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EFFECT OF CROP RESIDUALS FILLED MOLES ON SOME PHYSICAL AND HYDROPHYSICAL SOIL PROPERTIES

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ABSTRACT

Field experiments were undertaken to evaluate the effect of crop residuals filled moles on some physical and hydrophysical soil properties as well as to get rid of these residuals causative the black cloud covered the sky of Egypt . 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 orientation with respect to one another and spaced at 3, 5 and 7 m apart. Furthermore economical analysis was done by calculating the net revenue for every treatment to determine the economical treatment. The moles were constructed by a special ditcher. The experiments were conducted at El-Gemmeiza Agricultural Research Station, El-Gharbia Governorate, during three consecutive growing seasons from 2002 to 2004. Cultivated crops comprised wheat, rice, and onion of bulb seeds in a consecutive sequence. El-Gemmeiza soil is silty clay loam in texture with less than 4% of $CaCO_3$. 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} .

The obtained results can be summarized as follows :-

1- The rate of fuel consumption increased 19.51 % by increasing mole depth, and the power consumption increased from 43.28 to 51.54 KW, as the mole depth increased from 30 to 60 cm. The slip ratio also increased reaching maximum values of 6.22 and 11.53 % at operating forward speed of 3.05 Km/hr for the two mole depths of 30 and 60 cm, respectively.

2- Soil penetration resistance decreased by increasing mole depth and by decreasing mole space and decreased also with all added residuals.

3- The soil bulk density decreased in all treatments, while total soil porosity and void ratio took the opposite trend.

4- A decrease in the settling percentage was observed in all treatments, indicating a higher degree of structural stability.

5-The soil hydraulic conductivity and the water holding capacity besides available water increased in all treatments.

6- Water consumption was decreased and water use efficiency was increased with all treatments.

7- According to the economic evaluation, the 60 cm mole depth with corn stalks at 3 m spacing was the most valuable compared to other treatments since it gave the highest net revenue.

8- From the above results, it is more useful to use these treatments with the three crop residuals at different rates to get a markedly improve in soil physical and hydrophysical properties which reflect on higher yield incorporated with high net income.

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

INTRODUCTION

The strategy of present and future is to keep the natural resources for soil and water of the state away from pollution and to improve the properties of agricultural products for the public health and to protect the environment.

For many centuries, it has been noticed that the capacity of soils to produce crops is affected by the amount of soil content of organic matter (Abdel-Gaffar, 1982). The organic matter of soil is a key attribute of its fertility.

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.

The organic matter can increase soil productivity by improving soil physical and chemical properties and release nutrients to the soil mostly through plant residues decomposition (Goh *et al.* 2001). However, the organic matter content in Egyptian soil gradually decreased and in order to increase it, the use of different sources of organic residues became necessary (El-Maddah, 2000). 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.

Albinet (1971) found that the structural stability and porosity of alluvial soils were improved by application of straw. Miller and Aursted (1971) found that straw incorporation of the furrow bottom increased furrow infiltration into a sandy loam soil during 3 years study period. Straw incorporation became less effective as the season progressed. The annual addition of 13.4 tons of straw/ha increased infiltration over the control about 90 % during the first season, 65 % during the second and 35 % during the third season. Talha *et al.* (1979a) found that the values of hydraulic conductivity, infiltration rate and total porosity of alluvial soil were increased as a result of added clover and wheat straw, while the values of bulk density were decreased.

Rate of decay of plant residues applied to the soil is, in turn, affected by several factors. The most important among these is the chemical composition of the residues. In this respect, Michael *et al.* (1984) pointed out that soybean leaves decayed most rapidly loosing 44.3 % of its original organic carbon as CO_2 over 78 days, while soybean stems lost 41.4 % and wheat straw lost 35 % over the same period. Heal *et al.* (1997) stated that the decomposition of crop residues in soil and their carbon and nitrogen mineralization are largely influenced by the quality of plant materials, i.e., by their origin and composition.

Im (1982) concluded that the addition of organic materials improved the soil permeability to water even if the soil was severely compacted. The improvement of permeability was entirely due to the increase in total porosity.

Since organic matter has high water holding capacity, its addition to soil should increase the amount of available water.

The aim of this work is to get rid of crop residuals especially rice straw causative the black cloud covered the sky of Egypt and to assess the effect and residual effect of these residuals (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 improving some soil physical and hydrophysical properties.

MATERIALS AND METHODS

Field experiments were carried out on silty clay loam soil at El-Gemmeiza Agricultural Research Station, El-Gharbia Governorate, during three consecutive growing seasons. The factors involved in this study were two mole depths (30 and 60 cm) at three spacings (3, 5 and 7 m) with three organic plant residuals (cotton stalks, rice straw and corn stalks) as a complete structure (without grinding) placed in moles arranged in parallel orientations with respect to one anothers as well as the control (untreated soil) to get rid from the burning of crop residuals causative the black cloud covered the sky of Egypt and to evaluate the effect and residual effects of these treatments on some soil physical and hydrophysical properties. Some soil properties of the experimental soil are presented in Table (1a) and analysis results of the used organic residuals are shown in Table (1b). The studied soil has a shallow water table (80cm from the soil surface) which caused lower hydraulic conductivity and permeability and higher EC 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 residuals are : cotton stalks, rice straw and corn stalks. The rates of plant residuals were 140, 84 and 60 m^3/fed. at 30 cm depth, while at 60 cm mole depth were 350, 210 and 150 m^3/fed. at 3, 5 and 7 m spacings, respectively. These residuals were added into the moles before sowing, and covered with 10 cm of 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:

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

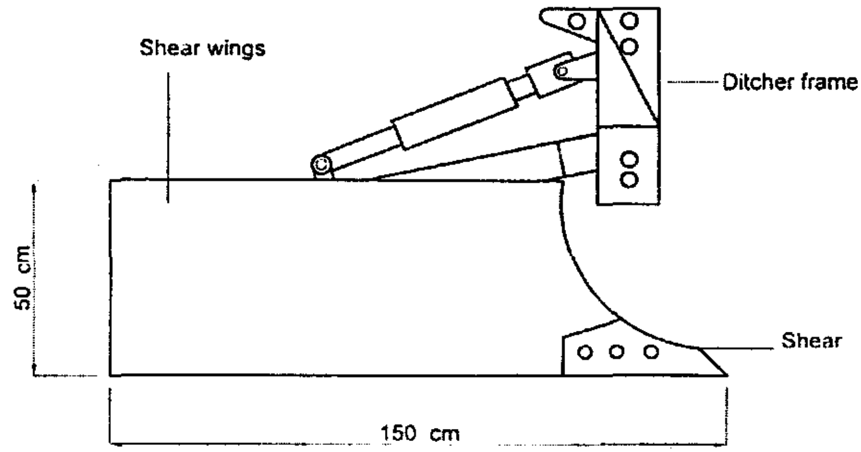
Table (1a) : Some physical and chemical properties of the used soil.

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+}	12.69	13.78
Mg^{2+}	13.71	14.85
Na^{+}	25.89	29.39
K^{+}	0.39	0.36
Soluble anions, meq l^{-1}		
CO_3^{2-}	0.65	0.69
HCO^{3-}	4.78	5.61
Cl^{-}	34.14	36.65
SO_4^{2-}	13.11	15.43
Particle size distribution		
Sand, %	11.35	13.11
Silt, %	52.55	48.27
Clay, %	36.10	38.62
Texture class	* S.C.L	* S.C.L
Bulk density (Db, g cm^{-3})	1.29	1.34
Total porosity (E), %	51.32	49.43
Void ratio (e)	1.05	0.98
Hydraulic conductivity (Kh, cm hr^{-1})	0.56	0.52
$CaCO_3$, %	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

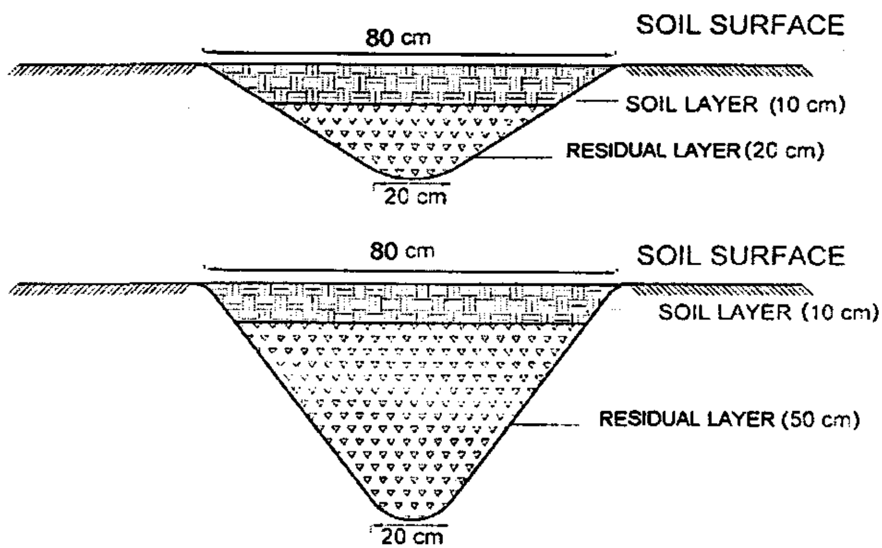
*** S.C.L = Silty clay loam**

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

Organic residual	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



SIDE VIEW OF THE USED DITCHER



SCHEMATIC OF THE MOLLING AFTER DITCHERING

Fig. (1)

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

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

where : Fc = Fuel consumption rate, L/hr

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 residuals and prior to planting and the recommended agricultural processes were practiced. Also, an activated dose of nitrogen fertilizer was added before sowing by about one month to correct C/N ratio of the added residuals.

Wheat seeds (Sakha 69 variety) were planted in the first season (winter 2002/2003) 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 2003) at the rate of 60 Kg/fed. where sown in a nursery, after 30 days seedlings were transplanted in June 2003, and onion of bulb seeds (Behairy red) were planted in the third season (winter 2003/2004), at the rate of 1.5 ton/fed. at December 2003.

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.

