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IMPACT OF SUBSOILING, ORGANIC MANURE AND NITROGEN SOURCES ON SOME SOIL PROPERTIES AND SUGAR BEET PRODUCTIVITY

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ABSTRACT: *A field experiment was conducted at the Experimental Farm of Sakha Agric. Res. Station, during the winter seasons (2014/2015 and 2015/2016) to evaluate the effect of subsoiling and organic manure combined with nitrogen fertilizer sources (ammonia gas and urea) on improving some soil physical and chemical properties as well as sugar beet productivity and N-uptake.*

The following findings can be summarized as follows: -

The reduction of salinity after two years with subsoiling + urea, subsoiling + ammonia gas and subsoiling + compost + ammonia gas was 2.52, 2.52 and 3.02 dS/m, respectively compared to control. The corresponding values of ESP are 2.20, 2.06 and 2.59, respectively. Compost application was decreased soil salinity and sodicity. Reduction of salinity and sodicity were 0.69 dS/m and 0.79% with compost +urea and 0.63 dS/m and 0.88%, respectively with compost + ammonia gas compared to control. Nitrogen fertilizer sources (ammonia gas and urea) had no clear effect on salinity and sodicity in the soil.

Subsoiling with and without compost are superior in enhancing soil bulk density and porosity. Average soil bulk density reduced from 1.31 g/cm^3 with control to 1.16 g/cm^3 after treatments application. Basic infiltration rate and cumulative infiltration are increased in the treated soils. The lowest values of basic infiltration rate (0.59 cm/h) and cumulative infiltration (6.28 cm) of soil were achieved under control, while the highest values (from 0.62 to 0.94 cm/h for basic infiltration rate and from 7.52 to 12.13cm for cumulative infiltration) under other treatments.

Subsoiling are superior to compost in enhancing of quickly drainable pores (QDP), slowly drainable pores (SDP) and fine capillary pores (FCP)) of the soil. The lowest value of QDP (8.17%) and SDP (9.96%) and high percent of FCP (28.09%) are found with control. Treatments application increases QDP (from 9.76 to 13.38%) and SDP (10.47 to 15.36 %) and decreases FCP (24.56 to 17.86 %).

Subsoiling and/or compost as well as nitrogen sources caused significant increases for root yield, juice quality, gross sugar and N-uptake of sugar beet. The increases of sugar beet roots yield are 1.58, 5.09, 2.68, 6.36 and 6.38 tonfed.$^{-1}$ for compost +urea, subsoiling+ urea, compost+ ammonia gas, subsoiling+ ammonia gas and subsoiling +compost+ ammonia gas, respectively over than control in the first season. The corresponding values were 2.54, 5.26, 3.31, 6.41 and 6.72 tonfed.$^{-1}$, respectively for the abovementioned treatments in the second season. Gross sugar yield and N-uptake were parallel to the yield results in both seasons. The low value of N-uptake by root of sugar beet (average of 36.69 kgfed^{-1}) was found with control, and the high values (varied from 40.10 to 52.16 kgfed^{-1}) were found with treatments application in both seasons. Anhydrous ammonia injected gave higher root yield and N-uptake of sugar beet than mineral nitrogen source (urea).

Key words: *Subsoiling, clay soil, sugar beet, ammonia injected, compost.*

INTRODUCTION

Subsoiling is widely used on heavy soils to improve productivity of pastures and crops. Subsoiling in the drainage mode seeks to lift and shatter the soil peds to induce improved structure and so improve the water movement to the permanent pipe system (Abdel-Mawgoud *et al.,* 2006 and Antar *et al.,* 2014). Subsoiling will enhance downward movement of irrigation water carrying off excess salts from soil surface layers. After wards, regular subsequent irrigations will gradually reduce the salt content in groundwater at least when close to soil surface. The percolating water will constitute a temporary front preventing the saline groundwater in subsurface soil layers from linking with the upper ones (Moukhtar *et al.,* 2002 and 2003).

Improved crop growth following subsoiling is generally considered to be the result of the physical shattering of the hardpan, which allows to increase water penetration into the subsoil. This may also accelerate the leaching of sodium from the subsoil thereby further reducing the possibility of reformation of the hardpan (Lickacz, 1993). Said (2002) revealed that soil compaction influenced soil strength, bulk density, distribution and continuity of pores with consequent an adverse effect on drainage, root penetration, aeration, biological processes and nutrient uptake; all of which could have a direct bearing on crop production. The cumulative and basic infiltration rate of the treated soil by subsoiling markedly increased relative to the untreated one. He also, found that the treated soil resulted in a sharp decrease in the bulk density and penetration resistance in coincidence with a sharp increase in total porosity and macro pores relative to the untreated one (Said, 2003).

To decide the amount of fertilizers to apply, the farmer usually considers the crop requirement and sometimes the nitrogen stored in the soil at beginning of the crop cycle, but there is no evaluation of the soil capability to provide nitrogen minerals from its organic pool. Anhydrous ammonia is one of the most efficient and widely used as source of nitrogen for plant growth. The advantages of ammonia relatively easy application and ready availability have led to its increased use as a fertilizer. The anhydrous ammonia when injected before sowing, gave higher yield and minerals uptake than other nitrogen sources (Abd El-Kader, 2002). Ammonia gas progressed than urea for sugar beet root yield and gave maximum root yield (30.8 ton / fed.) (Atia *et al.,* 2007). Ammonia gas is good and cheaper source of nitrogen fertilizer compared with any other N source and gave the maximum economic return from sugar beet cultivation (Zalat *et al.* 2011). Injected ammonia gas at level (102 kg fed^{-1}.) gave the highest root, sugar and top yields compared with other levels under study (0, 45 and 75 kg fed^{-1}) as well as N, P, K and Na content than urea fertilizer (Mostafa and Darwish, 2001). On the other hand, increasing levels of ammonia gas injection decrease sucrose and purity percentage.

