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EFFECT OF TILLAGE AND NITROGEN APPLICATION REGIME ON: 2-SOME PHYSICAL PROPERTIES AND DISTRIBUTION OF MICRONUTRIENTS IN CALCAREOUS SOIL

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Tillage and nitrogen (N) management practices have profound effects on the variations in plant nutrients and other physical properties of surface and subsurface soil layers. The study included field experiment established in 2002, at Maryout Experimental station where its soil is calcareous. The aim of the study was to evaluate the effect of three tillage systems [no–tillage (NT), chisel plowing (CP), and moldboard plowing (MP)] with two nitrogen rates (0 and 45 kg/fed.), the latter was added in three doses, on some physical properties of soil and the distributions of micronutrients in different soil surface layers, (0-10, 10-20 and 20-30 cm).

The results showed that soil bulk density was significantly different between tillage systems and N fertilizer rates. Soil bulk density decreased for all tillage systems compared with no- tillage, at the three depths. Also, it was found that the penetration resistance decreased for all treatments and increased with increasing of soil depth. The maximum values were obtained in no-tillage and unfertilized treatments, however the minimum value was associated with moldboard plow and 45-kg N/fed treatment regardless of N doses. The main effect of tillage or nitrogen doses on soil aggregates TA% was significant, however, the interaction effect between them was not significant. For example, aggregation over both sites and all N doses were 52.07%, 38.57% and 30.57% and the mean weight diameter were 0.26, 0.17 and 0.13 mm for NT, CP and MP, respectively.

Total aggregation for NT were 48.8, 51.10, 53.30 and 55.10%, for CP were 29.50, 40.00, 43.10 and 41.70%, and for MP were 28.50, 30.60, 32.00 and 31.20% for zero, two, three and four N doses, respectively.

Nitrogen fertilization had little effect on nutrient distributions, most dramatic changes occurred within the

0-10 cm depth, due to tillage methods where soil under NT had lower content of Fe and Cu and greater content of Zn and Mn than under CP and MP.

Keywords: tillage, nitrogen, soil bulk density, penetration resistance, aggregation, copper, iron, manganese, zinc, calcareous soils.

Different tillage systems modify soil physical properties depending on factors such as cropping pattern, soil type, climatic conditions and previous tillage system (Mahboubi *et al.*, 1993; Chagas *et al.*, 1994). Tillage generally reduces soil bulk density (BD) and mechanical impedance and increases permeability, thus improving internal drainage (Hamblin, 1985; Howeler *et al.*, 1993).

Reduced tillage could increase bulk density as a result of soil compaction (Maurya 1988). Varsa *et al.* (1997), Unger and Jones (1998) and Diaz-Zorita (2000) reported that penetrometer resistance (PR) and BD were greatly reduced in deep tilled plots compared with reduced tillage and no-tillage treatments. However, Unger (1984) and Hill and Cruse (1985) observed no significant effect of no- tillage and plow tillage on BD of a Mollisol. These contradictory results may be due to complex interactions among crop species, soil properties, and climatic characteristics (Rasmussen, 1999). Biswas and Khosla (1977) noted an increase in total porosity with increasing soil aggregation, and attributed this to the decrease in soil BD upon aggregation. Shaiboon (1993) identified a linear relationship between soil bulk density and soil penetration resistance. Tillage also affects soil nutrient concentration and their availability (Etana *et al.*, 1999). Thus, the stability of the soil aggregates is of fundamental importance as it governs, to a large extent, other physical properties in cultivated soil such as the pore space, the hydraulic conductivity and erodibility, consequently they will influence the plant growth (Carr, 1975).

