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Direct Effects of Rice Stubble Management on some Physical Properties of Soil

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RICE stubble management is widely practiced in cropping systems and often utlized as a means of reducing stubble loads on the soil surface. However, the short-term effects of these management regimes on soil surface properties are largely unknown. Therefore, this study was carried out at the Experimental Farm of Tani El-Nataf, Sakha Agriculture Research Station, Kafr El-Sheikh Governorate, Egypt, to investigate the direct effects of three methods of rice stubble management {no-tillage (NT), notillage + stubble burning (NT + SB) and conventional tillage (CT)} on soil bulk density and related moisture content, total porosity, pore size distribution and infiltration rate, in two successive agricultural seasons, *i.e.*, 1996–97 and 1997–98.

Burning treatment (NT + SB) has a positive significant effect on the values of soil bulk density. This effect was restricted to the surface soil layer (0 – 5 cm) in the two seasons. In contrast, conventional tillage (CT) treatment has a negative significant influence on the soil bulk density values.

Significant ($P < 0.05$) decreases of approximately 3–4% in total porosity and 6.5 – 5.5 % in the quickly drainable pores in the surface soil layer (0-5cm) were achieved in the burnt plots relative to unburnt plots (NT treatment). However, burning had no significant effect on the lower soil layers. In contrast, plowing practice (CT treatment) has a positive significant effect on the values of total porosity as well as quickly drainable pores. The increasing in the total porosity and > 30μ pores after CT treatment in the surface layer ranged between 6.2 to 6.8 % and 9.1 to 10.5 %, respectively. Furthermore, this positive impact of conventional tillage treatment was extended to include all investigated soil depths.

The statistical analysis obviously indicates that the decline in both basic infiltration rate and cumulative infiltration after burning treatment (NT + SB) was of negative significant values, as the basic I.R.reduced from 2.32 to 0.43 cm hr^{-1} in the first season and from 2.76 to 0.43 cm hr^{-1} in the second one. Also, cumulative infiltration decreased by 72.9 to 79.3% in the two seasons. On the other hand, increasing the basic infiltration rate or cumulative infiltration after (CT) treatment is of positive significant value.

The micromorphological investigation on the surface and subsurface soil before and after burning of rice stubble certainly submitted the occurrence of macropore blockage mechanism due to the precipitating or infilling by residual ash.

Burning is known to alter the physical and chemical properties of soil. During and immediately after burning plant residues, major changes may take place in the surface soil layer. The soil environment is directly affected by a modification of microclimate and inputs of heat and ash.

The changes in soil bulk density induced by burning have been studied a long time ago. Biederbeck *et al.* (1980) found that the bulk density values were significantly greater in the burnt plots than unburnt ones (1.17 compared to 1.05 g/cm^3). Eden *et al.* (1991); Tomkins *et al.* (1991) and Hulugalle (1992) concluded that bulk density at 0-2 cm depth increased significantly following burning. On the other hand, they found no significant trend in the bulk densities of the 2-5 cm and 5-10 cm depths.

Soil porosity is defined as the fraction of the soil volume not occupied by the soil particles. Giovannini *et al.* (1988) Boyer & Miller (1994) and Giovannini & Lucchesi (1997) observed that burning reduced soil total porosity, available soil moisture holding capacity and macroporespace of the surface and subsurface soil layers and consequently, increased the bulk density of surface soils.

Infiltration is defined as the downward entry of water into soils. Biederabeck *et al.* (1980) and Valzano *et al.* (1997) reported that there was a significant decrease of approximately 50 % in sorptivity, the final infiltration rate and hydraulic conductivity in the burnt plots relative to the adjacent unburnt ones.

The type of tillage practice and its suitability to soil and plant is one of the main problems in arid regions, and it has influence on soil physical properties and fertility status. Hill (1990) and Hulugalle *et al.* (1990) observed that bulk density and proportion of micropores were greater than proportion of macropores, with no-tillage than conventionally tilled. On the other hand, Franzluebbers *et al.* (1995); Potter *et al.* (1997) and Unger & Jones (1998) reported that soil bulk density was reduced shortly after tillage, but increased under no-tillage during the growing season in all crops. Also, they found that bulk density values were lowest near the surface and gradually increased with depth. In this concept, Hill (1990); Sojka *et al.* (1997) and Morssi (1997) concluded that conventionally tilled soils had greater pore volume in pores with radii > 15 μm. than no-tilled soils. Also, the amount of pore space available for the storage of plant available water was greater for conventionally tilled soils. On the other hand, Singh *et al.* (1996) noticed that the total porosity of the notill + straw treatment was significantly lower (0.619) than of the till + straw treatment (0.643) in the 2.5-5 cm layer, and there was no effect of those treatments on total porosity of the 10-12.5 cm layer.

