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EFFECT OF SOIL SALINITY, NITOGEN FERTILIZATION LEVELS AND POTASSIUM FERTILIZATION FORMS ON GROWTH, YIELD AND QUALITY OF SUGAR BEET CROP IN EASTNORTHERN DELTA OF EGYPT

El Kholy, M. H.[1]; M.T. Abdelhamid[2] and E.H.H. Selim[3]

1- Soil, Water and Environment Res. Inst., ARC, Egypt

2- National Res. Center, Botany Dep., Dokki, Cairo, Egypt

3- Sugar Crops Res. Inst., ARC, Egypt

E- mail: dr_mahmoud_elkholy@hotmail.com

ABSTRACT

Two field experiments were carried out at El-Serw Agricultural Research Station, Damietta Governorate, Egypt, in 2003/2004 and 2004/2005 seasons, to study the effect of three nitrogen fertilizer rates i.e. (30, 60 and 90 kg N/fad) and two potassium fertilizer rates i.e. (o and 24 kg K_2O/fed), in two forms i.e. Potassium sulphate (SOP) and Potassium chloride (MOP), on growth and yield of sugar beet plant, as well as, its resistance against Cercospora Leaf Spot disease, under three different levels of natural soil salinity i.e. (2.8-5, 6-10 and 11-12 dS/m at 25 ^{0}c).

The obtained results of the combined analysis of the three levels of soil salinity in the two growing seasons, showed the following trends:

1- Significant negative effect between sugar beet yield and raising soil salinity levels has been established in both seasons.
2- The highest and best optimum beet root yield and quality were obtained at the soil salinity level of 2.8-5 dS/m, compared to the other soil salinity levels.
3- Soil salinity level more than 10 dS/m indicated the hazard and deteriorating effect, on growth and yield of sugar beet, in eastnorthern Delta region.
4- The average root length, fresh root weight and yield of top, root and sugar (ton/fed) of sugar beet plant, significantly increased with increasing N fertilizer rate from 30 to 90 kg N/fed, under each soil salinity level, while it gave opposite effect on sucrose percentage in both seasons. Application of 90 kg N/fed increased root yield (ton/fed) by 15.76 and 13.96%, and sugar yield (ton/fed) by 14.96 and 10.7% as compared with the control treatment (30 kg N/fed) in 2003/2004 and 2004/2005 seasons, respectively.
5- Results also showed that fertilizing sugar beet plants, with 24 kg K_2O in the form of potassium sulphate (SOP), or potassium chloride (MOP), gave the highest values of all studied characters without significant differences between them, as compared with the control (no K addition).
6- All the interaction effects between soil salinity levels, nitrogen rates and potassium forms, were significant on all studied characters in both seasons. The highest values of all studied characters were recorded with soil salinity level, up to 5.0 dS/m, 90 kg N/fed + 24 kg K_2O/fed, in the form of MOP or SOP, as compared with all the other treatments in both seasons.
7- Potassium fertilization in the form of both MOP and SOP, obviously increased the resistance of sugar beet to leaf spot disease, caused by Cercospora beticola Sacc. Comparably no potassium additions under all the three soil salinity levels and the three N fertilizer rates.
8- Soil salinity level more than 10 dS/m, achieved higher Na, and Cl% and lower K% in beet roots, while increasing N levels caused lower Na and Cl% in beet roots. Also, both MOP and SOP caused lower Na% in beet roots, while SOP caused lower Cl% in beet roots.

9- Generally, it could be concluded that under salt affected soil conditions, sugar beet plants fertilization with 90 kg N/fed and 24 kg K_2O/fed, in the form of MOP or SOP increased root and sugar yield (ton/fad), as well as, induced its resistance to leaf spot disease, caused by Cercospora Beticola Sacc.