Japanese cone penetrometer, modle SR-2Dik 5500 was used to measure the penetration resistance of soil. This measurement was done 4 times. The first 3 times, each was done 10 days after the primary three irrigation, while the latest was done direct before harvesting in the first and third seasons. While, in the second season was done only just before harvesting.

After harvesting of each crop, soil samples (0-30 and 30-60 cm depths) were collected from each plot to determine some soil physical and hydrophysical properties.

Soil bulk density (Db, g/cm^3) was determined using the core methods (Vomocil, 1986). Total porosity (E,%) and void ratio (e) were calculated using the following equations:-

$$E \ , \% = (1 - \frac{Db}{Dr}) X \, 100$$

and $$e = \frac{Dr}{Db} - 1$$

where :- Db: is the bulk density, g/cm^3

Dr : is the real density, taken as 2.65 g/cm^3

Hydraulic conductivity (cm/hr) was determined using undisturbed soil cores using a constant water head according to Richards (1954), settling percentage of the soil aggregates was determined in soil aggregates of 2-5 mm size, as the method described by Williams and Cooke (1961) and soil moisture characteristics were determined using the method outlined by Stakman (1969).

Water consumption (Cu) was determined by collecting soil samples from each plot before and after 48 hours of every irrigation and computed according to the equation of Israelsen and Hansen (1962).

$$Water\ consumption\ (cm) = \frac{\theta_2 - \theta_1}{100}\ X\ Db\ X\ D$$

where : Θ_2 = Soil moisture percentage on weight basis after 48 hours from irrigation.

Θ_1 = Soil moisture percentage before irrigation.

Db = Bulk density, g/cm^3.

D = Soil depth, cm.

Water use efficiency (WUE) was calculated by dividing the marketable seed yield of wheat, rice and onion (Kg/fed.) by water consumptive use according to the equation of Jensen (1983).

$$WUE,\ Kg\ fed^{-1}\ cm^{-1} = \frac{Seed\ \ yield,\ Kg\ fed^{-1}}{Water\ \ consumption\ ,\ cm}$$

Total yield (wheat rice and onion seed) for each plot was weighed and related to Kg fed^{-1}.

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 200 L.E./ton straw of wheat in the first season and 1000 L.E./ton seeds of rice in the second one and 40 L.E./kg of onion seeds 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 residuals, 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:

1-The power requirements

Data presented in Table (2) show that, the rate of fuel consumption increased by increasing the moling depth with all mole spacing because of increased soil draft. The results also indicate that, by increasing ,moling depth from 30 to 60 cm the fuel consumption increased by about 19.51%.

From the obtained data presented in Table (2), it is also clear that the power requirements were varying with the moling depth. As the moling depth increased from 30 to 60 cm, the power consumption increased from 43.28 to 51.54 KW.

2- Slip ratio

From the obtained data in Table (2) it is clear that, for all mole spaces (3, 5 and 7 m) and increasing the mole depth, the slip ratio tended to increase. The maximum values of slip ratio were found to be 6.22 and 11.53 % at operating forward speed of about 3.05 Km/h for mole depth of about 30 and 60 cm respectively.

Table (2): Effect of different treatments on fuel consumption, power requirement and slip percent.

Mole depth, cm	Mole space, m	Actual field capacity fed/hr	Fuel consumption L/hr	Fuel consumption L/fed	Power requirement Kw	Slip, %
30	3	1.31	12.95	9.89	41.28	5.65
	5	2.13	13.60	6.52	44.52	6.22
	7	3.27	13.89	4.16	44.05	6.14
60	3	1.25	15.35	13.08	52.32	11.05
	5	2.12	15.92	7.51	50.94	11.25
	7	3.05	16.05	5.26	51.36	11.53

3- Soil penetration resistance:

Data presented in Table (3) show that, the effect of mole depth, moles spacing and kind of residuals on penetration resistance at sequence measuring timed. The results indicate that the penetration values decreased by increasing mole depth since increasing moling depth decreased the soil compaction, in the three growing seasons.

Table (3): Effect of different treatments on penetration resistance (Mpa) at sequence measuring time.

Mole depth, cm	Residual kind	Mole space, m	First season (wheat)				Second season (rice)	Third season (onion)			
			10 days after 1st irri.	10 days after 2nd irri.	10 days after 3rd irri.	Just before harvesting	Just before harvesting	10 days after 1st irri.	10 days after 2nd irri.	10 days after 3rd irri.	Just before harvesting
30	Cotton stalks	3	1.70	1.76	1.85	2.00	1.79	1.60	1.62	1.68	1.78
		5	1.80	1.84	1.92	2.11	1.90	1.66	1.71	1.79	1.92
		7	1.96	2.08	2.18	2.20	2.23	1.69	1.78	1.87	2.04
	Rice straw	3	1.66	1.72	1.84	1.98	1.75	1.64	1.69	1.72	1.80
		5	1.76	1.82	1.89	2.09	1.81	1.67	1.76	1.82	1.95
		7	1.95	1.98	2.05	2.13	1.95	1.70	1.83	1.91	2.20
	Corn stalks	3	1.63	1.71	1.76	1.88	1.78	1.65	1.70	1.73	1.90
		5	1.75	1.79	1.88	2.06	1.83	1.68	1.77	1.84	1.99
		7	1.85	1.89	1.96	2.12	2.19	1.81	1.89	1.92	2.28
60	Cotton stalks	3	1.55	1.60	1.79	1.90	1.90	1.50	1.54	1.60	1.69
		5	1.65	1.71	1.85	1.98	1.98	1.59	1.65	1.73	1.74
		7	1.80	1.82	1.96	2.03	2.03	1.65	1.71	1.80	1.82
	Rice straw	3	1.58	1.62	1.78	1.84	1.72	1.54	1.62	1.65	1.81
		5	1.63	1.72	1.82	1.97	1.95	1.60	1.66	1.75	1.84
		7	1.70	1.80	1.92	2.00	1.99	1.70	1.72	1.82	1.87
	Corn stalks	3	1.55	1.68	1.69	1.72	1.84	1.58	1.64	1.68	1.90
		5	1.62	1.74	1.81	1.95	1.97	1.63	1.69	1.78	1.93
		7	1.67	1.90	1.92	1.99	2.00	1.80	1.82	1.88	2.06
Control			2.66	3.00	3.04	3.05	3.10	2.75	3.00	3.08	3.12

On the other hand, it is obvious that mole space also affect soil penetration resistances. The effect of different spaces on decreasing the values of penetration resistance during the three growing seasons can be arranged in the following descending order : 3m > 5m > 7m > the control. The results indicate also that the application of 7m mole space causes higher soil penetration values especially at 30 cm mole space depth. This may be due to the rapid movement of the drain water from the mid zone of the narrow mole space than the wider zone.

Also, it can be seen that soil penetration resistance just before harvesting have the highest values. This may be because of natural dries of soil during the growing period. These results are in line with El-Maddah *et al.* (2003).

As for residual kind on penetration resistances values, it could be observed that all added residual kinds decreased soil penetration resistance values compared with the control during the three growing seasons. The best treatment was corn stalks in the first season, while it was rice straw in the second season, and cotton stalks in the third season in both 30 and 60 cm mole depth. The decrease of soil penetration resistance with organic residual treatments may be related to the products of organic materials decomposition during growth seasons, microbial gums and promoting root growth enhanced soil aggregation processes, subsequently soil penetrability resistance decreases (Khalil *et al.* 1997).

Concerning the combined effect of different treatments on soil penetration resistance, it could be observed that all mole depths and mole spaces besides all residual kinds decreased soil penetration resistance values comparing to the control. The best treatment was found to be 60 cm mole depth at 3 m spacing with corn stalks residual in the first season since it recorded the lowest values which were 1.55, 1.68, 1.69 and 1.72 MPa, while it was 60 cm mole depth at 3 m spacing with rice straw in the second season which recorded 1.72 MPa and was the same treatment with cotton stalks in the third season which recorded 1.50, 1.54, 1.60 and 1.69 MPa respectively, for the primary three irrigation and just before harvesting except the second season where the value was just before harvesting only. While the control detected the highest values which were 2.66, 3.00, 3.04 and 3.05 MPa respectively in the first season and was 3.10 MPa in the second one while they were 2.75, 3.00, 3.08 and 3.12 MPa respectively in the third season for the same time.

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

1- Soil bulk density, total porosity and void ratio

Data in Tables (4 to 6) and Fig. (2) show that all mole treatments and kinds of residual led to significant decreases in soil bulk density and significant increases in total soil porosity and void ratio of the two sequence soil depths (0-30 and 30-60 cm) at the end pf the three seasons comparing to the control (untreated soil).

Mole depth tended to lower soil bulk density and increase total porosity and void ratio. The 60 cm mole depth decreases bulk density (Db) by 13.95 and 9.70 % respectively over the control for the two depths in the first season, while (Db) was decreased by 16.53 and 12.21 % respectively at the same depths in the second one and by 19.20 and 17.19 %, respectively at the same depths in the third season. The 30 cm mole depth decreases (Db) by 5.43 and 4.48 % respectively for the two depths in the first season and it was decreased by 6.30 and 3.82 % respectively for the same depths in the second one. The decrease in (Db) was 7.20 and 5.47 % respectively at the same depths in the third season.