Medeiros *et al.* (1996) showed that tillage increases the surface water infiltration rate and hence decreases the amount of rainfall that is lost through run- off and increases the amount of water available to crops. On the other hand, Bissett and Leary (1996) noticed that potential infiltration rates were higher under conservation tillage.

Material and Methods

The experimental area was located at the Experimental Farm of Tani El-Nataf, Sakha Agriculture Research Station, Kafr El-Sheikh Governorate, Egypt. The experiment was carried out in two successive seasons of 1996-97 and 1997-98.

The investigated area (one feddan) was divided into equal homogenous plots. Each plot area was 5 x 32 m (160 m^2). These plots were separated from each other by fireproof tracks (1 x32 m). Three treatment of rice stubble management practices were investigated:

1-No tillage (NT): (control) rice stubble was removed and berseem seeds were sown on soil surface directly without any tillage operation.

2-No tillage + rice stubble burning (NT + SB), rice stubble was burnt on the surface of soil plots and berseem seeds were sown directly without any tillage operation.

3-Conventional tillage (CT), rice stubble was ploughed into a depth of 30cm. The conventional tillage consisted of moldboard plowing to incorporate crop residues, tandem-disking, and harrowing to prepare the seedbed of berseem.

A randomized complete block design with four replicates for each treatment was implemented in the experimental area.

The soil characteristics of the experimental site are reported in Table 1. Data indicate that the soil classified as clayey, non-saline, non-alkali soil.

Undisturbed and disturbed soil samples were collected to a total depth of 30 cm. Two sampling periods were chosen, after rice harvesting (AH), and after treatments (AT). For physical and chemical determinations, three successive layers of (0-5), (5-15) and (15-30) cm depth were collected. Physical and chemical characteristics of the studied soil site were determined according to the standard methods (black, 1965).

Micromorphological studies

Thin section examinations were prepared using undisturbed soil samples (Abdel-Hamid, 1973). The micromorphological description is carried out according to the proposed descriptive system after Brewer (1964).

TABLE 1. Some physical and chemical characteristics of the experimental soil site.

A-Physical characteristics

Soil depth (cm)	Particle size distribution (%)				Texture class	$CaCO_3$ %	O.M %
	C.sand	F.sand	Silt	Clay			
0-20	0.6	13.7	31.0	54.7	Clay	1.72	1.35
20-40	0.5	16.4	28.4	54.7	Clay	1.65	0.84
40-60	0.5	22.9	27.5	49.1	Clay	1.31	0.71

B- Chemical characteristics

Soil Depth (cm)	EC_e (dSm^{-1})*	pH	Soluble Cations (meq/L)				Soluble anions (meq/L)			
			Ca^{++}	Mg^{++}	Na^+	K^+	$CO_3^=$	HCO_3^-	Cl^-	$SO_4^=$
0-20	1.42	7.68	4.15	2.29	8.10	0.30	1.90	3.85	2.20	6.89
20-40	1.51	8.03	4.60	2.78	9.11	0.25	2.30	4.30	2.80	7.34
40-60	1.84	8.04	5.61	2.88	11.00	0.35	2.60	4.21	3.60	9.43

* In soil paste extract.

Results and Discussion

The calculated mean values of the dry soil bulk density and related soil moisture content, with 95% confidence limits, of the studied soil depths under the investigated treatments of rice stubble management are presented in Table 2. The data reveal that, the mean values of the initial soil bulk density (AH period) are relatively high. This seems to be due to the hoof pressure of cattles which were used in wet leveling process. On the other hand, the mean values of soil bulk density of the deeper soil layers are known to be greater than those of the upper ones. Since, the former were exposed to the weight of the latter, thus, the deeper layers become more compacted than the upper ones.

The effect of no tillage + stubble burning treatment (NT + SB) on the soil bulk density obviously show that, its mean values of the (0-5) cm layer seem to exceed the values of the corresponding layer of the initial soil bulk density (AH). The percentages of increasing were 5.6 and 4.5% in the two seasons, respectively. On the other hand, no significant differences between the values of soil bulk density occurred at the soil layers of (5-15) and (15-30) cm as a result of burning. This means that the impact of burning temperature on the soil bulk density was found to be superficial.

