RESEARCH ARTICLE

IMPACT OF MOLE DRAINS AND N-FERTILIZER RATES ON SOME SOIL PROPERTIES AND SUGAR BEET PRODUCTION IN CLAY SOIL.

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Abstract

A field experiment was conducted during two winter seasons 2013/2014 and 2014/2015 at El-HamulDistrict, Kafr El-Shiek Governorate, Egypt, to study and evaluate the effect of mole drains (2 and 4 m spacing between the ploughed lines and 60 cm depth) and applied N-fertilizer rates (100 N, 115 N and 130 N % from the recommended) + 3 ton/fed. of gypsum before cultivation on improving some soil physio-chemical properties and sugar beet production in heavy clay salt affected soil.

Data showed that: Application of mole drainsseem to be more effective in decreasing soil salinity and sodcity especially, in the top soil (0-60cm) and narrow spacing between the ploughed lines (2m). The reduction of soil salinity (0-60cm) were 21.11, 21.44, 17.04, 11.74, 11.17 and 10.95 % after the first season and 31.26, 31.37, 34.54, 12.34, 17.44 and 20.05% after the second season for treatment of 2m spacing + 100% N, 2m spacing + 115% N, 2m spacing + 130% N, 4m + 100% N, 4m spacing + 115% N, 4m spacing + 130% N, respectively than control. The corresponding values of ESP were 13.56, 13.90, 13.22, 4.56, 12.25 and 11.85% after the first season and 18.81, 18.75, 19.38, 10.57, 15.74 and 16.93% after the second season respectively.Mole drains and gypsum seemed to be more effective on increasing Ca^{++}/TSS ratio in the topsoil up to 60cm.

Mole drainsapplication was reduced bulk density and penetration resistance of the soil.Narrow spacing is superior to wider spacing in reducing bulk density and penetration resistance of the soil.Basic infiltration rates before treatments application was 0.61 cm/hr while, after application varied from 1.56 to 1.85 cm/hr. Narrow spacing is superior to wider spacing in increasing basic infiltration rate. While, no obvious different between bulk density, penetration resistanceand basic infiltration values under N-fertilizerrates treatments.

All moles drains treatments caused to significant increase in root and sugar yields in both seasons compared to control treatments. Root yield significant increased than control by 5.65, 6.98, 7.38, 5.02, 6.71 and 7.37 ton/fed. In the first season and 4.87, 6.53, 6.67, 4.70, 6.14 and 6.73 ton/fed. in the second season. In the same time sugar yield increased than control by 0.94, 1.15, 1.17, 0.82, 1.09 and 1.16 ton/fed. In the first season while at the second season the increase were 0.80, 1.07, 1.09, 0.87 and 1.01 ton/fed. On the other side quality % recorded the highest value with control (81.48 and 81.22%) in both seasons compared to other mole drains applications which recorded the lowest ones.

The lowest values of N-uptake (35.20 to 36.44 kg.fed[-1]) were found with control, and the highest ones (44.10 to 55.38 kgfed[-1]) were found with treatments in both seasons.The low values of impurities (K, Na andAlfa-amino –N) in sugar beet roots were found with treatments compared to the control.

Introduction:-

Soil salinity and sodicity are one of the main agricultural problems limiting plant, growth and development in the world especially in arid and semiarid regions (**Pessarakli, 2010**). In Egypt, northern part of the Nile Delta represents a large area of heavy clay soils with shallow drainage which are low permeability that might have a low productivity.

Drainage plays a vital role in low permeable clay soils in order to prevent soil degradation. A secondary drainage treatment of moling seeks to be an inexpensive "drain" at close spacing, intercepted by permanent laterals at wider spacing. Moling is the best suited to clay soils with a minimum clay content of about 30%. Mole drainage, on the suitable soil type and done properly can reduce waterlogging problems. Mole drainage is widely used on heavy soils to improve productivity of pastures and crops **(David, 2002).** Improved salt affected soils and crop growth following subsurface drainage and mole drains are 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**).**Antar, et al., (2008 and 2014)** and **Aiad et al., 2012**found that subsurface tillage seemed to be effective in lowering soil salinity and sodicity and bulk density especially in the soil depth (0-60cm). Sugar beet yields are related to the salinity contents in soil.The yields increased when the EC decreased as affected by subsoiling and/or moling.