INTRODUCTION

The economic importance of sugar beet has increased in the last two decades in Egypt and would partially substitute for sugar cane. A large portion of the salt affected soils in Eastnorthern Delta of Egypt, and the newly reclaimed soils will be devoted to the production of sugar beet. In this respect, sugar beet is one of the most salt tolerant crops. But, it was reported to be less tolerant of salinity during germination, emergence and in the seedling stage. Thus, growers may have difficulty establishing adequate numbers of plants, under saline conditions. Thirty to forty thousand plants are needed at harvest for good economic yields. Salinity levels of 6 to 12 dS/m are thought to reduce and delay emergence in sugar beets (Maas, 1986). Hence, its nutrition, irrigation, growth, yield, quality and other characteristics have been subjected to the greatest amount of study (El-Kishky, 1989 and El-Kadi and Kamh, 2001). Additionally, in Easnorthern Delta of Egypt, there are many factors affecting sugar beet production. Among such factors, increasing soil salinity and rising ground water table levels, near Manzala Lake represent serious problems, which could face crop production. Consequently, salinity hazard and accumulation of salts in soils, lead to unfavorable soil water regimes, and progressive decrease in crop production (El-Samnoudi and Abu-Arab, 1997).

Fertilizers use in many regions of Egypt, is highly unbalanced in favour of N and P at the expense of K. The consequences of such unbalanced fertilization on crop production, are declining fertilizer efficiency, which impact on both the economy and the environment, and will ultimately lead to a loss of soil fertility.In this respect, Krauss (2000) pointed out, that one of the factors responsible for stagnating yields, and decreasing fertilizer use efficiency (FUE), is the current imbalance in fertilizer use. This refers particular to the ratio of N to K. Farmers apply as potash fertilizers only a fraction (5%) of the K, that is removed by the harvested crops. Negative nutrient balances indicate soil nutrient mining, and thus loss of soil fertility. Also, Kochl (1977) reported that the major factor responsible for the deterioration in sugar beet yield, and technological quality, was the unbalanced N, P and K fertilization.

Nitrogen fertilization promotes vigorous early-season growth, thereby reducing the number of days to closure. Early closure allows the sugar beet to make better use of sunlight, and more sugar is produced. Excess nitrogen, at or near the end of the growing season, reduces sugar beet quality, by reducing sugar concentration (El-Hawary, 1999).

Potassium has a pivotal role in regulating both yield and quality of sugar beet. Potassium has many roles in the plant, including being an osmotic and being involved in many metabolic activities, such as carbohydrate and protein synthesis, as well as, translocation of sugar in plants, so it increases the sugar content of fruits, beets and sugar cane. Ksenz and Putskaya (1983) stated that foliar application of 10% KCl, caused an increase in sugar content of sugar beet. Leshchenko and Borisyuk (1991) reported that, foliar application of 30 Kg KCl + 0.3 Kg boric acid / ha to sugar beet plants, increased root yield by 2.1 ton / ha, sugar yield by 0.62 ton / ha and sugar content by 0.4 - 0.53%. Sobh *et al.* (1992) found that the percentage of white sugar was slightly decreased, when 24 Kg K_2O / fed applied along with 60 Kg N +30 Kg P_2O_5/fed, which may be due to the increase in K and Na contents. The same treatment lowered the juice purity from 78% to 76.2%. However, Ibrahim *et al.* (2002) found that the highest values of sucrose percentage and juice purity were achieved with potassium application up to 96 Kg K_2O /fed. The same trend was reported byTehrani and Malakouti, (1997). Kafkafi *et al.*, (2001) reported that, potassium is the cation that is taken up in the largest amount by sugar beet. Each ton of fresh harvested roots removes 1.3-2.8 kg of K. Depending on yield; the total K removed varies between 39 and 176 kg ha^{-1}. The most conspicuous field-observed feature of K deficiency is the appearance of variable amounts of brownish, dead tissue on the older blades of well-developed plants. The first definitive sign of K deficiency in the field is the development of a marginal, interveinal chlorosis toward the distal end of the older leaf blades. On the other hand, the k requirement of sugar beet in the field at certain levels of K deficiency, can be nearly replaced by Na. Because of the negative interaction between Na and K in sugar beet nutrition and a possible separate nutritional role for Na, diagnosis of K deficiency is difficult. Also, they added that sugar beet requires large amounts of Cl. Chloride concentration of 0.18-o.29 g kg^{-1} DM in the petioles, was found to be indicative of extreme Cl deficiency for beets. The critical Cl concentration was about 1-4 g kg^{-1} DM in the leaves and 5.7 g kg^{-1} DM in the petiole; an adequate concentration in the petioles was 7.1 g kg^{-1} DM. The Cl content of sugar beet tops at harvest varied from 28 to 148 kg ha^{-1} depending on the soil Cl level. Chloride applications of up to 1600 mg kg^{-1} produced positive effects on sugar beet.In clay soils applications, as high as 3200 mg kg^{-1} were tolerated before any yield reduction was observed.