The increase in soil bulk density after burning may be explained by the decrease of moisture content in this particular surface layer, as it was exposed to high temperature resulting from burning. Moreover, high soil temperature which led to composition of organic matter and a relative increase of the volume fraction of minerals characterized by high density. On the other hand, heat of burning causes soil aggregates to collapse, and this led to a considerable increase in soil compaction.

TABLE 2. Dependance of confidence limits of soil bulk density and related moisture content of rice stubble management.

Season	Soil parameter	Period	Item	Treatments (NT) depth (cm) (0-5)	(5-15)	(15-30)	(NT + SB) depth (cm) (0-5)	(5-15)	(15-30)	(CT) depth (cm) (0-5)	(5-15)	(15-30)
1996	Soil bulk density (g/cm^3)	AH	Mean	1.09	1.23	1.33	1.07	1.21	1.32	1.12	1.22	1.32
			S.D.	0.04	0.04	0.04	0.03	0.02	0.03	0.05	0.02	0.04
			C.V %	3.35	3.18	3.25	2.92	1.62	2.27	4.14	1.44	2.65
			C.L.	0.04	0.04	0.04	0.03	0.02	0.03	0.05	0.02	0.03
			Upper	1.13	1.26	1.37	1.10	1.22	1.35	1.17	1.23	1.36
			Lower	1.05	1.19	1.29	1.03	1.19	1.29	1.08	1.20	1.29
		AT	Mean	1.09	1.23	1.33	1.13	1.22	1.32	1.03	1.18	1.30
			S.D.	0.04	0.05	0.04	0.03	0.02	0.02	0.02	0.00	0.02
			C.V %	3.35	3.74	3.25	2.28	1.97	1.30	2.10	0.40	1.31
			C.L.	0.04	0.05	0.04	0.03	0.02	0.02	0.02	0.00	0.02
			Upper	1.13	1.28	1.37	1.16	1.24	1.33	1.05	1.19	1.32
			Lower	1.05	1.19	1.29	1.10	1.19	1.30	1.01	1.18	1.29
	Soil moisture content (% vol)	AH	Mean	24.82	28.44	32.51	25.91	26.22	30.59	26.23	29.64	31.52
			S.D.	1.82	1.53	1.99	2.91	2.13	2.31	1.65	0.92	2.06
			C.V %	7.33	5.36	6.12	11.25	8.12	7.54	6.30	3.11	6.54
			C.L.	1.78	1.50	1.95	2.86	2.09	2.26	1.62	0.90	2.02
			Upper	26.60	29.94	34.46	28.76	28.31	32.85	27.84	30.55	33.54
			Lower	23.04	26 95	30.56	23.05	24.14	28.33	24.61	28.74	29 50
		AT	Mean	28.82	28.44	32.51	0.48	26.02	33.15	22.40	25.00	30.08
			S.D.	1.82	1.52	1.99	1.83	1.73	1.67	1.79	1 88	4.08
			C.V %	7.33	5.36	6.12	8.95	6.66	5.03	7.99	7.53	13.57
			C.L.	1.78	1.49	1.95	1.80	1.70	1.63	1.75	1.85	4.00
			pper	26.60	29.94	34.46	2.28	27.72	34.78	24.16	26.85	34.08
			ower	23.04	26 95	30 56	8.69	24.32	31.52	20.65	23.16	26.08

TABLE 2. Contd.