Table (4): Effect of different treatments on some soil physical properties in the first season (winter 2002/2003)

Mole depth, cm	Residual kind	Mole space, m	Bulk density (Db, g/cm³)		Total porosity (E , %)		Void ratio (e)		Settling, %	
			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	1.24	1.28	53.21	51.70	1.14	1.07	19.54	19.74
		5	1.27	1.30	52.08	50.94	1.09	1.04	20.24	20.56
		7	1.28	1.31	51.70	50.57	1.07	1.02	21.43	21.69
	Rice straw	3	1.21	1.27	54.34	52.08	1.19	1.09	17.74	17.95
		5	1.22	1.29	53.96	51.32	1.17	1.06	18.56	18.63
		7	1.24	1.30	53.21	50.94	1.14	1.04	19.21	19.43
	Corn stalks	3	1.17	1.26	55.85	52.45	1.27	1.10	10.41	10.57
		5	1.18	1.27	55.47	52.08	1.25	1.09	11.63	11.72
		7	1.19	1.28	55.09	51.70	1.23	1.07	12.47	12.61
60	Cotton stalks	3	1.14	1.23	56.98	53.59	1.33	1.16	15.87	16.44
		5	1.15	1.25	56.60	52.83	1.31	1.12	16.94	17.13
		7	1.16	1.28	56.23	51.70	1.28	1.07	17.35	17.92
	Rice straw	3	1.10	1.21	58.49	54.34	1.41	1.19	13.75	13.94
		5	1.12	1.22	57.74	53.96	1.37	1.17	14.37	14.88
		7	1.13	1.24	57.36	53.21	1.35	1.14	15.61	15.84
	Corn stalks	3	1.06	1.14	60.00	56.98	1.50	1.33	5.24	5.83
		5	1.08	1.16	59.25	56.23	1.45	1.29	6.55	7.11
		7	1.09	1.17	58.87	55.85	1.43	1.27	9.67	9.91
Control			1.29	1.34	51.32	49.43	1.05	0.98	22.65	23.92
A Mole depth, cm	30		1.22	1.28	53.88	51.53	1.17	1.06	16.80	16.99
	60		1.11	1.21	57.95	54.30	1.38	1.19	12.82	13.22
	F		28226.72*	120.99*	51.60*	2.20^{NS}	19.65*	1.46^{NS}	159.01*	260.36*
	LSD_{05}		0.003	0.03	2.44	8.02	0.20	0.46	1.36	0.65
B Residual kind	Cotton stalks		1.21	1.28	54.47	51.89	1.20	1.08	18.56	18.91
	Rice straw		1.17	1.26	55.85	52.64	1.27	1.12	16.54	16.78
	Corn stalks		1.13	1.21	57.42	54.22	1.36	1.19	9.33	9.63
	F		36.60*	21.82*	52.28*	2.48^{NS}	43.17*	1.46^{NS}	436.21*	363.04*
	LSD_{05}		0.02	0.02	0.67	2.46	0.04	0.16	0.76	0.83
C Mole space, m	3		1.15	1.23	56.48	53.52	1.31	1.16	13.76	14.08
	5		1.17	1.25	55.85	52.89	1.27	1.13	14.72	15.01
	7		1.18	1.26	55.41	52.33	1.25	1.10	15.96	16.23
	F		4.81*	4.32*	2.10^{NS}	2.87^{NS}	1.68^{NS}	1.65^{NS}	19.28*	12.94*
	LSD_{05}		0.02	0.02	1.08	1.03	0.07	0.06	0.73	0.88

Total porosity (E) and void ratio (e) take the opposite direction, where they were increased in case of 60 cm mole depth by 12.92, 9.85 % and 31.43, 21.43 % for the two soil depths respectively in the first season. While in the second one the increases were 14.98, 12.18 % and 37.62, 29.41 % respectively at the same depths for total porosity and void ratio. In the third season the increases were 16.83, 16.13 % and 44.64, 41.12 % for the same depths. The 30 cm mole depth increased (E) and (e) by 4.99, 4.25 % and 11.42, 8.16 % respectively at the two depths in the first season and by 6.01, 4.01 % and 13.76, 8.82 % respectively for the same depths in the second one, while they were 6.10, 5.18 % and 14.29, 12.15 % respectively at the two depths in the third season.

Concerning the effect of organic residual kinds, data in Tables (4 to 6) and Fig. (2) indicate that all added plant residuals significantly decreased (Db) and significantly increased total porosity and void ratio of the two sequence soil depths (0-30 and 30-60 cm) at the end of the three seasons. The corn stalks treatment was the best one in both first and second seasons where it decreased (Db) by 12.40, 9.70 % and 14.96, 12.98 % respectively for the two soil depths over the control and increased total porosity and void ratio by 11.89, 9.69 % and 29.52, 21.43 % respectively at the same depths in the first season and by 13.59, 12.44 % and 33.95, 31.37 % at the same depths in the second one. Cotton stalks treatment was the best treatment in the third season since it recorded the high decreases in soil bulk density and high increases in soil total porosity and void ratio where the decreases in (Db) were 16.80 and 15.63 % respectively for the same depths and the increases in total porosity and void ratio were 14.97, 14.60 % and 39.29, 37.38 % respectively for the same depths.

With regard to mole space, data clear that the superiority was with closer mole spacing on decreasing soil bulk density and increasing total soil porosity and void ratio. Bulk density was obviously decreased by descending the mole spacing from 7 to 3 m in the three seasons. It was decreased by 10.85 and 8.21 % respectively for the two depths in the first season while it was decreased by 12.60 and 9.16 % respectively at the same depths in the second one and by 14.40 and 12.50 % respectively for the same depths in the third season, for 3 m spacing. As for 5 m spacing it was decreased by 9.30 and 6.72 % respectively for the two depths in the first season while it was 11.81 and 8.40 % respectively at the same depths in the second one and by 12.80 and 10.94 % for the same depths in the third season. Also, it was decreased by 8.59 and 5.97 % respectively for the two depths in the first season while it was 10.24 and 6.87 % for the same depths in the second one and by 11.20 and 10.16 % respectively for the same depths in the third season for 7 m mole spacing.

Total porosity and void ratio tended to take the opposite trend where they were increased by 10.06, 8.27 % and 24.76, 18.37 % respectively over the control for the two depths in the first season and by 11.46, 9.31 % and 28.44, 22.55 % respectively in the second one and by 12.74, 11.80 % and 33.04, 29.91 % respectively at the same depths in the third season for 3 m mole spacing. In case of 5 and 7 m spacing the increases of total porosity and void ratio take the same trend.

Regarding the combined effect of the results revealed that the 60 cm mole depth with corn stalks at 3 m spacing was the best treatment since it induced the lowest value of bulk density 1.06 and 1.14 g cm^{-3} respectively for the two soil depths in the first season while it was 1.01 and 1.03 g cm^{-3} at the same depths in the second one. As for the third season, the best treatment was 60 cm mole depth with cotton stalks at 3 m spacing and the values of (Db) were 0.95 and 0.98 g cm^{-3} at the same depths.

Table (5): Effect of different treatments on some soil physical properties in the second season (summer 2003)

Mole depth, cm	Residual kind	Mole space m	Bulk density (Db, g/cm^3)		Total porosity (E , %)		Void ratio (e)		Settling, %	
			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	1.22	1.27	53.96	52.08	1.17	1.09	19.83	19.87
		5	1.23	1.28	53.58	51.70	1.16	1.07	20.62	20.73
		7	1.25	1.29	52.83	51.32	1.12	1.05	21.71	21.82
	Rice straw	3	1.17	1.25	55.85	52.83	1.27	1.12	18.64	18.71
		5	1.19	1.26	55.09	52.45	1.23	1.10	18.79	18.92
		7	1.20	1.27	54.72	52.08	1.21	1.09	19.49	19.57
	Corn stalks	3	1.13	1.21	57.36	54.34	1.35	1.19	5.87	5.97
		5	1.14	1.24	56.98	53.21	1.32	1.14	7.32	7.47
		7	1.15	1.26	56.48	52.45	1.29	1.10	9.93	9.97
60	Cotton stalks	3	1.09	1.20	58.87	54.72	1.44	1.21	13.88	14.35
		5	1.10	1.22	58.49	53.96	1.41	1.17	14.84	15.43
		7	1.12	1.24	57.74	53.21	1.37	1.14	15.27	15.74
	Rice straw	3	1.05	1.15	60.38	56.60	1.52	1.31	16.74	16.92
		5	1.06	1.17	60.00	55.85	1.50	1.27	17.27	17.64
		7	1.08	1.19	59.25	55.09	1.45	1.23	17.41	17.83
	Corn stalks	3	1.01	1.03	61.89	61.13	1.63	1.58	10.85	10.98
		5	1.02	1.05	61.51	60.38	1.60	1.53	11.83	11.97
		7	1.04	1.07	60.75	59.62	1.55	1.48	12.84	12.95
Control			1.27	1.31	52.08	50.57	1.09	1.02	22.84	23.96
A Mole depth, cm	30		1.19	1.26	55.21	52.50	1.24	1.11	15.80	15.89
	60		1.06	1.15	59.88	56.73	1.50	1.32	14.55	14.87
	F		5280.36	112.93*	3602.67	112.35*	2490.54	167.77*	12.29^{NS}	20.82*
	LSD_{05}		0.01	0.05	0.22	1.72	0.02	0.07	1.54	0.97
B Residual kind	Cotton stalks		1.17	1.25	55.91	52.83	1.28	1.12	17.69	17.99
	Rice straw		1.13	1.22	57.55	54.15	1.36	1.19	18.06	18.27
	Corn stalks		1.08	1.14	59.16	56.86	1.46	1.34	9.77	9.89
	F		77.01*	85.53*	74.58*	85.81*	48.82*	88.02*	500.76*	268.61*
	LSD_{05}		0.02	0.02	0.61	0.72	0.04	0.04	0.68	0.95
C Mole space, m	3		1.11	1.19	58.05	55.28	1.40	1.25	14.30	14.47
	5		1.12	1.20	57.61	54.59	1.37	1.21	15.11	15.36
	7		1.14	1.22	56.96	53.96	1.33	1.18	16.11	16.31
	F		2.08^{NS}	4.26*	2.18^{NS}	4.26*	2.18^{NS}	3.46*	27.25*	61.15*
	LSD_{05}		0.03	0.02	1.08	0.93	0.07	0.05	0.51	0.34

Total porosity and void ratio take the opposite, where the highest values were 60.00, 56.98 % and 1.50, 1.33 respectively for the two soil depths in the first season and were 61.89, 61.13 % and 1.63, 1.58 respectively for the same depths in the second one while in the third season the values were 64.15, 63.02 % and 1.79, 1.71 respectively for the same depths.