Franzluebbers and Hans (1996) examined the effects of tillage and fertilization on the soil profile distribution of primary and secondary plant-available nutrients for various crop rotations that included sorghum. They found no significant effect of N fertilization on soil pH in the high-pH, and calcareous soil, but that soil pH and extractable Cu and Fe were significantly lower under no-tillage (NT) system to conventional tillage in the upper 5-cm of soil, while extractable P, K, Zn and Mn were higher. They concluded that nitrogen fertilization had little effect on soil profile-nutrient distribution after 8.5 years. Also, Intrawech *et al.* (1982) found that after 10 years of application of ammonia, ammonium nitrate, urea or urea ammonium nitrate solution (UAN), no significant differences occurred in pH, organic matter content, cation exchange capacity or concentrations of extractable P, K, Ca, Mg, Na, Zn, Fe, Cu, Mn, NO_3 and NH_4 because of N source.

The effect of tillage and nitrogen application on yield and nitrogen content of sunflower in calcareous soil were studied by Abou Yuossef and El-Eweddy (2003) but they did not evaluate the effect on soil physical properties. Therefore, the objective of this research is to compare the effects of tillage systems and time of N fertilizer application on some physical soil properties and micronutrients distribution in soil surface layers of calcareous soils.

MATERIALS AND METHODS

A field experiment was conducted at Maryut experimental station, Desert Research Center. The soil is a sandy clay loam. The initial soil properties are summarized in table (1) as reported by Abou Yuossef and El-Eweddy (2003).

TABLE (1). Some physical and chemical properties of the studied soil before sunflower planting.

Depth (cm)	Bulk density g/cm^3	Texture class	Particle size distribution %			O.M %	$CaCO_3$ %	EC dS/m	pH in 1: 2.5 susp.	Extractable micro nutrients (mg/kg)			
			Clay	Silt	Sand					Fe	Mn	Zn	Cu
0 -30	1.4	Sandy clay loam	31.8	20.0	48.2	0.42	27.9	2.8	7.98	5.22	3.85	0.51	0.18

The experimental design was a randomized complete block, the blocks (10×40 m^2) with tillage treatments (MP = moldboard plowing, CP = chisel plowing or NT = no-tillage). Each block was divided into plots of 2 × 8 m^2 where randomized nitrogen treatments in three replicates included 0 and 45 kg N/fed. The fertilizers were added to the plots 3 weeks after planting and applied as ammonium nitrate (33.5% N) in 2, 3 and 4 doses.

Sunflower hybrid "Vidoc" *(Helianthus annuus, L.)* was planted manually at a rate of 5 kg/fed. On June 2002. All treatments were fertilized with super phosphate at a rate of 150 kg/fed and potassium sulphate at a rate of 50 kg/fed. The plants were harvested in the third week of August 2002.

Composite soil samples were collected after harvesting at depths of 0-10, 10-20 and 20-30 cm. Bulk density of the soil after harvest was measured using the core method. A simple core-penetrometer was used to measure the penetration resistance. Aggregate stability size (5 to 8 mm) was measured using the wet sieving technique (Yoder, 1936). Fifty grams of air-dried aggregates equilibrated at 98 % relative humidity were mechanically sieved in water, and expressed as percent of total aggregation (TA), percent aggregation for aggregates exceeding 1mm in diameter (TA > 1) and the mean weight diameter (MWD) according to the method of Van Bavel (1949) as described by Hillel (1982). The MWD was measured on water stable aggregates. Total percent of aggregation refers to the percent of the total soil dry weight of a sample comprising water stable aggregates > 0.1-mm for TA and >1-mm for TA > 1.

The available Mn, Cu, Fe and Zn of soil were determined using DTPA extraction procedure as described by Lindsay and Norvell (1978), and analyzed using atomic absorption spectrophotometer.

RESULTS AND DISCUSSION

Bulk Density (BD)

The values of soil bulk density are given in table (2). This shows that the values significantly increased with decreasing intensity of tillage system. Such decrease in soil bulk density after tillage may be due to the breakdown of soil compaction, because ploughing increases pore spaces and therefore reduces soil bulk density. However, the values decreased with increasing soil depth in all nitrogen treatments. These results are in agreement with those obtained by Diaz-Zorita (2000) who found the bulk density in the 3- 20 cm layer of the soil was significantly increased when the intensity of the tillage system decreased.