Season	Soil parameter	Period	Item	Treatment								
				(NT) depth (cm)			(NT + SB) depth (cm)			(CT) depth (cm)		
				(0-5)	(5-15)	(15-30)	(0-5)	(5-15)	(15-30)	(0-5)	(5-15)	(15-30)
1997	Soil bulk density (g/cm^3)	AH	Mean	1.13	1.25	1.34	1.11	1.21	1.35	1.15	1.23	1.33
			S.D.	0.04	0.06	0.01	0.04	0.01	0.03	0.03	0.02	0.03
			C.V %	3.75	5.11	1.06	3.71	0.92	2.18	2.31	1.25	2.13
			C.L.	0.04	0.06	0.01	0.04	0.01	0.03	0.03	0.02	0.03
			Upper	1.17	1.31	1.35	1.15	1.22	1.38	1.17	1.25	1.36
			Lower	1.09	1.18	1.33	1.07	1.20	1.32	1.12	1.22	1.30
		AT	Mean	1.13	1.25	1.34	1.16	1.25	1.35	1.05	1.20	1.31
			S.D.	0.04	0.06	0.01	0.04	0.02	0.03	0.04	0.03	0.03
			C.V %	3.75	5.11	1.06	3.48	1.87	1.85	3.87	2.39	2.25
			C.L.	0.04	0.06	0.01	0.04	0.02	0.02	0.04	0.03	0.03
			Upper	1.17	1.31	1.35	1.20	1.27	1.38	1.08	1.23	1.34
			Lower	1.09	1.18	1.33	1.12	1.22	1.33	1.01	1.17	1.28
	Soil moisture content (% vol)	AH	Mean	24.59	31.03	32.84	22.50	26.07	29.70	23.80	28.27	33.12
			S.D.	1.61	0.62	0.45	1.90	2.21	2.41	0.67	0.35	1.72
			C.V %	6.55	2.01	1.37	8.43	8.48	8.10	2.82	1.23	5.19
			C.L.	1.58	0.61	0.44	1.86	2.17	2.36	0.66	0.34	1.68
			Upper	26.17	31.64	33.28	24.36	28.23	32.06	24.46	28.61	34.80
			Lower	23.01	30.42	32.40	20.64	23.90	27.34	23.14	27.93	31.44
		AT	Mean	24.59	31.03	32.84	18.40	25.80	31.45	20.22	25.29	32.24
			S.D.	1.61	0.62	0.45	1.08	0.30	0.52	3.21	0.71	0.33
			C.V %	6.55	2.01	1.37	5.85	1.17	1.65	15.85	2.79	1.03
			C.L.	1.58	0.61	0.44	1.05	0.30	0.51	3.14	0.69	0.33
			Upper	26.17	31.64	33.28	19.45	26.09	31.96	23.36	25.99	32.57
			Lower	23.01	30.42	32.40	17.35	25.50	30.94	17.08	24.60	31.92

S.D = Standard Deviation
C.V. % = Coefficient of Variation %
C.L. = Confidence limits at 5%
Upper Limit = Mean + C.L.
Lower Limit = Mean – C.L

Conventional tillage treatment (CT) leads to a clear reduction in the soil bulk density values comparing with other treatments especially, in the surface layer (Table 2). The decrements in the values of soil bulk density after conventional tillage treatment were -8.0, -3.3 and -1.5 % in the first studied season and were -8.7, -2.4 and -1.5 % in the second studied season at (0-5), (5-15) and (15-30) cm soil depths, respectively. The obtained results may be interpreted by the improved soil aeration, consequently, the increasing total porosity, which led to a noticeable reduction in soil bulk density. Furthermore, the incorporation of rice stubble with mineral fractions encourages the role of organic matter which acts as cementing material leading to the formation of soil aggregates and voids, thus, decreases soil bulk density.

Total porosity and pore size distribution

Data in Table 3 show that treatment of rice stubble burning (NT + SB) causes a considerable decrease in the values of total porosity, particularly, at the surface soil layer (0-5 cm). In contrast, conventional tillage causes relatively high increase in the total porosity of all soil depths. These variations are more pronounced at the upper layers. The reduction of total porosity after (NT + SB) treatment is seen by the decrease of the volume fraction of the organic matter, which is replaced by mineral ones. In addition, soil organic matter contributes to soil structure, and its composition causes a structure breakdown and collapse with the consequent decrease of porosity (Giovannini and Lucchesi, 1997). On the other hand, the increase in soil total porosity that followed conventional tillage treatment (CT) may be attributed to the ploughing process and disturbance of soil. Hence, this led to increase soil aeration and prosity, decrease soil bulk density and compaction.

TABLE 3. Mean values of soil total porosity (%) and pore size distribution (%) under the studied treatments of rice stubble management.