Alkali soils which are characterized by their adverse physical properties, their dispersed condition and impermeability to water, are to be directly connected with sodium as the dominant exchangeable base and the presence of magnesium silicate precipitated during the process of soil alkalinization. Gypsum applications followed by leaching, and biological methods such as growing salt-tolerant crops, were found successful in reclamation of a number of sodic and saline-sodic soils having good drainage conditions (**Ahmad et al., 1990; Oster et al., 1996 and Reda 2006).**

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. Sugar beetyield is affected by many factors such as drainage conditions and nitrogen fertilizer. Many investigators studied factors related to sugar beet yield among of them **Aiad et al., (2012)**and **Antar et al., (2008 and 2014)**.Nitrogen is the most important nutrients required for all plants to obtain improving yield and its quality (**Rees et al., 1995**). **Korany**and **El-Said (1998)** and **El-Shahawy et al. (2001)** concluded that improve root and top quality and sugar yield of sugar beet, may be due to improve soil structure and consequently the permeability and aeration.

The current study aims to study and evaluate the effect of mole drainsand applied N-fertilizer rates on improving some soil physio-chemical properties and sugar beet production in heavy clay soil.

Materials and methods:-

A field experiment was conducted through two winter seasons 2013/2014 and 2014/2015 at El-HamulDistrict, Kafr El-Shiek Governorate, Egypt), to evaluate the effect of mole drains (2 and 4 m spacing between the ploughed lines and 60 cm depth) and applied N-fertilizer rates (100 N, 115 N and 130 N % from the recommended dose) on

improving some soil physio-chemical properties and sugar beet production in heavy clay salt affected soil. The location is situated at 31° 18′ 12″ 7 N latitude and 31° 03′ 30″ 5 E longitude. Nitrogen fertilizer in the form of urea was added in three doses (before the first, second and the third irrigations). All plots received 3 ton/fed. of gypsum before cultivation as recommended. The different agricultural practices were done as recommended through the two growing seasons. The salinity of irrigation water ranges between 0.8 – 0.6 dSm-1 with an average of 0.70 dSm^{-1}. The initial of some soil properties for the experimental field are presented in Table (1).

The experiment design was a randomized complete block in seven treatments with three replicates as follows:
1. Open drainage + 100% of the recommended N (90Kg N/fed) (control).
2. Mole drains at 2m spacing + 100% of the recommended N (90Kg N/fed).
3. Mole drains at 2m spacing + 115% of the recommended N (104Kg N/fed).
4. Mole drains at 2m spacing +130% of the recommended N (117Kg N/fed).
5. Mole drains at 4m spacing + 100% of the recommended N (90Kg N/fed).
6. Mole drains at 4m spacing +115% of the recommended N (104Kg N/fed).
7. Mole drains at 4m spacing + 130% of the recommended N (117Kg N/fed).

Before winter season 2013/2014, mole drains installation with twodistances between the ploughed lines (2and 4m) and 60 cm depth perpendicular to the open drainage. "Mole drains are unlined channels formed in a clay subsoil with a ripper blade with a cylindrical foot, often with an expander which helps compact the channel wall." Open drain was used to collect the drainage water brought by mole drain channels.

In the two growing seasons, seeds of sugar beet (pleno cultivar) were sown. The plants were thinned to one plant before the first irrigation. All plots received 100 KgCa-superphosphate/fed, and 50 Kg K-sulfate/fed, during tillage operation. Soil samples (0-15, 15-30, 30-60 and 60-90cm depth) were collected before experiment and after the first and second seasons from treatments instillation for all treatments and monitored for some physical and chemical analysis. Salinity was determined in saturated soil best 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)**. Soil bulk density and total porosity of the different layers of soil profile were measured before experiment and after the first and second seasons from treatments instillation for all treatments using the core sampling technique as described by **Campbell (1994)**. Soil penetration resistance (SPR) was determined by hand penetrometer apparatus (Read by Newton/cm2) and, convert the Newton into Mega Pascal (MPa) values (100 Newton/cm^2 = 1 Mega Pascal). Infiltration rate was determined using double cylinder infiltrometer as described by **Garcia (1978)**. At harvest, root and top yields and sugar yield as ton/fed were determined in both seasons.