Soil degradation and nutrient have become serious threat to agricultural productivity, especially in clayey soil. Nowadays, it is recognizing the importance of improving soil fertility to ensure efficient crop production. Applying organic manure and gypsum to a clayey soil are an important practice in sustaining soil fertility and agricultural productivity. In this connection, the application of farmyard manure (FYM) showed significant increases in available P and K contents of the soil (Yadav and Chhipa, 2007). The interaction between application of compost, Sulphur and NP fertilizer gave the lowest values of bulk density and the highest values of total porosity and basic infiltration rate (El–Hamdi *et al.* 2007). The addition of organic matter to soils improved the structural stability and permeability (Bouajila and Sanaa, 2011). Injected ammonia gas was the best one in 1st and 2nd seasons followed by farm manure + urea treatment in root yield and its N-uptake (Antar and Awad, 2014).

Sugar beet (Beta vulgaris L) is the second important crop for sugar production in Egypt. The importance of this crop comes not only for its ability for growing in the new reclaimed lands, but also for giving higher sugar content and short growth period. Also, sugar beet is widely grown in areas with salinity problems. So, there is a great need for several studies under Egyptian soil conditions to establish the best recommendations for raising the quantity and quality of sugar beet production. One way of increasing production of sugar beet is proper soil management such as drainage and increasing the efficiency of added nitrogen fertilizer. The current study aims to evaluate the effect of subsoiling and organic manure combined with nitrogen fertilizer sources (ammonia gas and urea) on improving some soil physical and chemical properties as well as sugar beet productivity and N-uptake**.**

MATERIALS AND METHODS

A field experiment was conducted at the Experimental Farm of Sakha Agric. Res. Station, during the winter seasons (2014/2015 and 2015/2016) to evaluate the effect of some amendments application and nitrogen fertilizer sources on improving some soil physio-chemical properties and sugar beet productivity. The experiment is located at 31˚ 05ˉ 13.8˝ Latitude and 30° 56ˉ 10.6˝ Longitude. The soil has a clayey texture; the average textural for this soil is 11.8% sand, 33.5% silt and 54.7 % clay (Table 1). Initial of some soil properties are presented in Table (1).

The design of the experiment is randomized complete block and was established before winter season (2014/2015) as follows:

1: Urea (control) (as the farmer).
2: Urea+ compost.
3: Urea + subsoiling.
4: Ammonia gas +compost.
5: Ammonia gas + subsoiling.
6- Subsoiling with compost + ammonia gas.

“Urea and ammonia gas were applied at a rate of 120kg N fed.$^{-1}$(as recommended), compost was added at rate of 12 m^3/fed and subsoiling was established at 1.5m distance between the ploughed lines and 50cm depth.”

The salinity of irrigation water ranges between 0.5 – 0.6 dSm^{-1} with an average of 0.55dSm^{-1}.

In the winter seasons (2014/2015 and 2015/2016) sugar beet (*pleno variety*) was planted. All plots received 100 kg/fed. of superphosphate (15.5% P_2O_5) before cultivation. Nitrogen (as urea) was applied in three doses before the first, second and the third irrigations. Nitrogen (as ammonia gas) was injected at 10 to 15 cm soil depth, before cultivation. After five days from ammonia gas injection, seeds were sown and planting irrigation was applied. The different agricultural practices were done as recommended.

Table (1): The initial of some soil properties for the experimental field

Soil depth (cm)	Particle size distribution			Texture grade	EC (dS/m)	ESP	CEC Meq/100 soil	pH	OM %	Available N (mg/kg)	Bulk density g/cm^3	IR (cm/h)
	Sand%	Silt%	Clay%									
0-15	13.67	32.55	53.78	Clayey	6.58	15.17	42.63	8.17	1.98	24	1.24	0.59
15-30	13.68	32.09	54.23	Clayey	7.97	15.82	39.72	8.12	0.97	18	1.29	
30-60	13.88	32.63	53.49	Clayey	8.77	16.67	38.05	8.15	0.58	12	1.38	
Mean	13.74	32.42	53.83	Clayey	7.77	15.89	40.13	18.15	1.18	18	1.30	

Soil samples (0-15, 15-30 and 30-60 cm depth) were collected before conducting the experiment and after harvesting the first and second seasons from treatments for some physical and chemical analysis. Salinity was determined in saturated soil paste extract according to Page *et al.* (1982). Exchangeable sodium was determined using ammonium chloride and measured by using flame photometer according to Page *et al.* (1982). Infiltration rate was determined using double cylinder infiltrometer as described by Garcia (1978). Soil bulk density and total porosity of the different layers of soil profile were measured after first and second seasons using the core sampling technique as described by Campbell (1994) for all treatments. Pore size distribution was calculated from soil moisture retention curves according to DeLeenher and De Boodt (1965). Soil pores are classified according to their size and ability to retain water at different pressure head, to quickly drainable pores (QDP) that can hold water between 0.00 and 100cm head, slowly drainable pores (SDP) difference between 100 and 330 cm head. Water holding pores (WHP) or medium pores which retain soil moisture between field capacity (330cm head) and wilting point (15000cm head) and fine capillary pores (FCP) which retained soil moisture at suction head of 15.0 atm.