Treat.	Soil depth (cm)	Period									
		AH					AT				
		Total Porosity %	Pore size distribution %				Total Porosity	Pore size distribution %			
			3000-30 μ	30-9 μ	9-0.2 μ	< 0.2 μ		3000-30 μ	30-9 μ	9-0.2 μ	< 0.2 μ
1996											
NT	0-5	58.24	38.58	5.00	15.01	41.41	58.24	38.58	5.00	15.01	41.41
	5-15	54.87	36.30	1.78	17.70	44.23	54.87	36.30	1.78	17.70	44.23
	15-30	50.37	26.72	6.47	15.19	51.61	50.37	26.72	6.47	15.19	51.61
NT+SB	0-5	59.13	39.62	5.88	13.99	40.51	56.70	37.03	6.14	14.59	42.24
	5-15	55.70	37.28	1.09	17.01	44.62	55.24	36.76	1.11	17.16	44.95
	15-30	50.81	31.77	0.51	16.71	51.01	50.81	31.78	0.51	16.71	50.99
CT	0-5	57.03	38.99	1.68	13.52	45.81	60.54	42.53	1.59	12.74	43.15
	5-15	55.24	37.38	1.45	18.20	42.98	56.47	38.71	1.42	17.82	42.06
	15-30	50.69	30.00	0.71	14.46	54.83	51.43	31.01	0.70	14.25	54.03
1997											
NT	0-5	56.70	36.93	5.13	15.41	42.52	56.70	36.93	5.13	15.41	42.52
	5-15	54.23	35.52	1.80	17.93	44.77	54.23	35.52	1.80	17.93	44.77
	15-30	50.00	26.20	6.52	15.30	51.99	50.00	26.20	6.52	15.30	51.99
NT+SB	0-5	57.54	57.54	1.34	17.85	42.48	55.62	36.21	1.39	18.46	43.94
	5-15	55.55	55.55	1.34	18.48	43.63	54.17	34.96	1.37	18.94	44.74
	15-30	49.63	49.63	2.56	14.47	54.91	49.57	27.97	2.56	14.49	54.98
CT	0-5	56.07	56.07	1.71	13.75	46.59	59.90	41.95	1.61	12.87	43.61
	5-15	54.63	54.63	1.47	18.41	43.47	55.80	37.96	1.44	18.03	42.57
	15-30	50.37	50.37	0.70	14.34	54.85	51.12	30.59	0.70	14.34	54.37

The pore size distribution under the studied treatments (Table 3) indicates that, at the initial state unuseful pores (< 0.2 μm) are the dominant pore sizes along the profile depths and increase with increasing soil depth. On the other hand, quickly drainable pores (> 30 μm) form a considerable part of total porosity as they generally, decrease by increasing soil depth.

Rice stubble burning resulted in a pronounced reduction in the values of quickly drainable pores (> 30 μm), especially at the surface soil layer. The decrements in this pore diameter were found to be 6.5 and 5.5% in both studied seasons, respectively in comparison to NT treatment. The most likely explanation of this phenomenon may be that fire causes aggregates to become unstable and undergo greater collapse when wetted. This enhanced instability may be due to changes in the soil moisture or loss of organic carbon as a direct result of the fire.

Soil under conventional tillage treatment (CT) verifies that the amount of quickly drainable pores (> 30 μm) significantly increased parallel to the decrease in the unuseful pores (< 0.2 μ). This trend was clearly noticed along the all studied soil depths, in both two seasons under investigation.

Infiltration rate

Data in Table 4 indicate that, at the initial state, after harvesting, values of basic infiltration rate are somewhat low. This finding may be attributed to using puddling practice in the preparing soil for rice cultivation. This inhibits the movement of water, due to shear stress which destroies the macropores, and also due to lodging of finer particles which caused the plugging of the pore channels.

The treatment of rice stubble burning (NT+SB) has an immediate effect on the values of basic infiltration rate to be significantly reduced. Basic infiltration rate declined from 2.32 cm hr^{-1} under no tillage treatment (NT) to 0.43 cm hr^{-1} under no tillage + stubble burring treatment (NT + SB) (Season 1996) and from 2.76 cm hr^{-1} under (NT) treatment to 0.43 cm hr^{-1} under (NT + SB) treatment season 1997. On the other side, burning treatment also caused a significant reduction in the values of cumulative infiltration. The estimated reductions were found to be 72.9 % and 79.3 % compared with no-tillage (NT) treatment in the two seasons, respectively. In contrast, values of basic infiltration rate changed from 2.32 and 2.76 cm hr^{-1} under (NT) treatment to be 4.58 and 4.47 cm hr^{-1} under (CT) treatment at both studied seasons, respectively. Also, the results suggested that (CT) treatment contributed to increasing the cumulative infiltration in comparison with the control treatment (NT), whereas, the cumulative infiltration values were increased by 85.5 and 59.0 % in both seasons, respectively.

TABLE 4. Dependence of basic infiltration rate and cumulative infiltration on the treatments of rice stubble management.