Sucrose % and juice purity % were determined in Delta company sugar in El-Hamul district. Sugar yield was Calculated from multiplied root yield (ton / fed) x sucrose %

Alkaline coefficient (Ac) calculated as follow:
Ac= [(Na+K)∕(α-amino N)]   according to **Wieninger and kubadinow 1971 and polloch 1984** .
Statistical analysis: Some of the obtained data are subjected to statistical analysis according to **Snedecor** and **Cochran (1980).** Treatments were compared by Duncan's multiple range test (Duncan, 1955)

Table 1:- The initial of some soil properties for the experimental field.

Soil depth (cm)	Particle size distribution			Texture grade	N (ppm)	EC (dS/m)	ESP %	Bulk density g/cm^3	IR (cm/h)
	Sand%	Silt%	Clay%						
0-15	13.29	30.28	56.43	Clayey	31	7.98	16.74	1.35	0.64
15-30	13.71	30.65	55.64	Clayey	27	8.79	17.94	1.35	
30-60	14.88	29.84	55.28	Clayey	24	10.54	19.16	1.41	
60-90	14.87	31.24	53.89	Clayey	21	11.74	21.37	1.45	
Mean	14.19	30.50	55.31	Clayey	25.8	9.76	18.80	1.39	

Results and discussion:-
Soil salinity and sodcity:-

Data presented in Tables (1 and 2) show that, application of mole drainsseem to be more effective in decreasing soil salinity and sodcity in presence gypsum. The salinity and sodcity of the soil increased markedly with the increasing of soil depth. Soil salinity and sodcityin the topsoil up to 60cm, before treatments application (Table, 1) are relatively high (EC_e varied from 7.98 to 10.54 dSm^{-1} and ESP from 16.74 to 19.16) comparing with that after the first and second seasons (Table, 2) which, varied from 5.13 to 9.24 $dSm^{-1}$for EC_e and 13.05 to 17.56 for ESP. The decreases of soil salinity and sodcity in the topsoil up to 60cm, after the second season of treatment installation are more pronounced compared to that after one season (Table, 2). Salinity and sodcityof the soil are decreased in the upper layer (0-60cm) in all treatments while, no decrease was shown in the deeper layer 60-90cm. These results might be explained by the effect of mole drains on water table recession, which occurred only through mole depth and thus contributed to an active salt transfer during the falling of water table. It could be concluded that in heavy textured soils, the ponding conditions under open drains, realizes desalinization of the surface soil layers and partly of the subsurface layers. Whereas, mole drains is effective in removing salts from the upper layers only. Salt leaching from deeper layers depends on the efficiency of drainage system.Similar results were obtained byMoukhtar et al., (2003) and Abdel-Mawgoud et al. (2003).

It is clear that narrow mole spacing (2m) is superior to wider mole spacing (4m)in reducing soil salinity and sodcityin both seasons. This may be due to the good effectiveness of narrow mole spacing (2m) than wider mole spacing (4m). The reduction of soil salinity in the topsoil up to 60cm, were 21.11, 21.44, 17.04, 11.74, 11.17 and 10.95 % after the first season and 31.26, 31.37, 34.54, 12.34, 17.44 and 20.05% after the second season for treatment of 2m spacing + 100% N, 2m spacing + 115% N, 2m spacing + 130% N, 4m + 100% N, 4m spacing + 115% N, 4m spacing + 130% N, respectively than control. The corresponding values of ESP are 13.56, 13.90, 13.22, 4.56, 12.25 and 11.85% after the first season and 18.81, 18.75, 19.38, 10.57, 15.74 and 16.93% after the second season respectively. Results could be attributed mainly to that subsoil forms many lines with big crack extent from soil surface to subsoil depth (60cm deep) 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, moling or 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. Similar results were obtained byAiad et al., (2012) and Antar, et al., (2014) while, no obvious different for soil salinity and sodcity values under N-fertilizerrates treatments in both seasons.

Table 2:- Salinity and sodcity of the soil as affected by the different studied treatments.