Table (6): Effect of different treatments on some soil physical properties in the third season (winter 2003/2004)

Mole depth, cm	Resid-ual kind	Mole space, m	Bulk density (Db, g/cm^3)		Total porosity (E, %)		Void ratio (e)		Settling, %	
			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	1.10	1.15	58.49	56.60	1.41	1.31	10.23	10.98
		5	1.11	1.17	57.99	55.85	1.38	1.27	11.15	11.97
		7	1.13	1.18	57.36	55.47	1.35	1.25	12.17	12.95
	Rice straw	3	1.14	1.19	56.98	55.09	1.33	1.23	16.83	16.98
		5	1.16	1.21	56.23	54.34	1.29	1.19	17.43	17.82
		7	1.18	1.22	55.47	53.96	1.25	1.17	17.65	17.87
	Corn stalks	3	1.20	1.24	54.72	53.21	1.21	1.14	19.35	19.99
		5	1.22	1.25	53.96	52.83	1.17	1.12	20.41	20.94
		7	1.24	1.27	53.21	52.08	1.14	1.09	21.78	21.95
60	Cotton stalks	3	0.95	0.98	64.15	63.02	1.79	1.71	5.95	5.98
		5	0.97	0.99	63.40	62.64	1.73	1.68	7.39	7.49
		7	0.98	1.01	63.02	61.89	1.71	1.62	9.99	10.05
	Rice straw	3	0.99	1.04	62.64	60.75	1.68	1.55	12.93	13.11
		5	1.00	1.06	62.26	60.00	1.65	1.50	13.89	13.96
		7	1.03	1.07	61.13	59.62	1.57	1.48	14.92	14.97
	Corn stalks	3	1.05	1.11	60.38	58.11	1.52	1.39	17.72	17.93
		5	1.07	1.13	59.62	57.36	1.48	1.35	18.40	18.63
		7	1.09	1.14	58.87	56.98	1.43	1.33	18.95	19.05
Control			1.25	1.28	52.83	51.70	1.12	1.07	23.17	23.98
A Mole depth, cm	30		1.16	1.21	56.05	54.38	1.28	1.20	16.33	16.83
	60		1.01	1.06	61.72	60.04	1.62	1.51	13.35	13.46
	F		692.09*	729.00*	784.68*	724.96*	481.67*	400.61*	94.86*	32.10*
	LSD_{05}		0.02	0.02	0.87	1.11	0.07	0.07	1.32	2.56
B Residual kind	Cotton stalks		1.04	1.08	60.74	59.25	1.56	1.47	9.48	9.90
	Rice straw		1.08	1.13	59.12	57.29	1.46	1.35	15.61	15.79
	Corn stalks		1.15	1.19	56.79	55.10	1.33	1.24	19.44	19.75
	F		112.06*	75.20*	116.32*	75.12*	108.00*	67.04*	816.86*	968.17*
	LSD_{05}		0.02	0.02	0.60	0.48	0.04	0.05	0.57	0.52
C Mole space, m	3		1.07	1.12	59.56	57.80	1.49	1.39	13.84	14.16
	5		1.09	1.14	58.91	57.17	1.45	1.35	14.78	15.14
	7		1.11	1.15	58.18	56.67	1.41	1.32	15.91	16.14
	F		11.38*	6.84*	11.25*	6.82*	9.93*	7.85*	47.53*	23.71*
	LSD_{05}		0.02	0.02	0.60	0.63	0.04	0.03	0.44	0.59

These decreases of soil bulk density may be attributed to the high content of organic matter in these residuals which refers to formation of soil aggregates and may be indicated by the improvement in soil structure. These results agree with that obtained by El-Maddah (2000) and El-Maddah and El-Sodany (2003). In general also increasing total soil porosity and void ratio may be related to seasonal variation of bulk density, but this usually requires addition of these residuals for longer periods.

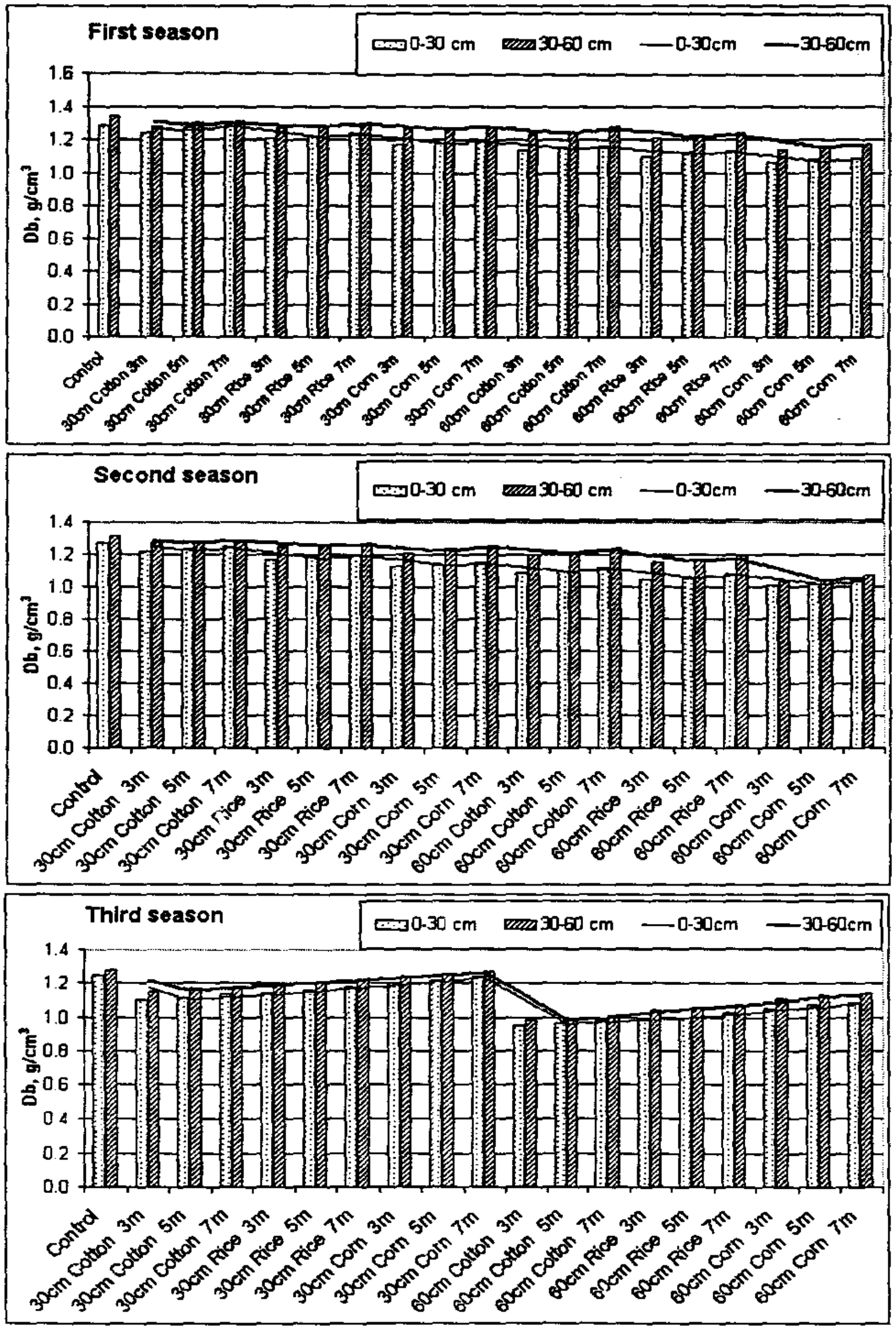


Fig. (2): Effect of different treatments on soil bulk density (Db, g/cm^3) in the three seasons

2- Structural stability (Settling percentage)

The percentage of settling of the soil aggregated were determined as an aspect of structural stability. The low values of settling percentage indicated high degree of structure stability and vice versa. Results in Tables (4 to 6) indicate that the effect of all different treatments on soil structure stability was obvious. The lowest value of settling % (i.e. higher degree of soil structure stability) was resulted under deep mole where the 60 cm mole depth treatments gave the lowest average values which were 12.82 and 13.22 % respectively for the two sequence layer depths (0-30 and 30-60 cm) in the first season, while it was 14.55 and 14.87 % respectively at the same depths in the second one. In the third season it was 13.35 and 13.46 % respectively at the same depths.

Concerning the kind of residuals, data reveal that all added residual plants significantly increased the structure stability, in the three seasons at the two layer depths, where the corn stalks treatment was the best one in both first and second seasons. The mean values were 9.33 and 9.63 %, 9.77 and 9.89 % respectively at the two depths in the two seasons, while the cotton stalks treatment was the best one in the third season since it recorded the highest degree of structure stability, where the mean values were 9.48 and 9.90 % respeotively at the same depths. These results agree with those of Albinet (1971).

With regard to mole space, data show that by decreasing the mole space from 7 to 3 m the values of settling were decreased at the two layer depths in the three seasons. The mean values were 13.76 and 14.08 % respectively for the two soil depths in the first season, while they were 14.30 and 14.47 % for the same depths in the second one, and were 13.84 and 14.16 % at the same depths in the third season.

Regarding to 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 season since it gave lowest value of settling percent where the mean values were 5.24 and 5.83 % at the two depths, while it was 30 cm mole depth with also corn stalks at 3 m spacing where the values were4 5.87 and 5.97 % respectively at the same depths in the second one. While in the third season the best treatment was 60 cm mole depth with cotton stalks at 3 m spacing and the values were 5.95 and 5.98 % respectively at the same depths.

The improvement effect of these treatments may be attributed to the formation of water stable aggregates as a result of root exudates, root growth and decay besides the decomposition of the added residual plants. The results agree with that obtained by El-Maddah and El-Sodany (2003).

III- Effect of different treatments on some soil hydrophysical properties:

1- Soil hydraulic conductivity :

Soil saturated hydraulic conductivity and soil infiltration characteristics are supposed to be increased with the presence of wide and continuous pores. Thus their values are affected by any factors that affect the soil porosity such as mole depth and addition of organic residuals. Results in Tables (7 to 9) and Fig. (3) show that all mole treatments and residual kinds indicated progressive increase in soil hydraulic conductivity (Kh) of the two sequence depths (0-30 and 30-60 cm) at the end of the three seasons comparing to the control (untreated soil). It can be noticed that Kh values increased with increasing soil depths. Mole depth caused a gradual increase in Kh where 60 cm mole depth increased it by 53.57 and 53.85 % respectively for the two depths in the first season, while it was 61.40 and 54.72 % respectively at the same depths in the second one and were 58.62 and 61.11 % respectively at the same depths in the third season. The 30 cm mole depth increased it by 35.71 and 36.54 % respectively for the two depths in the first season and by 47.37 and 52.83 % respectively at the same depths in the second one. While in the third season it was 48.28 and 48.15 % respectively for the same depths.