Effect of tillage system and nitrogen fertilization gave significant differences on soil bulk density, however, the effect of the interaction between tillage system and nitrogen fertilization was not significant (Table 2). Mean soil Bulk density, for example, at the depth of 0-10cm (averaged across all N fertilizer treatments) was 1.06 g/cm^3, 1.03 g/cm^3 and 0.97 g/cm^3 for NT, CP and MP, respectively. It is clear that the values increased with increasing soil depths. Similar trend was obtained by Ishaq *et al.* (2002).

TABLE (2). Tillage effects on soil bulk density averaged across N fertilization regime after sunflower harvest in 2002.

Depth (cm)	N Fret. Treatment	Bulk density (g/cm^3)		
		NT	CP	MP
0-10	0	1.14	1.02	1.00
	2	1.02	1.09	0.99
	3	1.09	1.01	.0.96
	4	1.01	1.01	0.95
Mean		**1.06**	**1.03**	**0.97**
10---20	0	1.31	1.25	1.13
	2	1.32	1.31	1.06
	3	1.22	1.18	1.01
	4	1.22	1.18	1.00
Mean		**1.27**	**1.23**	**1.05**
20-30	0	1.61	1.52	1.46
	2	1.59	1.56	1.39
	3	1.47	1.46	1.36
	4	1.47	1.46	1.36
Mean		**1.54**	**1.50**	**1.39**
L.S.D (0.05)				
Tillage system (T)		0.08		
N doses		0 29		
TXN		n. s		

NT= no-tillage, CP= chisel plowing, MP= moldboard plowing.
n.s = non significant.

Soil Penetration Resistance (PR)

The effects of tillage systems and nitrogen fertilization on soil penetration resistance are depicted in fig (1), grouping all nitrogen treatments. This shows that the lowest value come within the moldboard plow with N fertilization treatment as compared without application. The maximum values of soil penetration resistance were associated with no-tillage with N fertilization. In general, the soil penetration specific resistance decreased with increasing plowing depth, and decreased slightly with nitrogen fertilization, this may return to the increase of soil moisture content with the increase of depth. These results are in agreement with those obtained by Al Aghbari (1996), and Imara and Hamissa (2000).

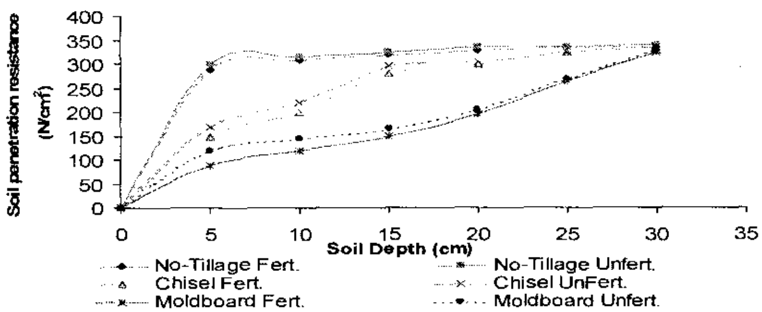

Fig (1). Effect of tillage systems and nitrogen fertilization on soil penetration resistance after harvesting.

TABLE (3). Tillage and N regime effects on total percent aggregation (TA) and percent aggregation >1 mm(TA>1).

Depth (cm)	N Fert. Treatment	TA %			TA>1. m m		
		NT	CP	MP	NT	CP	MP
0-10	0	48.80	29.50	28.50	34.60	19.70	19.20
	2	51.10	40.00	30.60	35.00	22.80	20.00
	3	53.30	43.10	32.00	35.60	33.00	21.00
	4	55.10	41.70	31.20	43.30	27.10	20.30
Mean		**52.07**	**38.57**	**30.57**	**37.12**	**25.65**	**20.12**
10--20	0	40.60	30.30	29.50	35.00	19.30	18.70
	2	48.20	38.20	30.30	35.70	23.20	19.80
	3	50.60	40.10	32.70	38.80	32.80	21.00
	4	49.30	39.60	32.60	36.10	25.80	20.90
Mean		**47.17**	**37.05**	**31.25**	**36.40**	**25.27**	**20.10**
20-30	0	49.90	42.30	30.50	40.10	29.70	17.70
	2	43.30	40.50	28.20	38.00	24.50	18.60
	3	48.60	32.70	26.50	33.50	23.30	21.10
	4	52.00	36.00	30.20	36.20	20.30	19.50
Mean		**48.45**	**37.87**	**30.20**	**36.95**	**24.49**	**19.22**
L.S.D (0.05)							
Tillage system (T)		2.47			3.05		
N doses		2.85			n.s		
TXN		n.s			n.s		