Treatments	Soil depth (cm)	First season		Second season	
		EC dSm^{-1}	ESP	EC dSm^{-1}	ESP
Open drainage + 100% N (control).	0-15	7.86	16.04	7.78	16.51
	15-30	8.29	17.44	8.23	17.22
	30-60	10.43	19.16	10.48	19.07
	60-90	11.66	20.28	11.76	20.04
Average (0-60)		8.86	17.55	8.83	17.60
Mole drains at 2m spacing + 100% N.	0-15	6.44	14.22	5.34	13.05
	15-30	6.91	15.09	5.87	14.88
	30-60	7.63	16.21	7.01	14.95
	60-90	11.62	19.52	11.63	19.61
Average (0-60)		6.99	15.17	6.07	14.29
Mole drains at 2m spacing + 115% N.	0-15	6.53	14.33	5.53	13.27
	15-30	6.66	14.67	5.70	14.65
	30-60	7.69	16.34	6.96	14.98
	60-90	11.16	19.66	11.68	20.02
Average (0-60)		6.96	15.11	6.06	14.30
Mole drains at 2m spacing + 130% N.	0-15	6.78	14.16	5.13	13.45
	15-30	7.27	14.66	5.32	13.87
	30-60	8.01	16.87	6.88	15.24
	60-90	11.87	20.09	11.72	19.87
Average (0-60)		7.35	15.23	5.78	14.19
Mole drains at 4m spacing + 100% N.	0-15	6.89	14. 87	6.56	14.46
	15-30	7.54	15.93	7.43	15.48
	30-60	9.02	17.56	9.24	17.29
	60-90	11.27	20.62	11.35	19.86
Average (0-60)		7.82	16.75	7.74	15.74
Mole drains at 4m spacing + 115% N.	0-15	6.77	14.76	6.14	14.02
	15-30	7.65	15.27	7.05	14.35
	30-60	9.18	16.17	8.67	16.11
	60-90	11.34	20.47	11.24	20.44
Average (0-60)		7.87	15.40	7.29	14.83
Mole drains at 4m spacing + 130%N.	0-15	7.01	14.64	6.22	13.85
	15-30	7.44	15.74	6.44	14.67
	30-60	9.22	16.04	8.53	15.34
	60-90	11.24	20.41	11.30	20.04
Average (0-60)		7.89	15.47	7.06	14.62

Ratio of Ca^{++}/TSS:-

Results in Table (3) show that, application of mole drains and added of gypsum seemed to be more effective on increasing Ca^{++}/TSS ratio in the topsoil up to 60cm, than before application and control treatment. The increases of Ca^{++}/TSS ratio after the second season are more pronounced compared to that after the first season. This may be due to the leachability of Na$^+$ is higher than that of Ca^{++} and Mg^{++} with mole drains. Also, Na$^+$ and Cl$^-$ are leached more readily than SO$_4^+$, Ca^{++} and Mg^{++}. In this concern, **Ali and Kahlown (2001)** mentioned that reclamation of saline – sodic and sodic soils, however, can not be achieved by simple leaching. Reclamation of these soils is difficult, time consuming and more expensive than that of saline soils due to replacement of exchangeable sodium with calcium. Hence, it requires the addition of chemical amendments such as gypsum along with leaching. Change in Ca^{++}/TSS ratio were no observed in deeper layer (60-90cm). Whereas, mole drains is effective in removing salts especially Na$^+$ from the topsoil up to 60cm. Results also, show that, narrow mole spacing (2m) is superior to wider mole spacing (4m) in increasing Ca^{++}/TSS ratio. This may be due to the good effectiveness of narrow mole spacing (2m) than wider mole spacing (4m). While, no obvious different betweenCa^{++}/TSS ratio values under N-fertilizerrates treatments in both seasons.

Table 3:-Ca^{++}/TSSratio of the soil as affected by the different studied treatments.

Treatments	Season	Soil depth (cm)				Average (0-60)
		0-15	15-30	30-60	60-90	
Open drainage + 100% N (control).	First	17.24	15.65	13.51	13.02	15.47
	Second	16.87	15.84	13.52	13.24	15.41
Mole drains at 2m spacing + 100% N.	First	24.44	24.63	19.41	14.87	22.83
	Second	25.89	24.87	20.12	14.32	23.63
Mole drains at 2m spacing + 115% N.	First	24.31	24.56	18.24	13.41	22.37
	Second	25.87	24.54	20.12	14.87	23.51
Mole drains at 2m spacing + 130%N.	First	24.32	24.17	19.89	13.75	22.79
	Second	26.42	24.35	20.2	14.32	23.66
Mole drains at 4m spacing + 100% N.	First	23.45	23.45	18.74	14.74	21.88
	Second	24.33	24.25	20.1	13.74	22.89
Mole drains at 4m spacing + 115% N.	First	24.12	22.84	19.14	13.41	22.03
	Second	25.13	23.42	19.54	14.12	22.70
Mole drains at 4m spacing + 130%N.	First	23.45	23.54	18.86	14.11	21.95
	Second	24.12	24.18	20.12	13.98	22.81