Concerning the residual kinds, data in Tables (7 to 9) and Fig. (3) indicate that all added residual of plants significantly increased hydraulic conductivity in the three seasons at the two layer depths.

Table (7): Effect of different treatments on some soil hydrophysical properties in the first season (winter 2002/2003)

Mole depth, cm	Residual kind	Mole space, m	Kh, cm/hr		Soil moisture content, % SP		FC		WP		AW, %		Cu, cm	WUE, Kg fed^{-1}cm^{-1}	Wheat grain yield Kg/fed
			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	0.69	0.64	79.62	77.11	42.73	40.33	22.08	20.68	20.65	19.65	87.62	29.41	2577.00
		5	0.66	0.62	80.11	77.65	42.91	40.74	22.14	20.92	20.77	19.82	88.95	28.54	2539.00
		7	0.64	0.61	81.67	79.32	43.35	40.97	22.94	21.11	20.86	20.11	90.32	27.39	2474.00
	Rice straw	3	0.74	0.69	85.69	85.37	45.37	43.19	24.66	23.63	20.71	19.56	86.24	31.71	2735.00
		5	0.72	0.67	86.72	85.89	45.74	43.69	24.77	23.76	20.97	19.93	86.69	30.77	2667.00
		7	0.70	0.65	87.84	86.77	45.98	43.96	24.82	23.78	21.16	20.18	87.41	30.01	2623.00
	Corn stalks	3	0.92	0.85	88.21	83.81	46.23	44.15	25.38	24.31	20.85	19.84	84.75	35.40	3000.00
		5	0.90	0.83	88.63	84.15	46.74	44.74	25.72	24.67	21.02	20.07	85.11	34.02	2895.00
		7	0.89	0.82	89.74	84.71	46.89	44.97	25.76	24.77	21.13	20.20	85.82	33.19	2825.00
60	Cotton stalks	3	0.81	0.76	76.64	74.67	41.86	39.15	21.36	19.72	20.50	19.43	83.84	32.15	2695.00
		5	0.78	0.74	77.14	75.69	42.12	39.67	21.45	19.98	20.67	19.69	84.15	31.04	2612.00
		7	0.75	0.71	78.35	76.47	42.65	39.94	21.81	20.10	20.84	19.84	84.95	30.03	2551.00
	Rice straw	3	0.87	0.80	82.15	79.72	43.54	41.27	23.57	22.56	19.97	18.71	80.43	35.68	2870.00
		5	0.84	0.78	82.89	80.21	43.89	41.82	23.60	23.03	20.29	18.79	81.95	33.98	2785.00
		7	0.82	0.77	83.53	80.74	44.25	42.13	23.65	23.21	20.60	18.92	82.47	32.86	2710.00
	Corn stalks	3	0.97	0.91	83.91	81.22	44.23	42.51	24.27	23.03	19.96	19.48	77.69	40.22	3125.00
		5	0.95	0.89	84.47	81.53	44.92	42.87	24.40	23.27	20.52	19.60	78.82	37.81	2980.00
		7	0.93	0.88	85.13	82.67	45.11	42.96	24.57	23.33	20.54	19.63	79.65	36.10	2875.00
Control			0.56	0.52	76.15	74.17	41.10	38.32	21.30	19.67	19.80	18.65	94.45	23.51	2220.00
A Mole depth, cm	30		0.76	0.71	85.36	82.75	45.10	42.97	24.25	23.07	20.90	19.93	86.99	31.16	2703.89
	60		0.86	0.80	81.58	79.21	43.62	41.37	23.19	22.03	20.43	19.34	81.55	34.43	2800.33
	F		715.74^*	228.74^*	62.12^*	121.45^*	13.68^{NS}	189.36^*	24.29^*	4.34^{NS}	1.64^{NS}	16.50^{NS}	1322.38^*	482.28^*	0.95NS
	LSD_{05}		0.02	0.03	2.06	1.38	1.73	0.50	0.93	2.16	1.58	0.62	0.64	0.64	0.43
B Residual kind	Cotton stalks		0.72	0.68	78.92	76.82	42.60	40.13	21.96	20.42	20.72	19.76	86.64	29.76	2574.67
	Rice straw		0.78	0.73	84.80	83.12	44.80	42.68	24.18	23.33	20.62	19.35	84.20	32.50	2731.67
	Corn stalks		0.93	0.86	86.68	83.02	45.69	43.70	25.02	23.90	20.67	19.80	81.97	36.12	2950.00
	F		195.60^*	262.61^*	394.06^*	299.96^*	31.33^*	162.99^*	28.14^*	34.74^*	0.01^{NS}	1.86^{NS}	31.19^*	95.56^*	15.68^*
	LSD_{05}		0.02	0.02	0.66	0.68	0.92	0.47	0.97	1.03	1.38	0.60	1.36	1.06	0.16
C Mole space, m	3		0.83	0.78	82.70	80.32	43.99	41.77	23.55	22.32	20.44	19.45	83.43	34.10	2833.67
	5		0.81	0.76	83.33	80.85	44.39	42.26	23.68	22.61	20.71	19.65	84.28	32.69	2746.33
	7		0.79	0.74	84.36	81.78	44.71	42.49	23.93	22.72	20.86	19.81	85.10	31.60	2676.33
	F		11.81^*	7.24^*	6.12^*	5.70^*	1.72^{NS}	3.59^*	0.30^{NS}	1.03^{NS}	0.27^{NS}	0.35^{NS}	1.74^{NS}	32.06^*	1.72NS
	LSD_{05}		0.02	0.02	1.00	0.91	0.79	0.57	1.01	0.59	1.19	0.91	1.85	0.65	0.18

Kh = Hydraulic conductivity **SP = Saturation percentage**
FC = Field capacity **WP = Wilting point**
AW = Available water **Cu = water consumption**
WUE = water use efficiency

The superiority was to corn stalks in the first season where the increases were 29.17 and 26.47 % respectively for the two depths than cotton stalks and were 19.23 and 17.81 % respectively at the same depths than rice straw, while in the second season the increases were 19.50 and 20.78 % respectively for the two depths than cotton stalks and were 18.07 and 22.37 % respectively at the same depths than rice straw. In the third season the best residual was cotton stalks which caused increases in Kh by 36.00 and 38.57 % respectively for the two depths than corn stalks and were 14.61 and 15.48 % respectively for the same depths than rice straw. These results are in line with Talha *et al.* (1979a).

Regarding the mole spacing, it can be noticed that decreasing the distance between the moles lead to an increase in soil hydraulic conductivity where the 3 m spacing increased it by 48.21 and 50.00 %, respectively at the two layer depths in the first season and by 57.89 and 60.38 %, respectively at the same depths in the second one and by 56.90 and 59.26 %, respectively at the same depths in the third season.

With regard to 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 season since it gave the highest value of Kh 0.97 and 0.91 cm hr^{-1} respectively at the two depths, while it was 30 cm mole depth with corn stalks also at 3 m spacing where the values were 1.02 and 0.98 cm hr^{-1} respectively at the same depths in the second one. In the third season the best treatment was 60 cm mole depth with cotton stalks at 3 m spacing and the values were 1.08 and 1.03 cm hr^{-1} respectively at the same depths.

Table (8): Effect of different treatments on some soil hydrophysical properties in the second season (summer 2003)