Treatment	Season	AT (Period)							
		Basic I.R. (cm hr^{-1})				Cumulative I R. (cm)			
		R1	R2	R3	Mean	R1	R2	R3	Mean
NT	1996	1.79	2.89	2.27	2.32 C*	48.97	74.61	60.31	61.30 C
NT+SB		0.37	0.51	0.42	0.43 D	15.46	19.46	14.91	16.61 D
CT		5.00	4.38	4.35	4.58 A	120.78	112.89	107.52	113.73 A
L.S.D at 0.05					0.745				15.80
NT	1997	2.67	2.89	2.71	2.76 C	71.06	75.00	70.83	72.37 C
NT+SB		0.49	0.40	0.40	0.43 D	16.04	14.92	14.05	15.00 D
CT		4.71	4.59	4.11	4.47 A	110.83	122.10	112.24	115.06 A
L.S.D at 0.05					0.615				7.203

* Means with the same letter are not significantly different.

The decline of basic infiltration rate as well as the cumulative infiltration is usually associated with the loss of macropores to the soil surface. Heating soil surface produced loss of the OH^{-} groups from the clay minerals and collapsed the internal structure of the clays, thus caused a considerable variation of the physico- chemical parameters of the soil which affect both horizontal and vertical water movement into soil (Cress-Well and Kirkegaard, 1995). However, the most likely explanation for the decline in basic infiltration rate and cumulative infiltration was either to high temperature or the fine particles of ash produced by the rice stubble burning caused a blockage of macropores at the soil surface, thus reducing infiltration rate.

Micromorphological investigations on the soil surface and subsurface after burning of rice stubble certainly displayed the occurrence of this mechanism, *i.e.*, macropore blockage due to the precipitation or infilling by residual ash (Plates 1 and 2). In contrast, the improvement in the basic infiltration rate as well cumulative infiltration under (CT) treatment may be explained by ploughing practice which increases the rate of water entry by loosing the soil surface reducing soil compactness and introducing a balanced pore size distribution, (Plates 3 and 4).

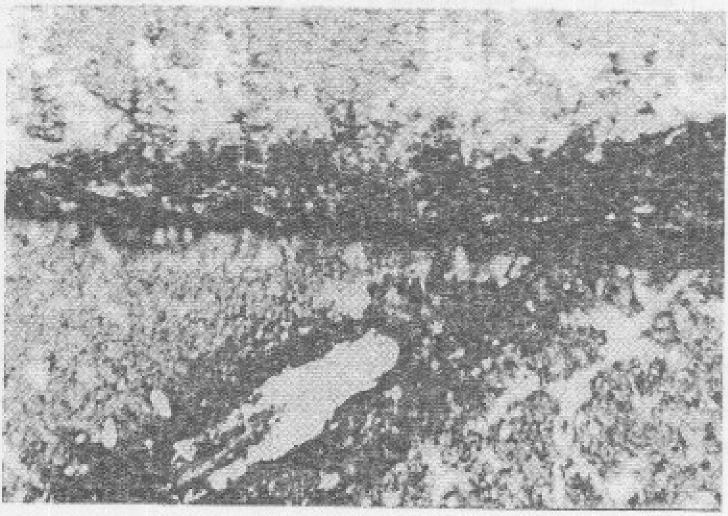

Plate 1. The ash precipitated in or blockage some voids in the soil (NT+ SB treatment), soil depth {0-5}cm; X 25.

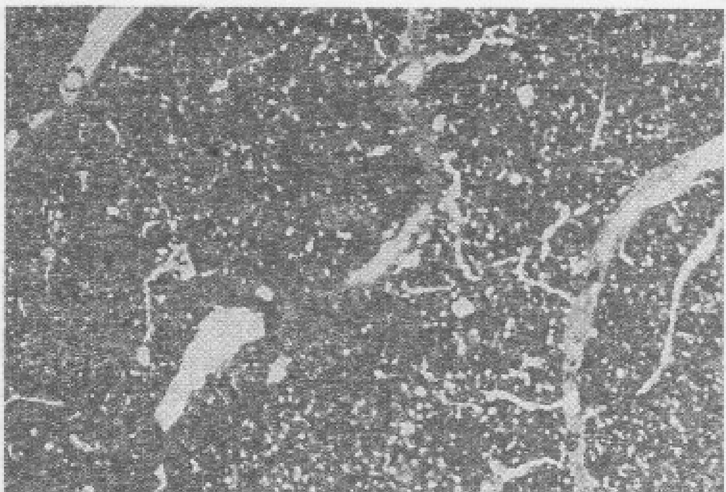

Plate 2. The ash precipitated partially in some voids in the soil (NT+SB treatment), soil depth {5-15}cm; X50.