Root and shoot, ton fed^{-1}of sugar beet were determined for different treatments while sucrose concentration and juice purity (%) for all treatments were determined in Delta Sugar Company at El-Hamoul, Kafr El-Sheikh Governorate. Gross sugar yield (ton/fed) was calculated by multiplying root yield (ton/fed) by sucrose and juice purity (%). Root and shoot samples for beet were taken and dried at 70ºC, grounded with a mill and its total N content was determined using Kjeldahl digestion (Cottenie *et al.,* 1982). N-uptake (kg/fed.) was calculated by multiplying dry yield (kg/fed.) by N % (N content in percentage either for root and shoot). Available N content of soil was determined using Kjeldahl digestion (Cottenie *et al.,* 1982).

Statistical analysis: Data for yield and yield component of sugar beet plant are subjected to statistical analysis according to Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

Soil salinity and sodicity:

Data in Table (2) show that, treatments application seems to be favorable effective in decreasing of soil salinity and sodicity. Subsoiling application are more pronounced on reduction of salinity and sodicity compared to other treatments. Salinity and sodicity of the soil increased with the increasing of soil depth. Salinity and sodicity of the soil, under urea (control) are relatively high (EC_e varied from 6.52 to 8.97dS/m and ESP from 15.22 to 16.77) comparing with other treatments (varied from 3.87 to 8.36 dS/m for EC_e and 12.26 to 16.27 for ESP). The decreases of soil salinity and sodicity after two years of treatments application are more pronounced compared to after one year (Table, 2). The reduction of salinity, after two years with compost+urea, subsoiling+ urea, compost + ammonia gas, subsoiling + ammonia gas and subsoiling + compost + ammonia gas were 0.69, 2.52, 0.63, 2.52 and 3.02 dS/m, respectively than urea (control). The corresponding values of ESP are 0.79, 2.20, 0.88, 2.06 and 2.59, for the stated treatments, respectively.

The effect of the treated treatments on improving soil desalinization, desodification are shown in Table (2). It should be mentioned that the greatest desalinization occurs after subsurface tillage. Results could be attributed mainly to that subsoil forms many lines with big crack extend from soil surface to subsoil depth and also numerous effective capillary cracks is formed. All these cracks together break the soil matrix and encourage downward of water as well as solute movement. The soil cracks life may be several months or years (Moukhtar *et al.,* 2002). Moukhtar *et al,* (2003) reported that, subsoiling enhance downward movement of irrigation water carrying off excess salts from surface layers. After wards, regular subsequent irrigations will gradually reduce the salt content in groundwater at least when it is close to soil surface.

Compost application (Table, 2) were realized somewhat in lower soil salinity and sodicity than the control. This may be due to the improved soil physical properties such as bulk density, porosity, aggregates stability and infiltration rate that affect water-air relationships in the root zone (Doran and Parking, 1994). Nitrogen fertilizer sources (ammonia gas and urea) had no clear effect on salinity and sodicity in the soil.

Table (2): Salinity and sodicity of the soil as affected by the different studied treatments.

Treatments	Soil depth (cm)	After first season		After second season	
		EC dSm^{-1}	ESP	EC dSm^{-1}	ESP
Urea (control).	0-15	6.52	15.27	6.59	15.22
	15-30	7.93	15.82	7.84	15.86
	30-60	8.97	16.67	8.69	16.77
Average		7.81	15.92	7.71	15.95
Urea + compost.	0-15	6.08	14.84	5.89	14.15
	15-30	7.23	15.54	7.12	15.22
	30-60	8.36	16.27	8.06	16.11
Average		7.22	15.55	7.02	15.16
Urea + subsoiling.	0-15	5.45	13.74	4.84	13.25
	15-30	5.42	14.52	4.88	13.64
	30-60	6.35	14.68	5.86	14.35
Average		5.74	14.31	5.19	13.75
Ammonia gas + compost	0-15	6.84	14.68	6.12	14.35
	15-30	6.87	15.29	7.24	14.89
	30-60	7.99	16.11	7.89	15.97
Average		7.23	15.36	7.08	15.07
Ammonia gas+subsoiling	0-15	4.84	13.24	4.31	12.88
	15-30	5.64	14.53	5.14	13.54
	30-60	6.74	15.41	6.11	15.26
Average		5.74	14.39	5.19	13.89
Ammonia gas + subsoiling + compost	0-15	4.22	13.11	3.87	12.26
	15-30	5.11	14.12	4.52	13.17
	30-60	6.01	15.03	5.68	14.66
Average		5.11	14.09	4.69	13.36

Soil bulk density and Soil porosity

Soil bulk density is considered as one of the parameters which indicate the status of soil structure and consequently soil water, air and heat regimes (Richards, 1954). Results in Table (3) show that, soil bulk density is increased with increasing soil depth for all tested profiles. This increase may be resulted from increasing soil compaction due to layers weight. Treatments application reduced soil bulk density, especially in the top-layer (0-30cm). Values of soil bulk density under control are relatively high (varied from 1.27 to 1.38 g/cm^3) at the first season comparing with other treatments (varied from 1.07 to 1.31 g/cm^3). Subsoiling with and without compost were superior to other treatments on reducing soil bulk density. It could be attributed to the effects of subsoiling on breaking soil clods and bigger granular into smaller crumbs as well as breaking and cracking the compacted layers (Amer, 1999 and Abdel-Mawgoud *et al.,* 2006). The applied compost were realized favorable effects in soil bulk density especially in the top soil layer (0-20cm). Similar results were obtained by Aiad *et al.,* (2012). In this concern, Cook *et al.,* (1979) reported that, improvement of the soil after compost application included an increase in water infiltration rate, a decrease in bulk density, and an increase in pore volume. The effect of subsoiling and/or compost treatments after two seasons were more pronounced relative to after one season in decreasing the soil bulk density.