There is close interaction between N and K. The direct effect of K on yield is less marked than of N, which itself constitutes a part of the organic matter synthesized during growth. Also K uptake is much affected by N level and in most cases, K is more effective at higher N levels, this applies especially to modern high yielding varieties. The interaction between N and K were small at low rates, but became more important at high rates and the best returns from one nutrient were obtained at high rates of others. Root crops especially, have a high K requirement, and it is commonly observed that root or tuber enlargement, is depressed relatively more, than leaf development when K is in short supply (Inal, 1997).

Agbani *et al.*, (1997) pointed out that the highest yields of both beet (100 t/ha) and sugar (15 t/ha), were obtained with 300 kg N/ha and 300 kg K_2O/ha. They found also that 150 kg N/ha and 300 kg K_2O/ha (1:2), has proved to be the most effective combination for the highest extractable sugar content (15 to 17.4%).

Although there is large amount of literature on the relationship between potassium (K) and plant disease, there is little quantitive information available on the concentration of K in soil or plant tissues that result in the observed effects on disease expression (Huber and waston, 1985). Generally, K fertilization reduces the intensity of several infections diseases.This occurs with diseases caused by obligate, as well as, by facultative parasites.

Consistently, severe problems reported by respondents, were sugar beet root maggot, red root pigweed and cercospora leaf spot, caused by *Cercospora peticola Sacc.* is one of the most widespread and destructive fungal disease affecting sugar beet. Leaf spot diseases are the most common and severe diseases, which cause severe losses in most growing areas in Egypt. Cercospora leaf spot (*Cercospora beticola Sacc.*) disease, represents the prevalent and common diseases under Egyptian conditions. Cercospora leaf spot diseases of sugar beet not only reduced root size and sucrose content, but also decreased the purity of juice derived from diseased beets (Smith and Martin. 1978).

The current study aims to investigate the effects of both soil salinity and some balanced mineral fertilizations, on growth, yield and quality of sugar beet crop under North Delta conditions.

MATERIALS AND METHODS

To achieve the above mentioned objectives, two field trials in two successive seasons, 2003/2004 and 2004/2005, were carried out at El-Serw Agricultural Research Station, Damietta Governorate, Egypt. The investigation was performed to study the effect of three different levels of soil salinity, nitrogen fertilizer rates and potassium fertilizer forms, on the yield, and yield components and the resistance against Cercospora leaf spot disease of sugar beet crop (Beta Vulgaris, L.).

Three experimental sites were chosen in every season, represented three levels of soil salinity (i.e. 2.8 - 5, 6 – 10 and > 11.0 dS/m at 25 ^{0}c). Each experiment was arranged following split plot design, with four replicates. Three nitrogen levels namely: 30, 60 and 90 kg N/fed were applied in the main plots, while the sub plots received potassium fertilization as follows:

1- Control (without K fertilizer)
2- 30 kg K_2o/fed. In the form of potassium chloride (MOP, 60%K_2o)
3- 30 kg K_2o/fed. In the form of potassium sulphate (SOP, 50% K_2o).

The area of each plot was 10.5 m2 (5 rows, 60 cm apart and 3.5 m long). Some soil physical and chemical determinations were conducted on soil samples, collected from the experimental field, at depth of 0 – 30 cm (the active root zone) according to Klute (1986) and Page *et al.* (1982), Table 1. On 12 and 15 October, seeds were sown in pits 20 cm apart, in 2003/2004 and 2004/2005 seasons, respectively. Seedlings were thinned to one plant per pit, after 40 days from sowing date. All experimental units were received 30 kg P2O5/fed, in the form of triple superphosphate (37% P_2O_5), prior to soil cultivations. Nitrogen was applied in two doses, the first one at thinning, and last one, 75 days after sowing, both as ammonium sulphate (20.5% N).

Potassium was added at thinning. All other agronomic practices were followed as usually done for the sugar beet crop.

Concerning the artificial infection, the methods adopted by Coles *et al.* (1990) were applied. Sugar beet plants having ninety days age were sprayed with conidia at concentration of 50 x 10^3 conidia (spores) / ml of isolate using an atomizer according to Crane and Calpanzos (1984). Plants were sprayed with water to make a slight film of water on leaves. Two grams of sucrose per liter was added to the inoculums, to enhance the infection.