Mole depth, cm	Residual kind	Mole space, m	Kh, cm/hr		Soil moisture content, %						AW, %		Cu, cm	WUE, Kg $fed^{-1}cm^{-1}$	Rice grain yield Kg/fed
					SP		FC		WP						
			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	0.76	0.75	73.87	71.68	40.68	38.66	21.51	20.34	19.17	18.32	106.85	35.96	3842.00
		5	0.72	0.71	74.56	72.57	40.96	39.04	21.59	20.62	19.37	18.42	107.92	34.29	3700.00
		7	0.69	0.67	75.67	73.42	41.10	39.36	21.69	20.86	19.41	18.50	108.65	33.32	3620.00
	Rice straw	3	0.83	0.80	82.27	81.17	43.89	42.09	23.27	22.88	20.62	19.21	103.22	38.50	3974.00
		5	0.80	0.78	82.91	81.89	44.12	42.35	23.42	23.01	20.70	19.34	104.65	36.60	3830.00
		7	0.78	0.77	83.76	82.37	44.53	42.75	23.71	23.23	20.82	19.52	105.82	35.53	3760.00
	Corn stalks	3	1.02	0.98	84.17	82.79	44.87	43.05	24.02	23.27	20.85	19.78	99.85	41.01	4095.00
		5	1.00	0.95	84.63	83.15	45.11	43.32	24.13	23.42	20.98	19.90	100.97	39.71	4010.00
		7	0.99	0.93	85.81	83.74	45.62	43.86	24.20	23.71	21.42	20.15	101.65	38.05	3868.00
60	Cotton stalks	3	0.94	0.86	76.83	73.97	41.21	39.41	21.74	20.87	19.47	18.54	95.84	44.70	4284.00
		5	0.92	0.83	77.47	74.83	41.45	39.87	21.96	21.20	19.49	18.67	97.63	42.31	4131.00
		7	0.90	0.82	77.85	75.48	41.65	40.13	22.12	21.37	19.53	18.76	98.75	41.52	4100.00
	Rice straw	3	0.89	0.76	80.15	78.79	42.83	41.21	22.88	22.18	19.95	19.03	93.78	47.87	4489.00
		5	0.86	0.74	80.96	79.43	43.25	41.53	23.01	22.42	20.24	19.11	94.35	45.88	4329.00
		7	0.84	0.71	81.75	80.74	43.54	41.89	23.23	22.56	20.31	19.31	95.15	44.02	4188.00
	Corn stalks	3	0.98	0.92	78.17	76.59	42.11	40.65	22.52	21.90	19.59	18.75	90.42	51.43	4650.00
		5	0.96	0.90	78.69	77.64	42.41	40.90	22.65	22.02	19.76	18.88	91.67	47.88	4389.00
		7	0.95	0.87	79.74	78.23	42.67	41.03	22.80	22.06	19.87	18.95	92.82	46.27	4295.00
Control			0.57	0.53	73.65	71.49	40.55	38.28	21.45	20.18	19.10	18.10	111.55	30.21	3370.00
A Mole depth, cm	30		0.84	0.82	80.85	79.20	43.43	41.61	23.06	22.37	20.37	19.24	104.40	37.00	3855.44
	60		0.92	0.82	79.07	77.30	42.35	40.74	22.55	21.35	19.80	18.69	94.49	45.76	4317.22
	F		113.17*	3.77^{ns}	310.83*	9.13^{ns}	6.79^{ns}	72.92*	9.24^{ns}	0.99^{ns}	1.22^{ns}	0.42^{ns}	208.65*	435.32*	44.53*
	LSD_{05}		0.03	0.02	0.44	2.70	1.79	0.44	0.73	2.27	2.22	2.30	2.95	1.81	0.30
B Residual kind	Cotton stalks		0.82	0.77	76.04	73.66	41.18	39.41	21.77	20.88	19.41	18.54	102.61	38.68	3946.17
	Rice straw		0.83	0.76	81.97	80.73	43.69	41.97	23.25	22.72	20.44	19.25	99.50	41.40	4095.00
	Corn stalks		0.98	0.93	81.87	80.36	43.80	42.14	23.39	22.73	20.41	19.40	96.23	44.06	4217.83
	F		125.12*	181.46*	186.73*	139.98*	13.73*	267.83*	26.34*	8.26*	1.43^{ns}	1.60^{ns}	58.72*	1137.57*	8.58*
	LSD_{05}		0.03	0.02	0.61	1.10	1.31	0.30	0.57	1.21	1.60	1.19	1.38	0.26	0.15
C Mole space, m	3		0.90	0.85	79.24	77.50	42.60	40.85	22.66	21.91	19.94	18.94	98.33	43.25	4222.33
	5		0.88	0.82	79.87	78.25	42.88	41.17	22.79	22.12	20.09	19.05	99.53	41.11	4064.83
	7		0.86	0.80	80.76	79.00	43.19	41.50	22.96	22.31	20.23	19.20	100.47	39.79	3971.83
	F		8.17*	9.18*	4.06*	15.69*	1.82^{ns}	3.92*	0.60^{ns}	1.88^{ns}	0.17^{ns}	0.35^{ns}	4.71*	115.15*	4.35*
	LSD_{05}		0.03	0.02	1.11	0.55	0.63	0.49	0.57	0.42	1.00	0.64	1.45	0.48	0.18

Kh = Hydraulic conductivity SP = Saturation percentage FC = Field capacity WP = Wilting point
AW = Available water Cu = water consumption WUE = water use efficiency

Generally, these increase in Kh may be due to modification in pore size distribution, i.e., the increase in drainable pores. (Abdel-Aziz *et al.*, 1996).

These results are in general agreement with those reported by El-Sabry *et al.* (1992) and El-Maddah and El-Sodany (2003).

Table (9): Effect of different treatments on some soil hydrophysical properties in the third season (winter 2003/2004)

Mole depth, cm	Residual kind	Mole space, m	Kh, cm/hr		Soil moisture content, % SP		FC		WP		AW, %		Cu, cm	WUE, Kg fed^{-1} cm^{-1}	Onion seed yield Kg/fed
			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	1.01	0.95	79.89	78.74	44.10	41.95	23.21	21.69	20.89	20.26	54.14	6.83	370.00
		5	0.99	0.93	80.15	79.19	44.32	42.25	23.33	21.72	20.99	20.53	55.97	6.49	363.00
		7	0.97	0.91	80.63	79.85	44.73	42.67	23.54	21.89	21.19	20.78	56.62	6.32	358.00
	Rice straw	3	0.89	0.83	78.12	75.84	41.89	40.38	22.10	21.10	19.79	19.28	58.24	6.11	356.00
		5	0.86	0.80	78.53	76.11	42.23	40.57	22.12	21.23	20.11	19.34	59.16	5.95	352.00
		7	0.84	0.79	78.96	76.64	42.47	40.88	22.33	21.31	20.14	19.57	60.45	5.73	347.00
	Corn stalks	3	0.74	0.69	74.38	72.13	40.23	38.64	21.12	19.95	19.11	18.69	61.17	5.62	344.00
		5	0.72	0.66	75.87	72.57	40.51	38.91	21.30	20.15	19.21	18.76	62.25	5.46	340.00
		7	0.70	0.64	76.49	73.17	40.79	39.25	21.45	20.44	19.34	18.81	63.87	5.29	338.00
60	Cotton stalks	3	1.08	1.03	79.06	77.13	42.74	41.13	22.49	21.34	20.25	19.79	47.72	8.40	401.00
		5	1.05	1.01	79.33	77.74	43.15	41.32	22.56	21.38	20.59	19.94	48.44	8.15	395.00
		7	1.03	0.99	79.65	78.35	43.32	41.65	22.67	21.55	20.65	20.10	49.21	7.97	392.00
	Rice straw	3	0.95	0.90	76.33	73.81	41.04	39.63	21.63	20.75	19.41	18.88	49.68	7.87	391.00
		5	0.92	0.87	77.08	74.74	41.21	39.82	21.69	20.84	19.52	18.98	50.11	7.72	387.00
		7	0.90	0.85	77.74	75.23	41.64	40.10	21.99	21.00	19.65	19.10	50.66	7.56	383.00
	Corn stalks	3	0.80	0.78	72.46	70.38	39.33	38.29	20.56	19.68	18.77	18.61	51.81	7.37	382.00
		5	0.77	0.72	73.72	71.41	39.58	38.44	20.77	19.81	18.81	18.63	52.16	7.23	377.00
		7	0.75	0.70	74.27	72.02	39.97	38.59	21.10	19.94	18.87	18.65	53.85	6.91	372.00
Control			0.58	0.54	72.32	70.28	39.30	38.25	20.23	20.20	19.07	18.05	64.65	5.21	337.00
A Mole depth, cm	30		0.86	0.80	78.11	76.03	42.36	40.61	22.28	21.05	20.09	19.56	59.10	5.98	352.00
	60		0.92	0.87	76.63	74.53	41.33	39.89	21.72	20.70	19.61	19.19	50.40	7.69	386.67
	F		53.22*	86.67*	297.33*	72.06*	113.06*	10.31^{NS}	21.51*	2.73^{NS}	4.71^{NS}	0.72^{NS}	950.58*	112.14*	143.08*
	LSD_{05}		0.03	0.04	0.37	0.76	0.42	0.97	0.52	0.92	0.94	1.88	1.21	0.69	12.47
B Residual kind	Cotton stalks		1.02	0.97	79.79	78.50	43.73	41.83	22.97	21.60	20.76	20.23	52.02	7.36	379.83
	Rice straw		0.89	0.84	77.79	75.40	41.75	40.23	21.98	21.04	19.77	19.19	54.72	6.82	369.33
	Corn stalks		0.75	0.70	74.53	71.95	40.07	38.69	21.05	20.00	19.02	18.69	57.52	6.31	358.83
	F		330.06*	253.00*	32.71*	174.89*	212.77*	149.38*	16.75*	17.48*	8.13*	9.66*	59.82*	286.09*	57.43*
	LSD_{05}		0.02	0.03	1.51	0.61	0.41	0.42	0.76	0.63	1.00	0.82	1.16	0.10	4.52
C Mole space, m	3		0.91	0.86	76.71	74.67	41.56	40.00	21.85	20.75	19.70	19.25	53.79	7.03	374.00
	5		0.89	0.83	77.45	75.29	41.83	40.22	21.96	20.86	19.87	19.36	54.68	6.83	369.00
	7		0.87	0.81	77.96	75.88	42.15	40.52	22.18	21.02	19.97	19.50	55.78	6.63	365.00
	F		9.05*	13.86*	5.63*	4.61*	4.98*	2.24^{NS}	0.71^{NS}	1.03^{NS}	0.37^{NS}	0.25^{NS}	16.85*	29.54*	12.40*
	LSD_{05}		0.02	0.02	0.77	0.82	0.39	0.51	0.58	0.39	0.65	0.73	0.71	0.11	3.74

Kh = Hydraulic conductivity SP = Saturation percentage FC = Field capacity WP = Wilting point
AW = Available water Cu = water consumption WUE = water use efficiency

2- Soil moisture characteristics:

Soil moisture content is one of the limiting factor on agriculture development, particularly in arid and semi-arid areas where the amount of water is very limited. The capacity of soils to receive or store water which is available to growing plants is a great importance to agriculture production. Soil moisture content distribution data provided strong evidence for both lateral and deeply movement of drain water in each tilled sector.

The recorded data in Tables (7 to 9) show that as the mole depth increase all moisture characteristics decrease, where the 60 cm mole depth treatment gave the lowest values of saturation percent (S.P), field capacity (F.C) and wilting point (W.P) which were 81.58, 79.21 % & 43.62, 41.37 % and 23.19, 22.03 % respectively for S.P, F.C and W.P at the two sequence layer depths (0-30 and 30-60 cm) in the first season, while they were 79.07, 77.30 % & 42.35, 40.74 % and 22.55, 21.85 % respectively for the same parameters at the same depths in the second one.