Soil porosity values (Table 3) take almost the opposite trend to that encountered with bulk density. The results indicate that the values of bulk density were increased and values of total porosity were decreased with the depth for all treatments. Subsoiling with and without compost are superior in enhancing soil porosity. Jodi DeJong (2004) stated that the theory behind subsoiling is to shatter a deep compacted layer in the soil to increase water movement, increase total porosity, create better aeration for the root and increase the availability of nutrients for plant growth. Bulk density and total porosity of the soil do not affect by nitrogen fertilizer sources (ammonia gas and urea).

Infiltration rate (IR) and cumulative infiltration:

Data illustrated in Table (4) and Figs (1,2,3 and 4) show that, basic infiltration rate and cumulative infiltration values after each season are increased in the treated soils. The lowest values of basic infiltration rate (0.58 cm/h) and cumulative infiltration (6.28 cm) of soil was achieved under control treatment, while the highest values (varied from 0.62 to 0.94 cm/h for basic and 7.52 to 12.13cm for cumulative infiltration) under other treatments at the first season. Subsoiling with and without compost were superior to compost without subsoiling on enhancing of infiltration rate and cumulative infiltration. This due to the tillage by subsoiling gave the top soil layer a chance to dry and permitted for shrinkage and formation of water passage ways which allowed a rather easier movement of water into subsoil line. Similar results were obtained by Abdel-Mawgoud *et al.,* (2004 and 2006). Also, application of treated compost realized favorable effects for infiltration rate and cumulative infiltration. Basic and cumulative infiltration values were higher with compost treatments than the control especially, after the second season. Similar results were obtained by Aiad *et al.,* (2012). Infiltration rate and cumulative infiltration do not affect by nitrogen fertilizer sources (ammonia gas and urea).

Table (3): Soil bulk density and total porosity after the first and second seasons as affected by treatments application.

Treatments	Depth (cm)	After first season		After second season	
		Soil bulk density g/cm^3	Porosity %	Soil bulk density g/cm^3	Porosity %
Urea (control).	0-15	1.27	52.08	1.28	51.70
	15-30	1.29	51.32	1.27	52.08
	30-60	1.38	47.92	1.36	48.68
Average		1.31	50.44	1.30	50.82
Urea + compost.	0-15	1.21	54.34	1.17	55.85
	15-30	1.25	52.83	1.24	53.21
	30-60	1.31	50.57	1.30	50.94
Average		1.26	52.58	1.24	53.33
Urea +subsoiling.	0-15	1.13	57.36	1.11	58.11
	15-30	1.20	54.72	1.19	55.09
	30-60	1.29	51.32	1.28	51.70
Average		1.21	54.47	1.19	54.97
Ammonia gas + compost.	0-15	1.19	55.09	1.15	56.60
	15-30	1.27	52.08	1.27	52.08
	30-60	1.31	50.57	1.30	50.94
Average		1.26	52.58	1.24	53.21
Ammonia gas +subsoiling	0-15	1.10	58.49	1.11	58.11
	15-30	1.24	53.21	1.19	55.09
	30-60	1.24	53.21	1.27	52.08
Average		1.19	54.97	1.19	55.09
Ammonia gas + subsoiling + compost	0-15	1.08	59.25	1.07	59.62
	15-30	1.17	55.85	1.15	56.60
	30-60	1.22	53.96	1.22	53.96
Average		1.16	56.35	1.15	56.73

Table (4): Basic infiltration rate (cm/h) and cumulative infiltration (cm) after the first and second seasons as affected by treatments application.

Treatments	First season		Second season	
	Basic IR (cm/h)	Cumulative infiltration (cm)	Basic IR (cm/h)	Cumulative infiltration (cm)
Urea (control)	0.58	6.28	0.59	6.59
Urea + compost	0.62	7.52	0.69	8.19
Urea + subsoiling	0.94	11.54	0.92	11.42
Ammonia gas + compost.	0.63	7.93	0.68	8.68
Ammonia gas + subsoiling	0.93	11.48	0.93	11.93
Ammonia gas + subsoiling+ compost	0.94	12.13	0.93	12.11

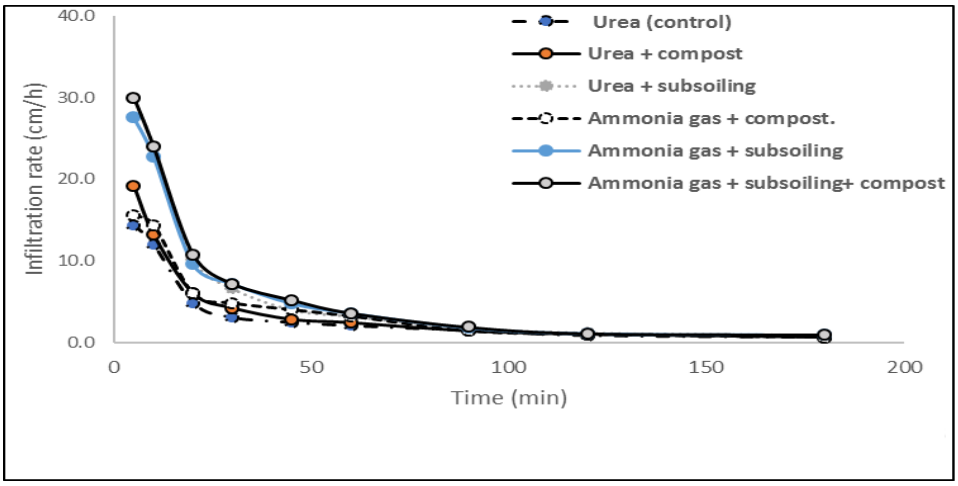

Fig. (1): Infiltration rate (cm/h) after the first season as affected by treatments application.