NT= no-tillage, CP= chisel plowing, MP= moldboard plowing, n.s = non significant
TA= total aggregation%,

Soil Aggregates

Tillage and N fertilization effect on total soil aggregates (TA%, TA > 1) regardless of soil depth are shown in table (3). There were significant differences in aggregation resulting from the tillage methods. The highest aggregation TA and TA > 1 was observed in the NT method of seedbed preparation. Both TA and TA > 1 were in the order of NT > CP > MP for all depths. For example, at the depth of 0-10 cm, the mean TA (average for N Fret.) in NT was 35% more than CP and 70% more than MP treatment. Similarly, the mean of TA > 1 in NT was more than CP and MP by 44% and 84%, respectively. TA and TA > 1 indexes were also affected by the interaction of tillage x N fertilizer. TA in NT exceeded that in CP and MP in all N- fertilizer treatments. Similar trends were observed in TA > 1. The data in table (3) also show that N doses effects on aggregation differed among tillage methods. The highest aggregation occurred in different N doses for different tillage methods. For example, in NT at depth of 0-10 cm, TA and TA > 1 were in the order of four doses > three does > two doses > without nitrogen fertilization. In CP and MP, TA and TA > 1 were in the order of three doses > four doses > two doses > without nitrogen fertilization. The maximum aggregation and large-size aggregates occurred in three doses and four doses in plow-based tillage systems compared with their occurrence in four doses and three doses in no-tillage system. Mahboubi and Lal (1998) found that aggregation fluctuated more for some tillage methods than for others.

Mean Weight Diameter of Aggregates (MWD)

Similar to aggregation, MWD was also significantly affected by tillage systems, while the effect of N doses and the interaction of N and tillage were not significant (Table 4). Average values of MWD as affected by tillage systems regardless of nitrogen doses were NT > CP > MP for all depths. For example, at the depth of 0-10, the mean MWD (The average over N. Fert.) in NT was 53% more than CP and 100% more than MP treatment. Table (4) also shows that N doses affects MWD, which differed among tillage systems. The highest MWD occurred in different N doses for different tillage systems. For example. in NT at the depth of 0-10 cm was in the order of two doses > four doses > three doses > without nitrogen fertilization, while in CP and MP were in the order of three doses > four doses = two doses > without nitrogen fertilization, respectively.

The maximum range or the difference in MWD among tillage systems of 0.17 mm occurred during the two N doses at the depth of 0-10 cm and MWD values were affected by tillage treatments in the order of NT > CP > MP. Similar results were reported by Mahboubi and Lal (1998).

TABLE (4). Tillage and N regime effects on mean weight diameter (MWD).

Depth (cm)	N Fert. Treatment	Tillage methods		
		NT	CP	MP
0-10	0	0.23	0.16	0.11
	2	0.30	0.18	0.13
	3	0.24	0.19	0.12
	4	0.29	0.19	0.15
Mean		**0.26**	**0.17**	**0.13**
10-20	0	0.25	0.19	0.16
	2	0.26	0.20	0.12
	3	0.23	0.16	0.11
	4	0.24	0.23	0.15
Mean		**0.24**	**0.19**	**0.14**
20-30	0	0.26	0.22	0.11
	2	0.25	0.19	0.15
	3	0.25	0.17	0.14
	4	0.27	0.18	0.16
Mean		**0.26**	**0.20**	**0.14**

NT= no-tillage, CP= chisel plowing, MP= moldboard plowing.