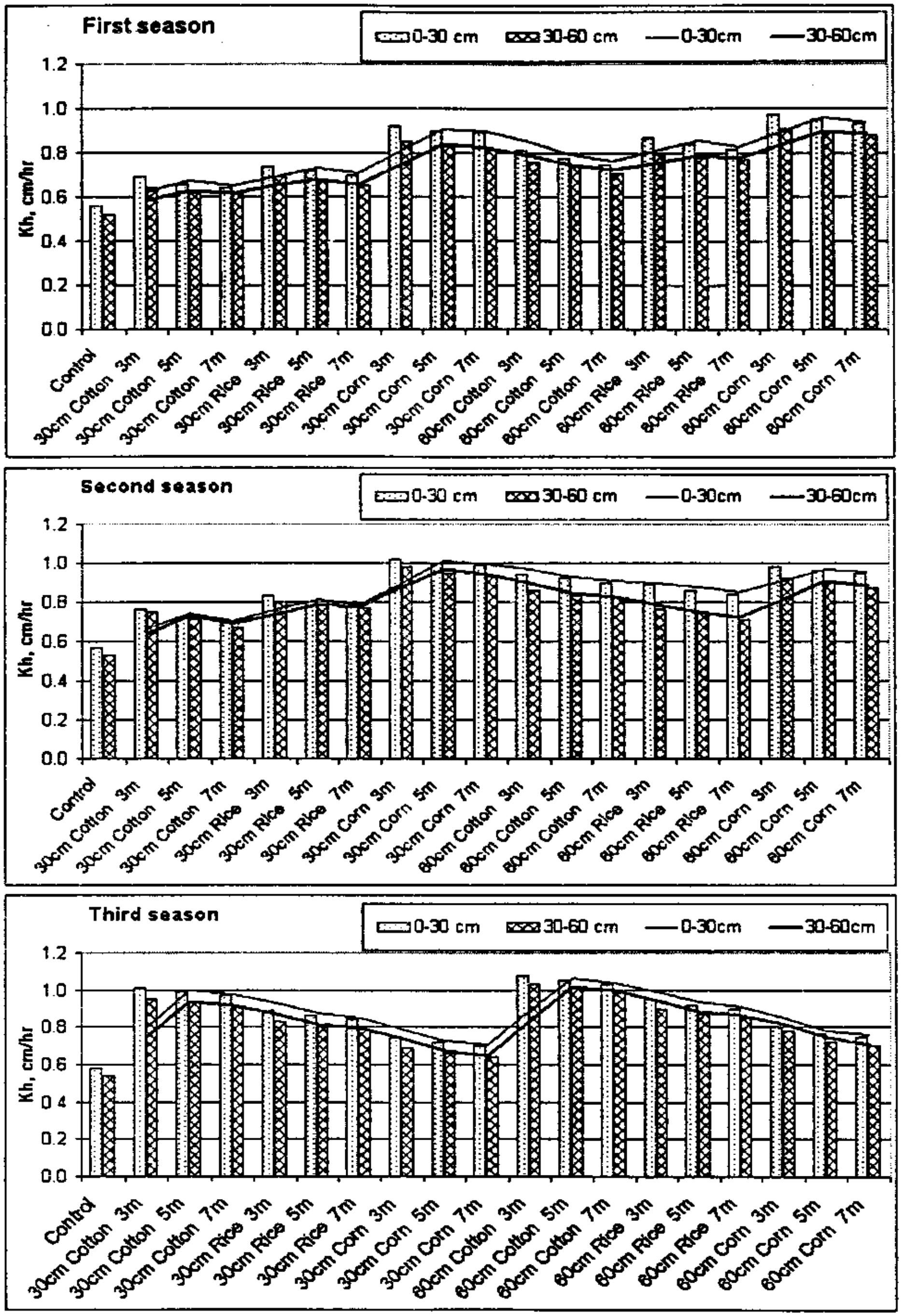


Fig. (3): Effect of different treatments on soil hydraulic conductivity (Kh, cm/hr) in the three seasons

As for the third season, the values were 76.63, 74.53 % & 41.33, 39.89 % and 21.72, 20.70 % respectively for the same parameters at the same depths. In case of 30 cm mole depth the mean values take the same trend for the two soil depths in the three growing seasons, but with high values.

With respect to the kind of organic residuals, data in Tables (7 to 9) indicate that all added plant residuals significantly increased all moisture characteristics at the two soil depths at the end of the three sequences seasons. The corn stalks treatment was the best treatment in both first and second seasons since it recorded the highest values of all moisture characteristics where the values were 86.68, 83.02 % & 45.69, 43.70 % and 25.02, 23.90 %, respectively for S.P, F.C and W.P at the two soil depths in the first season, while they were 81.87, 80.36 % & 43.80, 42.14 % and 23.39, 22.73 % respectively for the same parameters at the same depths in the second season. Thus the residual kinds can be arranged in their effects in the order : corn stalks > rice straw > cotton stalks > control in the first and second seasons. The cotton stalks treatment was the best one in the third season where it has the highest values of all moisture characteristics. The values were 79.79, 78.50 % and 43.73, 41.83 % and 22.97, 21.60 % respectively for the same parameters at the same depths, and the residual kinds can be arranged in the following order : cotton stalks > rice straw > corn stalks > control .

With regard to the mole spacings, data show that the lowest moisture content values are in favor with narrow mole space, where the 3 m mole space gave the lowest values. The mean values were 82.70, 80.32 % & 43.99, 41.77 % and 23.55, 22.32 % respectively for S.P, F.C and W.P % at the two layers of soil in the first season and were 79.24, 77.50 % & 42.60, 40.85 % and 22.66, 21.91 % respectively for the same parameters at the same depths in the second one. While in the third season, the values were 76.71, 74.67 % & 41.56, 40.00% and 21.85, 20.75 %, respectively for the same parameters at the same depths. With increasing mole spacings from 3 to 7 m the values were increased where it reached to 84.38, 81.78% & 44.71, 42.49 % and 23.93, 22.72 % respectively for S.P, F.C and W.P at the two layer depths in the first season and to 80.76, 79.00 % and 43.19, 41.50 % and 22.96, 22.31 %, respectively for the same parameters at the same depths in the second one. While they reached to 77.96, 75.88 % & 42.15, 40.52 % and 22.18, 21.02 %, respectively for the same parameters at the same depths in the third season.

With respect to the combined effect, data cleared that the best treatment was 30 cm mole depth with corn stalks at 7 m spacing in the first and second seasons since it gave the highest values of moisture content where the mean values were 89.74, 84.71 % & 46.89, 44.97 % and 25.76, 24.77 % respectively for S.P, F.C and W.P % for the two soil layers and 85.81, 83.74 % & 45.62, 43.86 % and 24.20, 23.71 % respectively for the same characters and same depths in the second one, while it was 30 cm mole depth with cotton stalks at 7 m space treatment in the third season where the mean values were 80.63, 79.85 % & 44.73, 42.67 % and 23.54, 21.89 % respectively for the same parameters at the same depths. These results may be due to sub-soiling has substantially improved water and root penetration (Michael and Ojha 1981) besides the decomposition of plant residuals may be led to formation of water stable aggregates. Also, these results are confirmed with Shetawy (2001) and El-Maddah and El-Sodany (2003).

3- Available water:

Results presented in Tables (7 to 9) reveal that soil available water (A.W, %) were increased with all mole treatments and residual kinds of the two sequences layer depths (0-30 and 30-60 cm) at the end of the three seasons comparing to the control (untreated soil). Also, it can be noticed that A.W,% values were decreased with increasing soil depths where the 60 cm mole depth recorded the values 20.43 and 19.34 % respectively for the two soil depths in the first season, while it was 19.80 and 18.89 % respectively at the same depths in the second one and were 19.61 and 19.19 % respectively at the same depths in the third season. In case of 30 cm mole depth the mean values take the same trend for the two soil depths in the three growing seasons but with high values.

Regarding the kind of plant residuals, data in Tables (7 to 9) indicate that all added plant residuals slightly increased A.W,% at the two soil depths at the end of the first and second season where their effect on increasing the values can be arranged in the following order : corn stalks > rice straw > cotton stalks. While in the third season the increase was significant, and the residual kinds can be arranged in the following order : cotton stalks > rice straw > corn stalks. This may be due to the rapid decomposition of the corn stalks than both rice straw and cotton stalks due to its narrow C/N ratio (Table 1b).

Regarding to the mole spacing, it can be noticed that decreasing the distance between the moles also, decrease the values of A.W, % where the 3m spacing recorded the lowest values of A.W % which were 20.44 and 19.45 % respectively at the two layer depths in the first season and 19.94 and 18.94 % respectively at the same depths in the second one and 19.70 and 19.25 % at the same depths in the third season. By increasing mole spacings from 3 to 7 m the values were slightly increased. This may be due to improve infiltration rate of the soil by installation moles at 3m spacing.

4- Water consumption (Cu) and water use efficiency (WUE):

Data in Tables (7 to 9) and Figs. (4 and 5) show that all mole treatments and residual kinds led to decrease in water consumption (Cu) at the three seasons compared with the control (untreated soil). While water use efficiency (WUE) take the opposite trend where the different mole treatments and residual kinds significantly increased it for wheat, rice and onion during the three growing seasons of study. Also, it is clear from data presented in Tables (7 to 9) that Cu values for wheat, rice and onion were increased by decreasing mole depth. The 30cm mole depth significantly increased Cu values over the 60cm mole depth. The increase percentages due to mole depth comprised 6.67, 10.48 and 17.26% for wheat, rice and onion respectively. These increases in Cu values may be due to that the moisture of soil under 30cm mole depth is more subjected to crop transpiration and evaporation from the soil. On the other hand, increasing mole depth tended to increase WUE in the three growing seasons where the 60cm mole depth increased it by 39.38, 23.71 and 28.60% over 30cm mole depth in the first, second and third seasons, respectively. Thus it is clear that WUE tended to decrease with the increase in water retained in root zone. These results are in line with those reported by El-Maddah and El-Sodany (2003).