To estimate disease severity induced in both season, ten plant leaves were randomly selected in each plot. Disease severity % (percentage of infection) of each particular treatment was recorded three times, starting from the first appearance of the disease symptoms, and ending at the stability of infection level. The average of disease severity was calculated for each plot.

At harvest time, after 190 days from sowing, five guarded plants were randomly taken from the middle rows of each plot, in the two seasons and the following data were recorded:

1-Root length (cm), 2- Root fresh weight (g), 3- Sucrose percentage in the roots was determined according to the procedure of Le Docte (1927). In addition, gross sugar yield (ton/fed.) was calculated by multiplying sucrose percentage and root yield (ton/fed.).

A random sample from dry roots, represented each replicate of every treatment, in both seasons was assigned to determine K and Na% by using flame photometrically, as described by Klute (1966). Chloride was determined according to Piper (1947).

Combined data of the three sites, of the two seasons, were statistically analyzed according to Gomez and Gomez (1984).

Table (1): Some physical and chemical properties of the studied soils in the chosen locations (0-40)

Soil properties	1st season	2nd season
Particle size distribution		
Coarse sand%	4.1	4.0
Fine sand%	22.0	13.1
Silt%	27.6	33.0
Clay%	46.3	49.9
Texture class	Clayey	Clayey
C.E.C., meq/100 g soil	41.2	42.1
pH (1:2.5 soil suspen.)	8.4	8.3
E.S.P, meq/100g soil	14	13
Organic matter%	1.48	1.52
CaCo3%	2.94	3.16
Available N (ppm)	33	28
Available P (ppm)	8.4	9.6
Available K (ppm)	384	396
Soil salinity levels:		
S1	5.0	2.8
S2	10.0	6.0
S3	12.0	11.0

RESULTS AND DISCUSSION

1- Effect of soil salinity levels:

Tables 2 to 7 represent the obtained data, for the effect of soil salinity levels (Ec_e), nitrogen fertilizer levels and potassium fertilizer forms, on some plant characters, yield of roots (ton/fed), sucrose percentage and sucrose yield (ton/fed) of beet crop, for the two studied seasons 2003/2004 and 2004/2005.

Increasing soil salinity led to severe reduction, in all the above mentioned characters. The more pronounced effect was observed when soil salinity level (EC_e) was more than 10.0 dS/m, which indicate the hazard and deteriorating effect of soil salinity on the existed sugar beet crop, grown under that level of soil salinity.

Fresh roots yields of sugar beet measured at lower salinity level, were found to be similar or higher, than the average commercial yield in North Delta region (25.0 ton/fed). However, and like most crops, sugar beet yield will vary on varying soil conditions, cultural practices and climate. The obtained results seem to indicate, that the reduction in fresh beet roots was accounted for primarily by the significant reduction in other plant growth characters, such as root length and top yield (Tables 2 and 3). Such findings are in the same line with those of El-Samnoudi and Abu-Arab (1997) and El-Hawary (1999).

Table (2): Effect of soil salinity levels, nitrogen fertilizer rates and potassium fertilizer forms on root length (cm) in 2003/2004 and 2004/2005 seasons

Soil salinity levels	Nitrogen levels, Kg/fed	2003/2004			Mean	2004/2005			Mean
		K-forms				K-forms			
		0	MOP	SOP		0	MOP	SOP	
S_1	30	27.44	28.45	28.61	28.17	29.62	31.72	31.99	31.11
	60	28.45	29.90	30.30	29.55	33.00	34.70	35.00	34.23
	90	28.79	31.38	31.82	30.66	33.84	38.70	39.10	37.21
	Mean	28.23	29.91	30.24	29.46	32.15	35.04	35.36	34.18
S_2	30	24.92	27.34	27.78	26.45	25.93	26.77	27.10	26.60
	60	25.76	28.20	28.61	27.52	26.94	27.68	27.95	27.52
	90	26.26	28.53	28.86	27.88	28.94	29.10	29.20	29.10
	Mean	25.41	28.02	28.42	27.28	27.27	27.85	28.10	27.74
S_3	30	21.38	21.40	21.81	21.53	23.23	24.32	24.41	24.00
	60	22.10	24.24	24.50	23.61	23.56	24.77	25.10	24.48
	90	24.24	24.22	24.49	24.32	24.10	25.55	25.76	24.14
	Mean	22.57	23.29	23.60	23.15	23.63	24.88	25.10	25.87
Over all means of Nitrogen	30	24.58	25.70	26.10	25.38	26.26	27.60	27.83	27.24
	60	25.44	27.45	27.10	26.89	27.83	29.10	29.35	28.74
	90	26.43	28.04	28.39	27.62	28.96	31.12	31.35	30.48
General means		25.40	27.07	27.42		27.68	29.26	29.52	