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 (4) show that, soil bulk density was increased with increasing soil depth for all tested profiles. This increase may be resulted from increasing soil compaction due to layers weight. Mole drainsapplication were reduced soil bulk density, especially in the topsoil up to 60cm. Soil bulk density before treatments application and control varied 1.35 to 1.41 Mgm^{-3} and from 1.14 to 1.36 Mgm^{-3} after two seasons from treatments application. It could be attributed to the effects of mole on breaking soil cods and bigger granular into smaller crumbs as well as breaking and cracking the compacted layers **(Amer, 1999 and Abdel-Mawgoud et al., 2006).**Results show that, narrow mole spacing (2m) is superior to wider mole spacing (4m) in reducing soil bulk density. This may be due to the good effectiveness of narrow mole spacing than wider mole spacing. While, no obvious different between soil bulk densityvalues under N-fertilizerrates treatments.The average values of soil bulk density (0-60cm) were 1.23, 1.26 and 1.25 Mgm^{-3} for mole spacing of 2m + 100% N, 2m spacing + 115% Nand 2m spacing + 130% N, respectively and were 1.28, 1.29 and 1.29 Mgm^{-3} for mole spacing of 4m + 100% N, 4m spacing + 115% Nand 4m spacing + 130% N, respectively.

Soil porosity values (Table 4) 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 (Table 4). **Jodi DeJong (2004)** and**Antar, et al., (2012)** stated that the theory behind mole drain and subsoiling are 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.

Infiltration rate (IR):-
Basic infiltration rates (BIR) of soil as affected by different treatments are presented in Table (4).Datashow that, Mole drainsapplication were increased basic infiltration rate than before treatments application. Basic infiltration rates before treatments application was 0.61 cm/hr while, after two seasons from treatments application varied from 1.56 to 1.85 cm/hr. This may be due to the subsurface tillage 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., (2003 and 2006) and Antar et al., (2012).**Results (Table 4)show that, narrow mole spacing (2m) is superior to wider mole spacing (4m) in increasing basic infiltration rate. This may be due to the good effectiveness of narrow mole spacing than wider mole spacing. The average values of basic infiltration rate were 1.84, 1.79 and 1.85 cm/hr for mole spacing of 2m + 100% N, 2m spacing + 115% Nand 2m spacing + 130% N, respectively and were 1.57, 1.56 and 1.61 cm/hr for mole spacing of 4m + 100% N, 4m spacing + 115% Nand 4m spacing + 130% N, respectively. While, no obvious different betweenbasic infiltration rate values under N-fertilizerrates treatments.

Table 4:-Bulk density, total porosity, penetration resistance (SPR) and Basic Infiltration rate (BIR) of the soil as affected by the different studied treatments (after two seasons).

Treatments	Soil depth (cm)	Soil bulk density (Mgm^{-3})	Soil porosity(%)	Basic infiltration rate cm/hr)	Soil penetration resistance (MPa)
Open drainage + 100% N (control).	0-15	1.35	49.06	0.61	1.29
	15-30	1.35	49.06		1.31
	30-60	1.41	46.79		1.39
Average (0-60)		1.37	48.30		1.33
Mole drains at 2m spacing + 100% N.	0-15	1.14	56.98	1.84	0.95
	15-30	1.25	52.83		1.18
	30-60	1.31	50.57		1.18
Average (0-60)		1.23	53.46		1.10
Mole drains at 2m spacing + 115% N.	0-15	1.18	55.47	1.79	0.94
	15-30	1.27	52.08		1.12
	30-60	1.32	50.19		1.09
Average (0-60)		1.26	52.58		1.05
Mole drains at 2m spacing + 130% N.	0-15	1.18	55.47	1.85	1.00
	15-30	1.25	52.83		1.00
	30-60	1.31	50.57		1.18
Average (0-60)		1.25	52.96		1.06
Mole drains at 4m spacing + 100% N.	0-15	1.23	53.58	1.57	1.11
	15-30	1.28	51.70		1.12
	30-60	1.33	49.81		1.17
Average (0-60)		1.28	51.70		1.13
Mole drains at 4m spacing + 115% N.	0-15	1.24	53.21		1.07
	15-30	1.28	51.70	1.56	1.12
	30-60	1.34	49.43		1.18
Average (0-60)		1.29	51.45		1.12
Mole drains at 4m spacing + 130% N.	0-15	1.24	53.21	1.61	1.01
	15-30	1.27	52.08		1.12
	30-60	1.36	48.68		1.12
Average (0-60)		1.29	51.32		1.08