Micronutrient Cations

Effects of tillage systems and of N fertilization on extractable soil Zn, Fe, Mn and Cu are shown in table (5). It would appear that the micronutrients under consideration are significantly affected by N fertilization, with exception of Cu, there is no significant interaction effect. Extractable Zn, Fe. Cu, but not Mn, were significantly affected by tillage treatments. The values of extractable Zn and Mn in the surface layer of 0-10 cm were greater than that in the sub-surface layer of 10-20 cm. However, extractable Zn was greater under NT method than under CP and MP methods for both surface and sub-surface layers in all cases of N fertilization. Extractable Zn, Mn, Cu and Fe increased with increasing N fertilization up to three doses, then decreased or remained unchanged. Similar observations were made for all tillage treatments and soil depths.

Franzluebbers and Hans (1996) found that soil profile distributions of extractable micronutrient cations (Zn, Fe, Mn, and Cu) were generally greater under NT method than under CT method in the 0-0.3 m depth probably due to reducing conditions, which appeared to be exacerbated with N fertilization.

From the above-mentioned discussion, it is clear that the nitrogen application as three doses during growth period under any tillage system (NT, CP, MP) enhance some physical properties and micronutrients status in surface layers of the calcareous soil. However, MP and CP methods improve some soil properties as compared with NT system. It can be recommend that moldboard or chisel plowing with three doses of 45 kg nitrogen/fed is the best measure for sunflower crop under calcareous soil condition.

Table (5). Distribution of micronutrients in surface soil as affected by tillage systems and doses of nitrogen fertilization.

Extractable Micro.		Zn			Fe			Mn			Cu		
Tillage Systems	N Fert. Treat.	Depth (cm)											
		0 -10	10 - 20	20 - 30	0 -10	10 - 20	20 - 30	0 - 10	10 - 20	02 - 30	0 -10	10 - 20	20 - 30
NT	0	0.82	0.34	0.26	5.81	7.00	8.15	6.23	3.06	2.50	0.18	0.31	0.21
	2	0.90	0.42	0.37	6.29	6.93	8.44	6.44	3.65	2.88	0.20	0.32	0.22
	3	0.97	0.46	0.42	6.69	6.85	8.61	9.37	3.84	3.46	0.12	0.33	0.20
	4	0.94	0.41	0.41	6.38	6.97	8.46	8.66	3.55	3.13	0.21	0.33	0.21
Mean		**0.90**	**0.41**	**0.36**	**6.29**	**6.94**	**8.41**	**7.67**	**3.52**	**2.99**	**0.17**	**0.32**	**0.20**
C P	0	0.66	0.32	0.25	6.10	6.69	8.34	5.05	2.83	2.41	0.32	0.21	0.22
	2	0.71	0.40	0.36	6.65	6.85	8.58	5.96	3.86	2.96	0.32	0.21	0.19
	3	0.75	0.41	0.38	7.00	6.75	8.71	6.76	4.50	3.51	0.32	0.22	0.19
	4	0.72	0.41	0.36	6.79	6.96	8.56	6.46	4.10	3.24	0.32	0.21	0.20
Mean		**0.71**	**0.38**	**0.34**	**6.63**	**6.81**	**8.54**	**6.05**	**3.82**	**3.03**	**0.32**	**0.21**	**0.20**
M P	0	0.53	0.31	0.26	6.13	7.23	8.23	4.07	2.75	2.41	0.30	0.23	0.22
	2	0.61	0.38	0.35	6.36	7.45	8.80	5.02	4.29	2.96	0.31	0.22	0.25
	3	0.64	0.40	0.37	6.50	7.60	9.62	5.83	5.63	3.47	0.33	0.23	0.28
	4	0.61	0.37	0.36	5.45	7.53	9.05	5.44	5.21	3.09	0.32	0.22	0.28
Mean		**0.60**	**0.36**	**0.33**	**6.11**	**7.45**	**8.92**	**5.09**	**4.47**	**2.98**	**0.32**	**0.22**	**0.26**
L.S.D (0.05)													
Systems (T)		0.0588			0.2864			ns			0.0179		
N doses		0.0679			0.3307			0.88			ns		
Interaction T x N		ns			ns			ns			ns		

NT= no-tillage, CP= chisel plowing, MP= moldboard plowing. ns = non significant.