LSD at 5%

	S	N	K	S*N	SI*K	NK	S*N*K
2003/2004	0.47	0.47	0.46	0.82	0.80	0.82	1.40
2004/2005	0.33	0.34	0.33	0.57	0.56	0.57	0.97

Table (3): Effect of soil salinity levels, nitrogen fertilizer rates and potassium fertilizer forms on top yield (ton/fad) In 2003/2004 and 2004/2005 seasons

Soil salinity levels	Nitrogen levels, Kg/fed	2003/2004			Mean	2004/2005			Mean
		K-forms				K-forms			
		0	MOP	SOP		0	MOP	SOP	
S_1	30	12.72	13.57	13.86	13.38	11.00	12.43	12.73	12.10
	60	13.10	14.62	14.90	14.21	11.82	13.40	13.64	12.97
	90	13.32	16.00	16.32	15.21	12.63	14.52	14.80	13.98
	Mean	13.05	14.73	15.03	14.27	11.82	13.45	13.74	13.02
S_2	30	9.27	11.21	11.41	10.63	9.00	10.26	10.55	9.94
	60	10.10	12.84	13.13	12.02	9.41	10.82	11.10	10.44
	90	10.57	14.10	14.37	13.01	10.42	11.78	12.10	11.43
	Mean	9.98	12.72	12.97	11.89	9.61	10.95	11.25	10.60
S_3	30	6.16	7.98	8.30	7.48	5.15	5.80	6.10	5.68
	60	7.00	8.68	8.92	8.20	6.92	7.70	8.00	7.54
	90	7.27	9.74	10.00	9.00	7.58	9.20	9.49	8.76
	Mean	6.81	8.80	9.10	8.24	6.55	7.57	7.86	7.33
Over all means of Nitrogen	30	9.38	10.92	11.19	10.50	8.38	9.50	9.79	9.24
	60	10.10	12.05	12.32	11.48	9.38	10.64	10.93	10.15
	90	10.39	13.28	13.56	12.41	9.94	11.83	12.13	11.39
General means		9.95	12.10	12.37		9.33	10.66	10.95	

LSD at 5%

	S	N	K	S*N	S*K	NK	S*N*K
2003/2004	0.35	0.35	.035	0.63	0.63	0.63	1.10
2004/2005	0.033	.033	.033	.055	0.55	0.55	0.95

Table (4): Effect of soil salinity levels, nitrogen fertilizer rates and potassium fertilizer forms on root yield (ton/fad) In 2003/2004 and 2004/2005 seasons

Soil salinity levels	Nitrogen levels, Kg/fed	2003/2004			Mean	2004/2005			Mean
		K-forms				K-forms			
		0	MOP	SOP		0	MOP	SOP	
S_1	30	23.68	25.66	26.00	25.11	26.34	28.25	28.53	27.71
	60	24.92	26.42	26.76	26.03	27.85	29.30	29.57	28.91
	90	26.56	28.25	28.58	27.80	30.53	32.41	32.69	31.88
	Mean	25.10	26.78	27.11	26.33	28.24	29.99	30.26	29.40
S_2	30	18.36	20.32	20.53	19.74	22.31	24.46	24.75	23.84
	60	22.98	24.21	24.64	23.94	23.58	25.25	25.48	24.77
	90	23.90	25.10	25.44	24.81	24.19	26.95	27.17	26.10
	Mean	21.75	23.21	23.54	22.83	23.36	25.55	25.80	24.90
S_3	30	13.36	14.65	14.98	14.33	18.00	19.21	19.37	18.86
	60	15.10	16.82	17.13	16.35	19.76	20.42	20.66	20.28
	90	16.93	17.46	17.79	17.39	21.75	22.22	22.47	22.15
	Mean	15.13	16.13	16.63	15.96	19.84	20.62	20.83	20.83
Over all means of Nitrogen	30	18.47	20.21	20.50	19.73	22.22	23.97	24.22	23.47
	60	21.00	22.48	22.84	22.11	23.73	24.99	25.24	24.65
	90	22.46	23.60	23.94	22.84	25.49	26.39	27.44	26.71
General means		20.66	22.04	22.43		23.81	25.39	25.63	