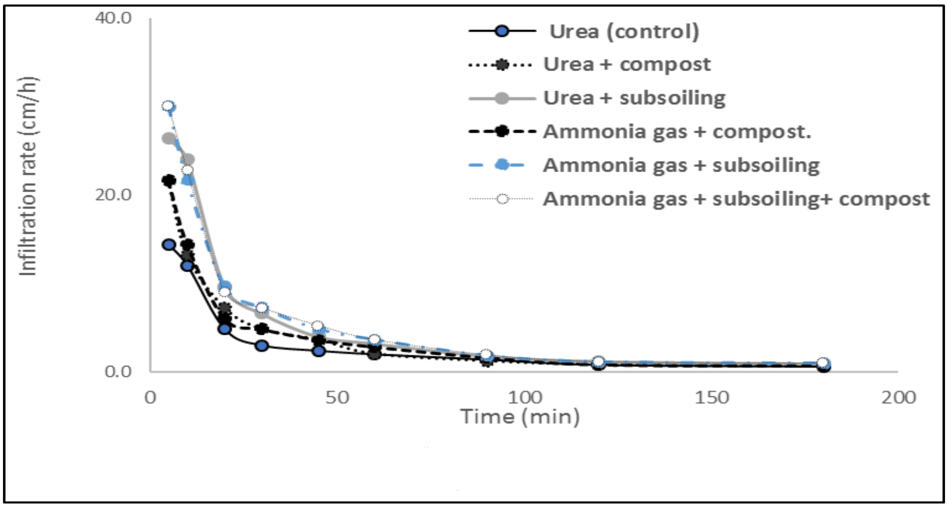

Fig. (2): Infiltration rate (cm/h) after the second season as affected by treatments application.

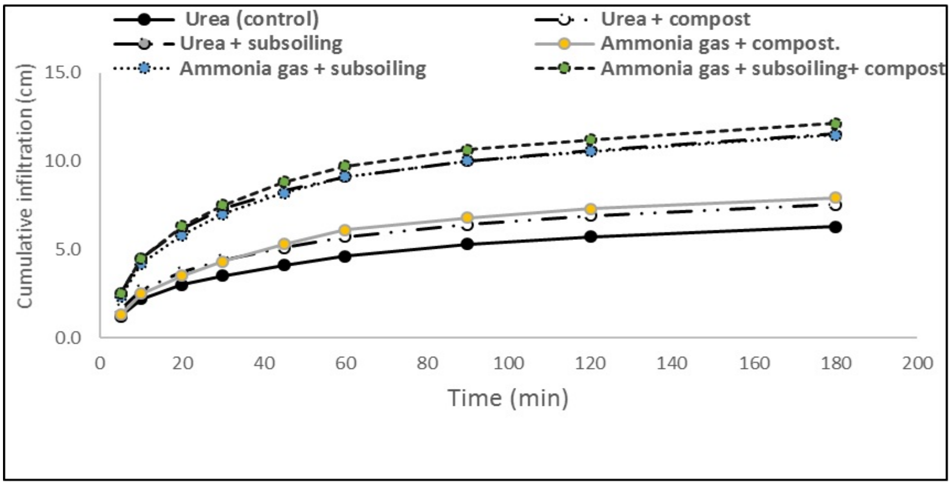

Fig. (3): Cumulative infiltration (cm) after the first season as affected by treatments application.

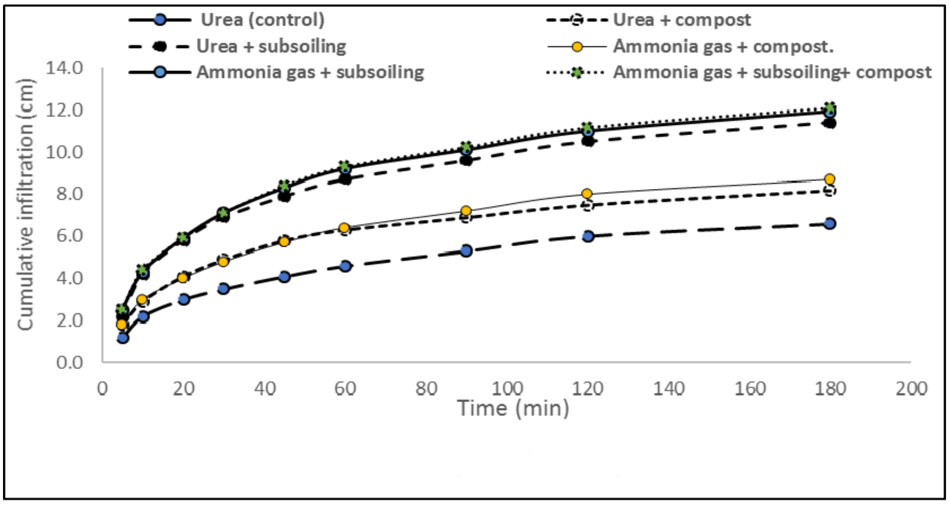

Fig. (4): Cumulative infiltration (cm) after the second season as affected by treatments application.