CONCLUSION

Results obtained from the present work showed that the soil bulk density decreased for all tillage systems compared with no-tillage at the three depths. The soil penetration resistance has a good indication of soil physical properties; the decrease of soil penetration resistance allows the roots of plants to easily penetrate in the soil. On the other hand, moldboard plow gave the lowest value of soil penetration resistance, but it increased with depth. The data also showed that, NT system had higher percent of aggregation compared with CP or MP methods. However, the total aggregation in CP and MP systems was better with N fertilized treatments. The maximum range or the difference in MWD among tillage systems of 0.17 mm occurred during the two doses at the depth of 0-10cm. Micronutrient cations Zn, Fe, Mn and Cu were generally greater under NT system than CP and MP system throughout the depth of 0-10 cm probably due to reducing conditions, which appeared to be exacerbated with N fertilization.

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تأثير الحرث وتنظيم إضافة النتروجين على:
٢-بعض الخواص الطبيعية وتوزيع العناصر الصغرى تحت ظروف الأراضى الجيرية

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قسم صيانة الأراضي- مركز بحوث الصحراء- المطرية- القاهرة- مصر

أجريت تجربة حقلية تحت ظروف الأراضي الجيرية في مزرعة محطة بحوث مريوط بهدف تقييم تأثير عمليات الحرث وتنظيم إضافة التسميد النيتروجيني مجزأ على فترات على بعض الخواص الطبيعية وتوزيع العناصر الصغرى في طبقات التربة السطحية (صفر-٣٠سم) وشملت المعاملات ثلاثة نظم للحرث هي (بدون حرث - محراث حفار - محراث قلاب مطرحي) مع مستويين من التسميد النيتروجيني (صفر ، ٤٥ كجم نتروجين/ فدان) وتم إضافة التسميد النيتروجيني على دفعات متساوية ٢، ٣، ٤ دفعة. وبعد الحصاد تم اخذ عينات تربه على أ عما ق حتى ٣٠ سم لإجراء التحليلات ألمناسبة. وقد أوضحت النتائج ما يلي:

١- انخفضت الكثافة الظاهرية بعد عملية الحرث ويرجع ذلك لتفكيك تماسك التربة حيث تسمح بزيادة الحجم عن طريق زيادة المسافات البينية وهذا الأثر يظهر في الأعماق السطحية مقارنه بالأعماق تحت السطحية الكبيرة وظهر ذلك عند استخدام المحراث القلاب المطرحي مع التسميد النيتروجيني.
٢- انخفضت مقاومة التربة للاختراق في جميع انظمه الحرث مع زيادة عمق الحرث مقارنةً بالكنترول وكان أقلهم اختراقا للتربه المحراث الحفار وأكثرهم كان المحراث القلاب المطرحى .
٣- انخفض القطر المتوسط لحبيبات التربة مع استخدام المحراث القلاب ومع عدم إضافة التسميد النتروجينى.
٤- أن توزيع عناصر الحديد، المنجنيز، الزنك، النحاس خلال الطبقة السطحية للتربة يكون أكثر تغيراً خلال الطبقة السطحية (صفر- ١٠ سم) حيث أن الحديد والنحاس يكونا أكثر انخفاضا والزنك والمنجنيز أكثر زيادة وذلك في المعا ملة بدون حرث مقارنه بمعاملة الحفار و القلاب في الطبقة السطحية
٥- نظم الحرث كان لها تأثير معنوي علي توزيع واستخلاص عناصر الزنك، الحديد، النحاس في التربة وكان الاختلاف في توزيع هذه العناصر واضحا في اللطبقه السطحية في حين أن التسميد النيتروجيني كان له تأثير معنوىعلى الزنك، الحديد، المنجنيز .