Soil penetration resistance:-
Soil penetration resistance (SPR) as affected by different treatments for the studied soil profile (0-60cm depth) is presented in Table (4). Data show that, the high values of SPR (varied from 1.29 to 1.39 MPa) were found with control treatment, and the low values (varied from 0.94 to 1.18 MPa) were found after two seasons from treatments application.This means that mole drains effect was more superiority on reducing soil penetration resistance. It could be attributed to the effects of moiling on breaking soil clods and bigger granular into smaller crumbs as well as breaking and cracking the compacted layers **(Amer, 1999, Abdel-Mawgoud et al., 2006 andAiad et al., (2012).**Also, narrow mole spacing (2m) is superior to wider mole spacing (4m) in reducing soil penetration resistance. This may be due to the good effectiveness narrow mole spacing than wider mole spacing.Results show that, no obvious trend with soil penetration resistance values under N-fertilizerrates treatments.

Yield:-
Data in Table (5) indicate clearly thatmole drains application caused significant increases for root, top and sugar yields compared to control. The yields were increased when the EC decreases as affected by mole drains and gypsum application. It can be concluded that heavy clay salt affected soils could have good productivity with the execution of mole drains and gypsum.While, there were insignificant differences within treatments after application. Data in Table (5) show that, there were no obvious differences between top yield in the first seasons only (ton fed^{-1}) while significant differences were found between values of percentages of sucrose % with all treatments. Significant differences were observed between mean values of root yields. The overall average ofroot yields were higher after application of mole drains than control by 4.95, 6.45, 7.05, 5.18, 6.75 and 7.07 $tonfed.^{-1}$ for 2m-mole spacing +

100% N, 2m -mole spacing + 115% N,2m-mole spacing + 130% N, 4m-mole spacing + 100% N, 4m spacing + 115% Nand 4m spacing + 130% N, respectively. The corresponding values of gross sugar yield were 0.81, 1.06, 1.17, 0.88, 1.10 and 1.17 tonfed.$^{-1}$, respectively. Such findings may be attributed to the effect of mole drains and gypsum on improving soil properties which effects on 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 root yield. It can be concluded that under such conditions the mole drains and gypsum 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).** sugar beet yields are increased with increasing N-fertilizer rate (from 100 to 115 and 130% from the recommended N) with both mole spacing in both seasons. Similar results were obtained by **Korany and El-Said (1998)**, **El-Shahawy et al. (2001)**. And **Hamad et al (2015)** they reported that root and top yields increased with increasing N rates up to 90 kg N / fed. Average of Juice purity % with open drainage + 100% N (control) was 77.36% while, after treatments application varied from 79.23 to 81.48%.

Quality of juice significantly affected by nitrogen levels, addition 100%N as control gave the highest root quality in both seasons (81.48 and 81.22%) respectively. This trait related to alkaline coefficient which gave maximum and optimum values compared with other nitrogen levels which gave lowest ones.

Table 5:- Sugar beet characters with different studied treatments.