Pore size distribution:

Pore size distribution (quickly drainable pores (QDP), slowly drainable pores (SDP), water holding pores (WHP) and fine capillary pores(FCP)) of the studied soil are presented in (Table, 5 and Fig, 5). Results show that, the low value of QDP (8.17%) and SDP (9.96%) and high percent of FCP (28.09%) are found with control treatment. These high values of FCP which are often filled with water and cause water logging, while plants grown in these soils suffer from drought. Treatments application were realized increases of QDP (varied from 9.76 to 13.38%) and SDP (varied from 10.47 to 15.36 %) and decrease of FCP (varied from 24.56 to 17.86 %). The increases of QDP and SDP and decreases of FCP are more pronounced with subsoiling with and without compost treatments compared to compost without subsoiling. Results also indicate that, subsoiling with compost is superior to subsoiling without compost in enhancing of pore size distribution in soil. The average values of QDP were 11.00,11.74, 10.91, 12.00 and 13.03% for compost with urea, subsoiling with urea, compost with ammonia gas, subsoiling with ammonia gas and subsoiling with compost and ammonia, respectively. The corresponding values are 11.32, 14.97, 11.13, 15.09 and 15.11%, respectively for SDP and 24.00, 19.71, 24.02, 19.04 and 17.99 %, respectively for FCP. Results showed that, subsoiling tend to enhancing of pore size distribution in soil. It could be attributed to the effects of subsoiling on breaking soil clods and bigger granular into smaller crumbs as well as breaking and cracking the compacted layers. In this concern, Abdel-Mawgoud (2004) found that subsoiling resulted in a noticeable increase in macro-pores with a consequent decrease in micro-pores compared with the control treatment. The applied compost was realized desirable effects in pore size distribution especially in the top soil layer. In this concern Cook *et al.,* (1979) reported that, improvements of the soil after compost application included an increase in water infiltration rate, a decrease in bulk density, and an increase in pore volume. Results (Table, 5 and Fig, 5) showed that, subsoiling and/or compost tend to enhancing of WHP% compared to control treatment. Nitrogen fertilizer sources (ammonia gas and urea) had not realized differences in pore size distribution in soil.

Table (5): Pore size distribution (QDP, SDP, WHP, FCP %) with soil depths after second season from treatments application.

Treatments	Soil depth (cm)	QDP%	SDP%	WHP%	FCP%
Urea (control)	0-15	9.03	10.21	22.79	27.86
	15-30	7.59	9.78	22.13	28.54
	30-60	7.89	9.89	22.91	27.88
Average		8.17	9.96	22.61	28.09
Urea + compost	0-15	11.93	11.37	23.28	23.56
	15-30	11.32	11.43	23.35	23.87
	30-60	9.76	11.16	23.55	24.56
Average		11.00	11.32	23.39	24.00
Urea + subsoiling	0-15	12.01	15.01	23.82	19.03
	15-30	12.40	15.15	23.10	19.77
	30-60	10.81	14.76	23.55	20.34
Average		11.74	14.97	23.49	19.71
Ammonia gas + compost	0-15	11.99	10.47	23.40	24.25
	15-30	10.19	11.73	24.00	23.95
	30-60	10.56	11.19	24.70	23.87
Average		10.91	11.13	24.03	24.02
Ammonia gas + subsoiling	0-15	12.11	15.28	23.97	18.87
	15-30	12.48	15.10	23.40	19.14
	30-60	11.40	14.88	24.44	19.12
Average		12.00	15.09	23.94	19.04
Ammonia gas + subsoiling +compost	0-15	13.22	15.36	23.79	17.96
	15-30	13.38	15.20	23.46	18.15
	30-60	12.49	14.76	24.75	17.86
Average		13.03	15.11	24.00	17.99

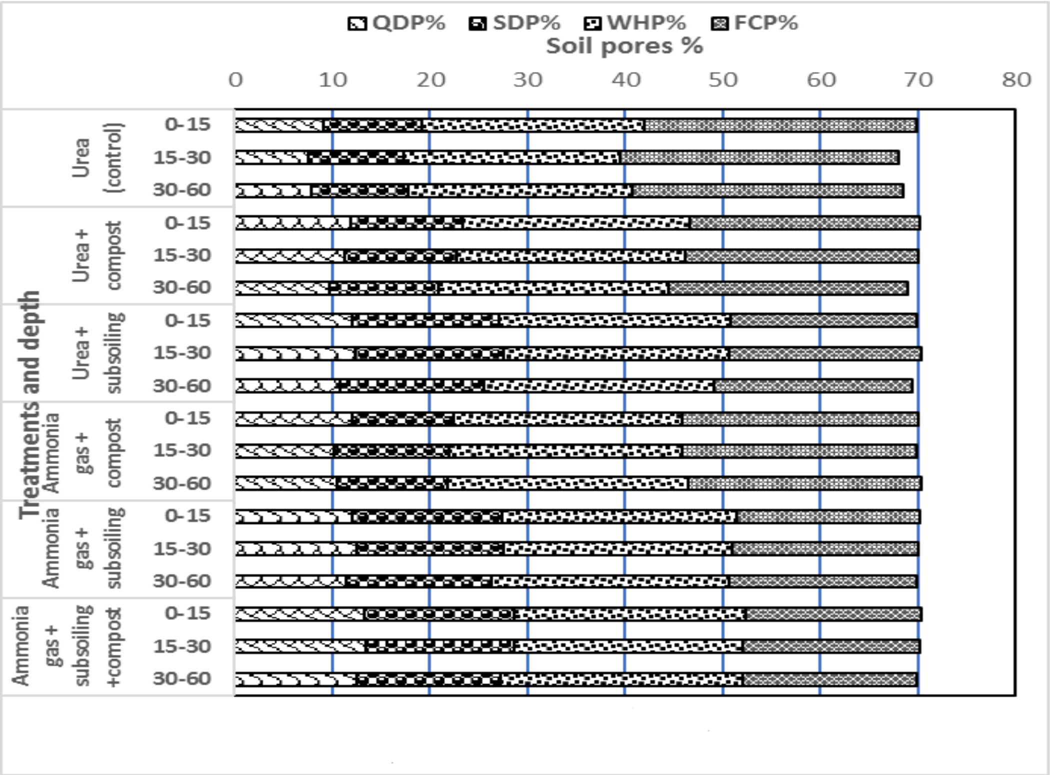

Fig. (5): Pore size distribution (QDP, SDP, WHP, FCP %) with soil depths for different treatments.