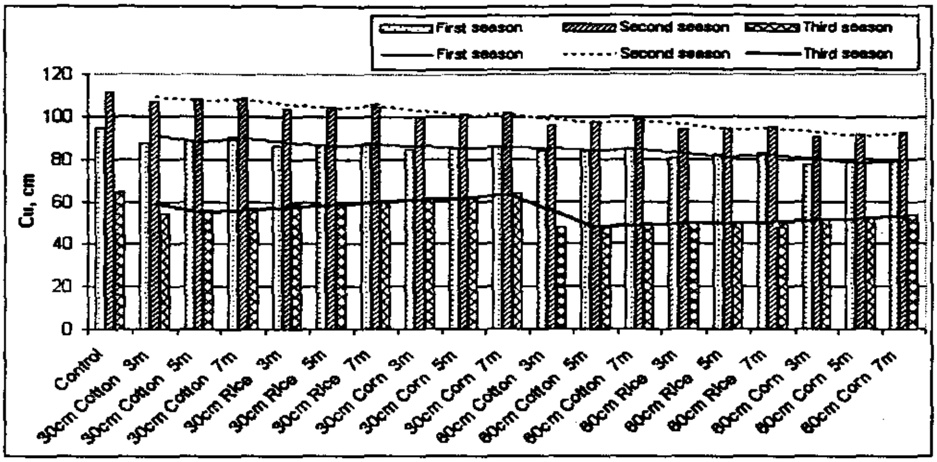


Fig. (4): Effect of different treatments on water consumption (Cu, cm) in the three seasons

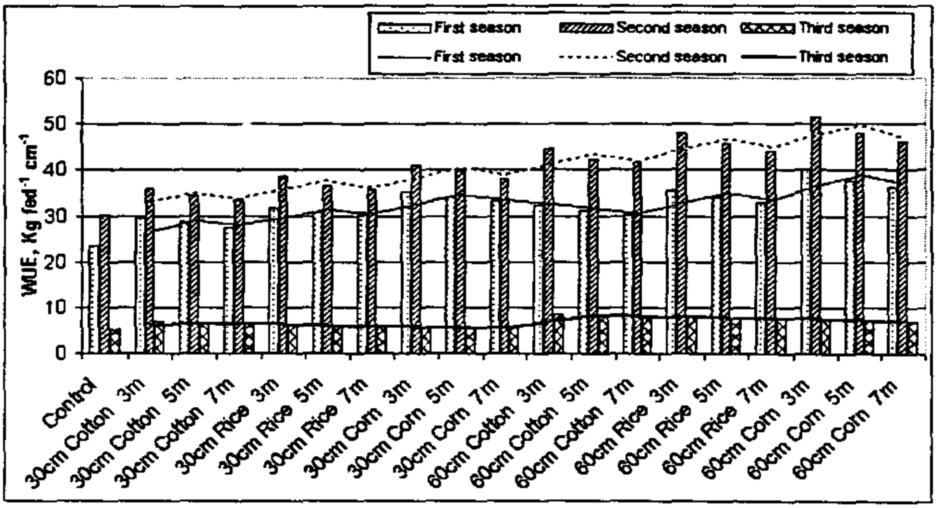


Fig. (5): Effect of different treatments on water use efficiency (WUE, Kg $fed^{-1}cm^{-1}$) in the three seasons

Regarding to residual kinds, data in Tables (7 to 9) and Figs. (4 and 5) indicate that all added residual plants significantly decrease the Cu and significantly increase the WUE in the three growing seasons. The superiority was to corn stalks in the first and second seasons where the decreases in Cu were 13.21 and 13.73%, respectively over the control (untreated soil) for the first and second seasons, while WUE increases were 53.64 and 45.86%, respectively over the control (untreated soil) for the same seasons. In the third season the best residual was cotton stalks which caused decrease in Cu by 19.53% and increase in WUE by 41.27% over the control.

Concerning to the effect of mole spacings on Cu for wheat, rice and onion, it noticed that increasing the mole spacings from 3 to 7m caused a significant increase in Cu values in second and third seasons only while in the first one the increase was insignificant where the values were 83.43, 84.28 and 85.10cm respectively for 3, 5 and 7m spacings in the first season and were 98.33, 99.53 and 100.47cm, respectively for the same spacings in the second one while they were 53.79, 54.68 and 55.78cm, respectively for the same spacings in the third season. This increase may be attributed to the increases of soil moisture content with increasing mole spacings as mentioned before.

Regarding to the effect of mole spacings on WUE, it seems that WUE was significantly increased by decreasing mole spacings, where the values was 31.60 kg fed^{-1} cm^{-1} for 7m spacings increased to be 32.69 and 34.10 kg fed^{-1} cm^{-1} respectively for 5 and 3m spacings in the first seasons, and was 39.79 kg fed^{-1} cm^{-1} for 7m spacings increased to be 41.11 and 43.25 kg fed^{-1} cm^{-1} respectively for the same spacings in the second one, while in the third season it was 6.63 kg fed^{-1} cm^{-1} for 7m spacings increased to reach 6.83 and 7.03 kg fed^{-1} cm^{-1} respectively for 5 and 3m spacings. This increases may be attributed to the significantly increases in the yield caused by installation of moles at 3, 5 and 7m spacings which obviously increased the relative yield (El-Abaseri *et al.* 1996).

With regard to the combined effect, data show that 60cm mole depth with corn stalks at 3m spacings was the best treatment in the first and second seasons since it gave the lowest values of Cu 77.69 and 90.42cm respectively, and gave the highest values of WUE 40.22 and 51.43 kg fed^{-1} cm^{-1} respectively for the first and second seasons. In the third season the best treatment was 60cm mole depth with cotton stalks at 3m spacing and the values were 47.72cm and 8.40 kg fed^{-1} cm^{-1}, respectively for Cu and WUE as shown in Tables (7 to 9).

VI- 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.

The average of total moling costs and net profit as affected by different treatments are shown in Table (10). 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) 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 economy to decrease mole space down to 3m to increase the net profit.

Table (10): 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 revenue
				Wheat grain	Wheat straw	Rice grain	Onion seed	
30	Cotton stalks	3	177.25	392.70	98.20	472.00	1320.00	2105.65
		5	121.78	350.90	79.80	330.00	1040.00	1678.92
		7	70.97	279.40	60.40	250.00	840.00	1376.83
	Rice straw	3	177.25	566.50	144.40	604.00	760.00	1897.65
		5	121.78	491.70	137.00	460.00	600.00	1566.92
		7	70.97	443.30	109.00	390.00	400.00	1271.33
	Corn stalks	3	177.25	858.00	206.00	725.00	280.00	1891.75
		5	121.78	742.50	186.00	640.00	120.00	1566.72
		7	70.97	665.50	180.00	498.00	40.00	1312.53
60	Cotton stalks	3	208.56	522.50	126.40	914.00	2560.00	3705.78
		5	151.84	431.20	114.40	761.00	2320.00	3474.76
		7	101.70	364.10	103.20	730.00	2200.00	3295.60
	Rice straw	3	208.56	715.00	173.40	1119.00	2160.00	3958.84
		5	151.84	621.50	154.40	959.00	2000.00	3583.06
		7	101.70	539.00	142.80	818.00	1840.00	3238.10
	Corn stalks	3	208.56	995.50	258.00	1280.00	1800.00	4124.94
		5	151.84	836.00	233.40	1019.00	1600.00	3536.56
		7	101.70	720.50	216.60	925.00	1400.00	3160.40

* = (yield of the treatment - control) - cost of the treatment.
The price of the yield and the costs of different treatments were calculated as subsidized price of 2003 and 2004

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 residuals can be arranged according to high their net revenue as follows : corn stalks > rice straw > cotton stalks.

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

Thus according to the economic evaluation in Table (10) 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 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 الأرض الطبيعية والهيدروفيزيائية

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تختص هذة التجارب الحقلية بتقييم تأثير إضافة مخلفات المحاصيل الموضوعة في أنفاق علي بعض الخواص الطبيعية والهيدروفيزيائية للتربة بالإضافة إلي التخلص من هذة المخلفات النباتية التي يسبب حرقها السحابة السوداء التي تغطي سماء مصر بالإضافة إلي إجراء الدراسة الاقتصادية بهدف تحديد أفضل معاملة لتحقيق اعلي صافي دخل مزرعي . وقد وضع (حطب القطن ، قش 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 هذة الأنفاق بواسطة ديتشر خاص . وقد نفذت هذة التجارب في محطة البحوث الزراعية بالجميزة – محافظة الغربية خلال ثلاث مواسم زراعية متتالية من عام ٢٠٠٢ إلي عام ٢٠٠٤ . 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 ٢,٤١ إلي ١,٨٦ % كما يتراوح رقم حموضة التربة بين ٧,٨٥ ، ٧,٩١ والتوصيل الكهربي بين ٥,٢٦ ، ٥,٨٣ ملليموز/سم . ويمكن تلخيص النتائج المتحصل عليها كالتالي :-

١. زيادة معدل استهلاك الوقود بنسبة ١٩,٥١ % بزيادة عمق الأنفاق، كما زاد استهلاك الطاقة من ٤٣,٢٨ إلي ٥١,٥٤ كيلو وات بزيادة عمق الأنفاق من ٣٠ إلي ٦٠ سم ، كما أدت هذة المعاملات إلي زيادة نسبة الانزلاق حيث وصلت أقصي قيمة إلي ٦,٢٢ ، ١١,٥٣ % عند سرعة أمامية ٣,٠٥ كم/ساعة لعمق ٣٠ ، ٦٠ سم علي التوالي .
٢. انخفضت قيم مقاومة الأرض للاختراق بزيادة عمق الأنفاق ونقص المسافة بينها كما أدت جميع المخلفات المضافة إلي انخفاضها.
٣. انخفاض قيم الكثافة الظاهرية في كل المعاملات أما المسامية الكلية للتربة ونسبة المسام فأنها تأخذ الاتجاه المضاد.
٤. لوحظ انخفاض نسبة التحبب في كل المعاملات مما يشير إلي وجود درجة عالية من ثبات البناء .
٥. زيادة قيم معدل التوصيل الهيدروليكي للتربة وقوة احتفاظ الأرض بالماء بالإضافة إلي زيادة الماء المتاح.
٦. انخفاض قيم الاستهلاك المائي وزيادة كفاءة استخدام المياة في كل المعاملات.
٧. 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 .
٨. مما سبق يتبين أنة من المفيد استعمال هذة المعاملات مع استعمال معدلات مختلفة من المخلفات للحصول علي تحسن واضح لخواص الأرض الطبيعية والهيدروفيزيائية التي تنعكس علي زيادة المحصول وتحقيق أعلي صافي دخل مزرعي .