Treatments	2013 / 2014					2014 / 2015				
	Yield (Ton fed^{-1})		Sugar %	Gross sugar yield (Ton fed^{-1})	Juice purity %	Yield (Ton fed^{-1})		Sugar %	Gross sugar yield (Ton fed^{-1})	Juice purity %
	Root	top				Root	top			
Open drainage + 100% N (control).	16.76	3.04	17.11	2.87	81.48	17.35	2.89	17.10	2.97	81.22
Mole drains at 2m spacing + 100%-N	22.41	3.11	17.01	3.81	80.98	22.22	3.12	17.00	3.77	80.67
Mole drains at 2m spacing + 115% -N	23.74	3.21	16.94	4.02	80.17	23.88	3.22	16.94	4.04	80.11
Mole drains at 2m spacing + 130%-N	24.14	3.24	16.76	4.04	77.87	24.11	3.26	16.86	4.06	79.23
Mole drains at 4m spacing + 100%-N	21.78	3.07	16.98	3.69	80.19	22.05	3.11	17.01	3.75	80.78
Mole drains at 4m spacing + 115%-N	23.47	3.17	16.89	3.96	79.89	23.54	3.18	16.89	3.98	79.85
Mole drains at 4m spacing + 130%-N	24.13	3.22	16.74	4.03	76.84	24.08	3.17	16.78	4.04	78.47
L S D 0.05	3.21	N . S	0.20	1.03	1.06	2.14	0.30	0.10	0.90	1.20

Data in Table (6) showed clearly that the N-uptake (kg/fed.) by roots and tops of sugar beetwere parallel to the yield results in both seasons. Whereas, mole drains application and increasing N-fertilizer rate (from 100 to 115 and 130% from the recommended N) caused increases for N-uptake by sugar beet roots and topscompared to control. The low values of N-uptake (35.20 and 36.44 kgfed^{-1}) were found with control treatment, while the high ones (44.10 and 55.38 kgfed^{-1}) were found after treatments application in both seasons, respectively.The high values of impurities (K and Na) in sugar beet roots were found with control treatment, while the low ones were found after treatments application in both seasons. On the other side α-amino–N take opposite trend than K and Na in both seasons and gave lowest values with control.

Table 6:-N-uptake of Sugar beet (kg fed^{-1}), K, Na and α–amino–N with different studied treatments.

Treatments	2013 / 2014						2014 / 2015					
	N-uptake (kg fed^{-1})		K	Na	α-amino N	A C	N-uptake (kg fed^{-1})		K	Na	α-amino N	A C
	Root	TOP					Root	TOP				
Open drainage + 100% N (control).	35.20	21.32	7.85	2.74	2.80	3.78	36.44	23.21	8.21	2.77	2.84	3.87
Mole drains at 2m spacing + 100%-N	50.09	21.54	5.47	1.88	3.41	2.16	50.66	22.45	6.41	1.78	3.42	2.39
Mole drains at 4m spacing + 115%-N	53.98	23.54	5.99	1.87	3.67	2.14	54.14	24.73	6.01	1.88	3.67	2.15
Mole drains at 2m spacing + 130%-N	54.78	19.25	6.24	1.69	4.55	1.74	55.38	20.24	6.42	1.97	4.85	1.73
Mole drains at 4m spacing + 100%-N	44.82	21.25	6.86	2.01	3.21	2.76	44.10	20.58	6.67	1.99	3.11	2.78
Mole drains at 4m spacing + 115%-N	53.18	22.31	6.74	1.89	3.58	2.41	54.45	24.25	6.73	2.14	3.87	2.29
Mole drains at 4m spacing + 130%-N	54.56	20.25	6.45	2.13	3.96	2.47	54.49	21.25	6.72	2.21	3.89	2.30
L S D 0.05	13.10	1.02	0.90	0.81	0.75	0.65	10.14	1.95	0.77	0.35	0.55	0.84

Potassium , sodium and alfaamino nitrogen (K , Na and α – N) were determined as (g / 100 g sugar)Alkaline coefficient:-
Regarding to alkaline coefficient as affected by mole drains and nitrogen levels, data presentedin Table (6) cleared that with increasing nitrogen levels up to 100% from recomendation dose to 130% caused to decreasing (AC) to(1.74 and 1.73) in both seasons, This mean that if (Ac) decrease than (1.8) this indicator that over fertilization happen. So, we must take care from increasing nitrogen dose which decreasing (Ac) low than (1.8).

Conclusion:-
❖ Molingis good way in clay soils to reserve the root zone from water logging and salinity in presence gypsum.
❖ Mole draintend to improve soil physio-chemical characteristics and increase sugar beet production.

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