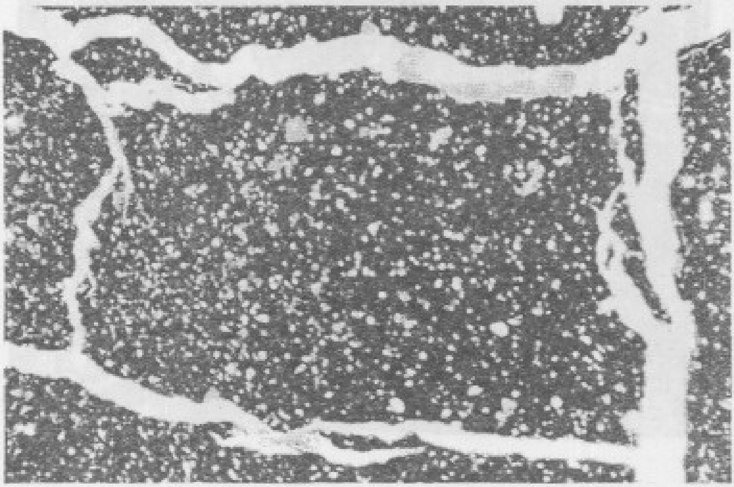

Plate 3. The void pattern of (CT) treatment at the surface layer {0-5}cm; X6.

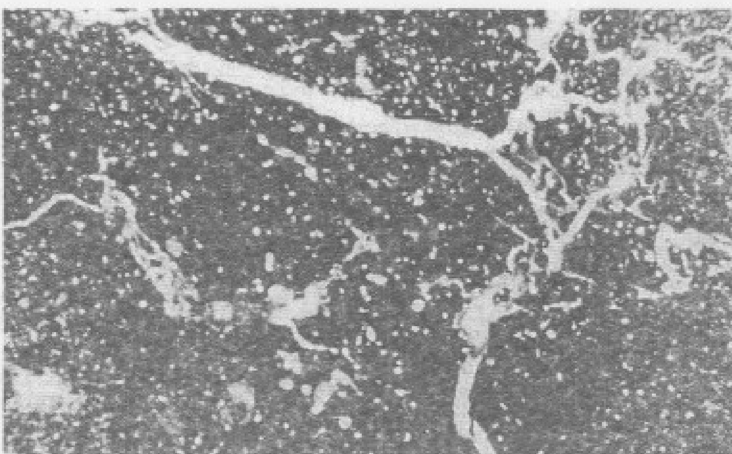

Plate 4. The void pattern of (CT) treatment at {15-30}cm soil depth; X6.

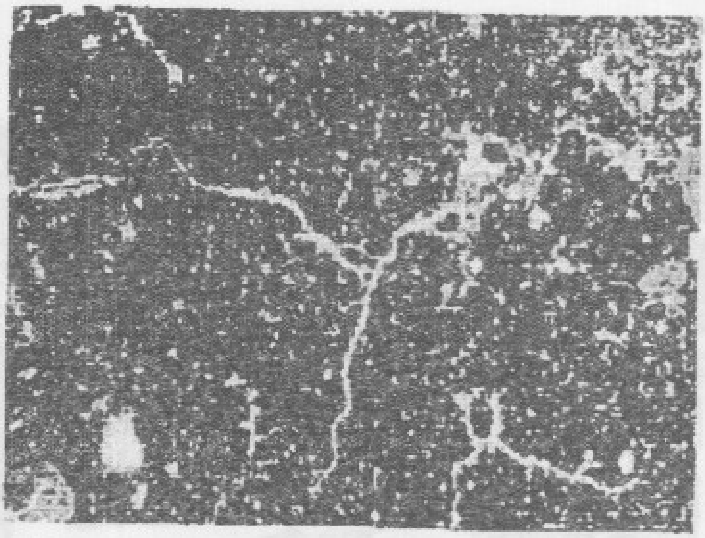

Plate 5 . The void pattern of (NT) treatment at {15-30}cm soil depth; X6.