Yields:

Data in Table (6) indicate that, subsoiling and/or compost as well as nitrogen sources caused significant increases of sugar beet yield compared to control. The yields are increased when improving soil properties as affected by treatments application. It can be concluded that heavy clay salt affected soils could have good productivity with the execution of subsoiling and compost. Sugar beet roots yield are higher with application of subsoiling and/or compost especially with ammonia gas injection than that control. The increases of sugar beet roots yield are 1.58, 5.09, 2.68, 6.36 and 6.38 ton fed.$^{-1}$ for compost +urea, subsoiling+ urea, compost+ ammonia gas, subsoiling+ ammonia gas and subsoiling+ compost +ammonia, respectively over than control in the first season. The corresponding values were 2.54, 5.26, 3.31, 6.41 and 6.72 tonfed.$^{-1}$, respectively in the second season. The increases of sugar beet root yield are more pronounced with subsoiling with and without compost compared to compost without subsoiling. Such findings may be attributed to the effect of subsoiling and/or compost on improving soil properties which affects water-air relationships in the root zone and increase the root penetration. In this regard, Abdel-Mawgoud *et al.,* (2006) mentioned that the subsurface tillage was superior in enhancing the sugar beet yield. It can be concluded that under such conditions the subsoiling and/or compost are the most effective treatments that ameliorate saline sodic clay soil. Similar results were obtained by Lickacz (1993), Aiad *et al.,* (2012) and El-Sanat *et al.,* (2012). Data (Table 6) show that, there were no obvious differences between shoot yield with all treatments and, the values varied from 2.66 to 3.02 ton fed^{-1}. Results (Table 6) show that, anhydrous ammonia injected before sowing with subsoiling and/or compost, gave higher root yield of sugar beet than mineral nitrogen source (urea) with subsoiling and/or compost. Abd El-Kader (2002) reported that when the anhydrous ammonia injected before sowing, gave higher yield and minerals uptake than other nitrogen sources.

Data in Table (7) show that, there were no obvious differences between sugar percentages with all treatments. Data showed that, the low values of juice quality of sugar beet (average of 78.78 %) were found with control treatment, and the high values (varied from 79.94 to 84.16 %) were found with treatments in both seasons. Data in Table (7) showed that, gross sugar yield were parallel to the sugar beet yield in both seasons. The increases of gross sugar yield are 0.25, 0.87, 0.49, 1.15 and 1.12 ton fed.$^{-1}$ for compost +urea, subsoiling+ urea, compost+ ammonia gas, subsoiling+ ammonia gas and subsoiling+ compost + ammonia, respectively over than control in the first season. The corresponding values were 0.34, 0.88, 0.57, 1.16 and 1.18 tonfed.$^{-1}$, respectively for the above mentioned treatments in the second season.

Data in Table (8) showed that, N-uptake by sugar beet roots and shoots were parallel to the yield results in both seasons. Data showed that, the low values of N-uptake by root of sugar beet (average of 36.69 kgfed^{-1}) were found with control treatment, and the high values (varied from 40.10 to 52.16 kgfed^{-1}) were found with treatments application in both seasons. The increases of N-uptake by sugar beet roots and shoots are more pronounced with anhydrous ammonia injected with subsoiling and/or compost compared to mineral nitrogen source (urea) and control. Results also indicate that, subsoiling is superior to compost in enhancing of N-uptake by sugar beet roots. Abd El-Kader (2002) reported that when the anhydrous ammonia injected before sowing, gave higher yield and minerals uptake than other nitrogen sources.

Table (6): Sugar beet yields with different studied treatments.

Treatments	Sugar beet yields (Ton/fed.)			
	First Season		Second Season	
	Roots	Shoots	Roots	Shoots
Urea (control)	16.32 c	2.77 b	16.36 d	2.73 b
Urea + compost	17.90 b	3.02 a	18.90 c	3.01 a
Urea + subsoiling	21.42 a	2.66 b	21.62 b	2.79 b
Ammonia gas + compost.	19.23 b	2.88 ab	19.67 c	2.92 ab
Ammonia gas + subsoiling	22.68 a	2.78 ab	22.77 a	2.84 ab
Ammonia gas + subsoiling+ compost	22.70 a	2.88 ab	23.08 a	2.85 ab
LSD 0.05 %	1.67	0.23	1.02	0.21

Table (7): Sugar %, sugar quality % and gross sugar yield (Ton fed^{-1}) with different studied treatments.

Treatments	Sugar yields					
	Sugar %		Quality %		Gross sugar (Ton fed^{-1})	
	First Season	Second Season	First Season	Second Season	First Season	Second Season
Urea (control)	17.74 b	17.86 b	78.53 f	79.05 e	2.27	2.31
Urea + compost	17.58 b	17.58 b	79.94 e	80.23 d	2.52	2.65
Urea + subsoiling	17.88 ab	17.83 b	82.04 c	82.68 b	3.14	3.19
Ammonia gas + compost.	17.96 ab	18.01 a	80.94 d	81.18 c	2.76	2.88
Ammonia gas + subsoiling	18.01 a	18.11 a	83.79 a	84.13 a	3.42	3.47
Ammonia gas + subsoiling +compost	17.95 ab	17.97 ab	83.19 b	84.22 a	3.39	3.49
LSD 0.05%	0.22	0.21	0.49	0.78	-	-

Table (8): N-uptake of Sugar beet (kg fed^{-1}), with different studied treatments.

