن تلخيص النتائج المتحصل عليها كالتالي :-

١. زيادة معدل استهلاك الوقود بنسبة ١٩,٥١ % بزيادة عمق الأنفاق، كما وصل استهلاك الطاقة إلي ٥١,٥٤ كيلو وات بزيادة عمق الأنفاق إلي ٦٠ سم ، كما زادت نسبة الانزلاق ووصلت أقصي قيمة إلي ٦,٢٢ ، ١١,٥٣ % عند سرعة أمامية ٣,٩٢ كم/ ساعة لعمقي ٣٠ ، ٦٠ سم علي التوالي .
٢. أدي إضافة مخلفات المحاصيل وجميع المعاملات إلي انخفاض بسيط في رقم حموضة التربة بينما حدث انخفاض تدريجي في درجة ملوحة التربة .
٣. أدت جميع المخلفات إلي تحسن ملحوظ في درجة صلاحية العناصر بالتربة سواء العناصر الكبرى أو الصغرى ، وزيادة الكربون العضوي ونسبة ك : ن في الطبقة السطحية وتحت السطحية للتربة .
٤. حدثت زيادة ملحوظة في المحصول ومكوناته استجابة لمخلفات المحاصيل المضافة وتراوحت نسبة الزيادة في حبوب وقش القمح مابين ١١,٤٤ ، ٤٠,٧٧ % وبين ٨,٦٧ ، ٣٧,٠٣ % علي التوالي . وتراوحت الزيادة في محصول حبوب الأرز بين ٧,٤٢ ، ٣٧,٩٨ % مقارنة بالكنترول (الأرض الغير معاملة) . وقد وصل اعلي محصول للبصل إلي ٢٠,٩٠٠ طن / فدان .
٥. يشير التحليل الاقتصادي إلي تفوق معاملة إنشاء الأنفاق علي عمق ٦٠ سم مع إضافة حطب الذرة علي مسافة ٣ متر مقارنة بالأنواع الأخرى حيث أنها أعطت اكبر عائد اقتصادي .

مما سبق يتبين أن إضافة مخلفات المحاصيل في أنفاق تعمل علي تحسن واضح لخواص التربة وصلاحية العناصر بها والتي تنعكس علي زيادة المحصول وتحقيق أعلي صافي دخل مزرعي .