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التأثيرات المباشرة لطرق تدوير مخلفات الأرز على بعض الصفات الفيزيائية للتربة

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تنتشر عملية تدوير مخلفات الأرز بصورة واسعة فى مناطق زراعة المحاصيل وذلك بهدف تقليل الكميات الناتجة من المخلفات والتى تتراكم على سطح التربة وتغطى جزءا كبيرا منها لا يستغل زراعيا ، ومع ذلك فإن التأثيرات القصيرة الأجل لطرق تدوير مخلفات الأرز على خواص سطح التربة تعتبر إلى حد كبير غير معروفة. من هذا المنطلق أجريت تجربة حقلية فى محطة البحوث الزراعية بسخا بمنطقة تانى النطاف محافظة كفر الشيخ لدراسة التأثيرات المباشرة لثلاثة طرق لتدوير مخلفات الأرز (بدون خدمة (NT) ، بدون خدمة + حرق (NT + SB) ، خدمة تقليدية مع قلب مخلفات الأرز (CT)) على كثافة التربة الظاهرية ومحتوى التربة الرطوبى ، قيم المسامية الكلية والتوزيع الحجمى للمسام ومعدل التسرب الأساسى والتسرب التراكمى – كما أخذت قطاعات رقيقة لدراسة تأثير المعاملات المختلفة على مسامية التربة والتوصيل المائى لسطح التربة.

أوضحت النتائج المتحصل عليها أن معاملة الحرق (NT + SB) لها تأثير معنوى على زيادة قيم الكثافة الظاهرية للتربة وأن هذا التأثير اقتصر على الطبقة السطحية (٠ – ٥سم) فقط أما الطبقات التى تليها فلم تتأثر بعملية حرق مخلفات الأرز. وبالعكس كان لمعاملة الخدمة التقليدية مع قلب مخلفات الأرز (CT) تأثير معنوى على خفض قيم الكثافة الظاهرية للتربة ، هذا التأثير إمتد إلى جميع الطبقات المدروسة خلال الموسمين.

بينت النتائج أيضاً أن قيم المسامية الكلية ومسام الصرف السريع قد إنخفضت فى الطبقة السطحية (٠ – ٥سم) عقب عملية حرق مخلفات الأرز وهذا الإنخفاض تراوح بين ٤,١ – ٣,٣ % ، ٦,٥ – ٥,٥ % على الترتيب خلال الموسمين مقارنة بمعاملة NT. وأيضاً لم يكن لعملية الحرق تأثير يذكر على هذه الصفات فى الطبقات التحت سطحية (٥–١٥ ، ١٥–٣٠). فى المقابل كان لعملية الخدمة التقليدية تأثير معنوى على زيادة قيم كل من المسامية الكلية والتوزيع الحجمى للمسام وتراوحت هذه الزيادة فى الطبقة السطحية ٦,٢ – ٦,٨ % ، ٩,١ – ١٠,٥ % على الترتيب خلال الموسمين – كما أمتد هذا التأثير المعنوى ليشمل الطبقات التحت سطحية أيضاً وذلك مقارنة بمعاملة NT.

أوضحت نتائج التحليلات الإحصائية أن الإنخفاض فى قيم كل من التسرب الأساسى (B.I.R) والتسرب التراكمى (C.I) عقب معاملة حرق مخلفات الأرز (NT + SB) هو إنخفاض معنوى جداً حيث إنخفض معدل التسرب الأساسى من ٢,٣٢ إلى ٠,٤٣ سم/ساعة فى الموسم الأول من ٢,٧٦ إلى ٠,٤٣ سم/ساعة فى الموسم الثانى. أما التسرب التراكمى فقد أنخفضت قيمته ما بين ٧٢,٩ % إلى ٧٧,١ % فى الموسمين. هذا الإنخفاض يعود أساسا لميكانيكية قفل مسام التربة الناتج عن ترسيب الرماد فى المسام الناتج عن حرق مخلفات الأرز. من ناحية أخرى أظهرت نتائج التحليلات الإحصائية أن الزيادة فى معدل التسرب الأساسى والتسرب التراكمى عقب معاملة الخدمة التقليدية (CT) هى زيادة معنوية جداً.

أكدت دراسات الشرائح الرقيقة Thin section لطبقات التربة السطحية وتحت السطحية فى جميع المعاملات أن الإنخفاض الحادث فى معدل التسرب الأساسى وأيضا التسرب التراكمى يعود إلى ميكانيكية قفل المسام الناتج عن ترسيب الرماد المتخلف عن حرق مخلفات الأرز.