Treatments	N-uptake of Sugar beet (kg fed^{-1})			
	First Season		Second Season	
	Roots	Shoots	Roots	Shoots
Urea (control)	36.71 c	17.76 b	36.65 d	17.69 b
Urea + compost	40.09 b	18.73 ab	40.63 c	19.01 a
Urea + subsoiling	41.76 b	16.96 b	41.50 c	18.03 ab
Ammonia gas + compost.	42.94 b	18.81 ab	43.75 b	19.04 a
Ammonia gas + subsoiling	51.26 a	18.80 ab	51.24 a	19.20 a
Ammonia gas + subsoiling+ compost	51.53 a	19.58 a	52.15 a	19.26 a
LSD 0.05%	3.30	0.98	2.17	1.01

Conclusion

- * subsoiling is proper way to enhancing the characteristics of clay soils.
- * subsoiling tend to improve soil physio-chemical characteristics and increase crop production.

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تأثير الحرث تحت التربة والسماد العضوي ومصادر النتروجين على بعض خصائص الأرض وإنتاجية بنجر السكر

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الملخص العربي

الإهتمام بالصرف ورفع كفاءة الأسمدة تلعب دوراً هاماً في إدارة الأراضي وزيادة الإنتاجية. وتهدف الدراسة الى تقييم الحرث تحت التربة والسماد العضوي ومصدر السماد المعدني (اليوريا وحقن الأمونيا الغازية) على تحسين بعض صفات التربة الفيزيائية والكيمائية وأيضاً الإنتاجية والنتروجين الممتص لنبات بنجر السكر

وتوضح النتائج أن:-

أدت معاملات الحرث تحت التربة الى تقليل الملوحة والصودية خصوصا بعد عامين من التنفيذ. حيث كان النقص في الملوحة بعد عامين 2.52، 2.52و 3.02 ديسيمنز/متر مع معاملات الحرث تحت التربة +يوريا، حرث تحت التربة + أمونيا غازية، حرث تحت التربة + كمبوست + أمونيا غازية على التوالى مقارنة بالكنترول. وكانت القيم المقابلة لل ESP هي 2.3، 2.06و 2.59 على التوالى. إضافة السماد العضوي أدى إلى إنخفاض قليل في الملوحة والصودية. وكان نقص الملوحة والصودية 0.69 ديسيمنز / متر ، 0.79% مع الكمبوست + اليوريا و0.63 ديسيمنز/متر ، 0.88% على التوالي مع الكمبوست + الأمونيا الغازية مقارنة بالكنترول. ومصدر السماد النتروجيني (الأمونيا الغازية واليوريا) لم تظهر تأثير على ملوحة وصودية التربة.

الحرث تحت التربة مع وبدون السماد العضوي كان لة أثر فعال في تحسين الكثافة الظاهرية والمسامية الكلية. حيث قلت الكثافة الظاهرية من 1.27و1.37 جم/سم^3 مع الكنترول الى 1.07و 1.31 جم/سم^3 بعد تطبيق المعاملات. وزاد معدل الرشح الأساسي والتجميعي في الأرض المعاملة. فكانت أقل القيم لمعدل الرشح الأساسي (0.59سم/ساعة) والرشح التجميعي (6.28سم) مع الكنترول بينما أعلى القيم (من 0.62 الى 0.94 سم/ساعة) للرشح الأساسي ومن (7.52 الي 12.13 سم) للرشح التجميعي. والحرث تحت التربة كان لة أثر فعال في تحسين مسام الصرف السريعة والمتوسطة والمسام الشعرية الدقيقة للتربة. حيث كانت أقل القيم للمسام السريعة (8.17%) والمسام المتوسطة (9.96%) وأعلى قيم للمسام الشعرية الدقيقة (28.09%) تحققت مع الكنترول. وأدي تطبيق المعاملات الى زيادة المسام السريعة (9.76 الى 13.38%) والمسام المتوسطة (10.47 الى 15.36%) ونقص المسام الشعرية الدقيقة (24.56 الى 17.86%) .

أدى الحرث تحت التربة والسماد العضوي ومصدر السماد المعدني الى زيادة معنوية في إنتاج بنجر السكر من الجذور، جودة العصير، إنتاج السكر الخام والنيتروجين الممتص مقارنة بالكنترول. حيث كانت الزيادة في إنتاجية بنجر السكر من الجذور 1.58، 5.09، 2.68، 6.36و 6.38 طن للفدان لكل من السماد العضوي + اليوريا، الحرث تحت التربة + اليوريا ، السماد العضوي + الامونيا الغازية، الحرث تحت التربة+ الامونيا الغازية ، الحرث تحت التربة + السماد العضوي + الأمونيا الغازية على التوالى مقارنة بالكنترول في الموسم الأول. وكانت القيم المماثلة علي التوالي للموسم الثاني هي 2.54، 5.26، 3.31، 6.41و 6.72 طن للفدان. وكانت نتائح السكر الخام والنيتروجين الممتص موازية لنتائج المحصول في كلا الموسمين. وأقل القيم للنيتروجين الممتص بجذور بنجر السكر (36.69 كيلوجرام/فدان) مع الكنترول وأعلى القيم (من 40.10 الى 52.16 كيلوجرام /فدان) مع المعاملات في كلا الموسمين. حقن الأمونيا الغازية قبل الزراعة مع الحرث تحت التربة أو السماد العضوي حقق أعلى قيمة من المحصول والنيتروجين الممتص مقارنة بالأسمدة المعدنية.