LSD at 5%

	S	N	K	S*N	S*K	NK	S*N*K
2003/2004	0.37	0.37	0.37	0.65	0.65	0.65	1.12
2004/2005	0.33	0.33	0.33	0.55	0.55	0.55	0.95

Table (5): Effect of soil salinity levels, nitrogen fertilizer rates and potassium fertilizer forms on sucrose percentage of sugar beet In 2003/2004 and 2004/2005 seasons

Soil salinity levels	Nitrogen levels, Kg/fed	2003/2004			Mean	2004/2005			Mean
		K-forms				K-forms			
		0	MOP	SOP		0	MOP	SOP	
S_1	30	18.79	20.10	20.00	19.61	18.69	20.90	20.88	20.16
	60	18.48	19.75	19.73	19.32	18.45	20.30	20.32	19.69
	90	18.15	19.60	19.59	19.12	18.18	19.92	19.89	19.33
	Mean	18.47	19.82	19.77	19.35	18.44	20.37	20.36	19.69
S_2	30	18.18	19.76	19.80	19.25	18.28	19.21	19.62	19.04
	60	17.95	19.58	19.62	19.10	18.13	19.48	19.52	19.04
	90	17.85	19.12	19.16	18.71	17.81	19.40	19.44	18.88
	Mean	19.99	19.49	19.53	19.02	18.10	19.36	19.53	19.00
S_3	30	17.97	19.10	19.20	18.76	17.98	19.44	19.52	18.98
	60	17.75	18.96	19.00	18.57	17.50	19.00	19.00	18.50
	90	17.40	18.65	18.69	18.25	17.40	18.98	19.10	18.21
	Mean	17.71	18.90	18.96	18.52	17.63	19.14	19.21	18.66
Over all means of Nitrogen	30	18.31	19.65	19.67	19.21	18.32	19.85	20.25	19.39
	60	18.10	19.43	19.45	19.00	17.92	19.59	19.61	19.10
	90	17.80	19.12	19.15	18.69	17.80	19.43	19.48	18.81
General means		18.72	19.40	19.42		18.00	19.62	19.70	

LSD at 5%

	S	N	K	S*N	S*K	NK	S*N*K
2003/2004	0.06	0.06	0.06	0.09	0.09	0.09	0.15
2004/2005	0.12	0.12	0.12	0.20	0.20	0.20	0.33

Table (6): Effect of soil salinity levels, nitrogen fertilizer rates and potassium fertilizer forms on sucrose yield (ton/fed) in 2003/2004 and 2004/2005 seasons

Soil salinity levels	Nitrogen levels, Kg/fed	2003/2004			Mean	2004/2005			Mean
		K-forms				K-forms			
		0	MOP	SOP		0	MOP	SOP	
S_1	30	4.45	5.16	5.20	4.94	4.92	5.90	5.96	5.59
	60	4.61	5.22	5.28	5.04	5.14	5.95	6.00	5.70
	90	4.82	5.54	5.60	5.32	5.55	6.46	6.50	6.17
	Mean	4.63	5.31	5.36	5.10	5.20	6.10	6.15	5.82
S_2	30	3.34	4.02	4.06	3.81	4.08	4.70	4.86	4.55
	60	4.12	4.74	4.83	4.56	4.28	4.29	4.97	4.72
	90	4.27	4.80	4.87	4.65	4.31	5.23	5.28	4.94
	Mean	3.91	4.52	4.59	4.34	4.22	4.95	5.04	4.74
S_3	30	2.40	2.80	2.88	2.69	3.24	3.74	3.78	3.59
	60	2.68	3.19	3.25	3.04	3.46	3.88	3.93	3.76
	90	2.95	3.26	3.32	3.18	3.78	4.22	4.29	4.10
	Mean	2.68	3.10	3.15	2.98	3.49	3.95	4.00	3.81
Over all means of Nitrogen	30	3.40	3.99	4.10	3.81	4.10	4.78	4.87	4.58
	60	3.80	4.38	4.45	4.21	4.29	4.92	4.97	4.73
	90	4.01	4.53	4.60	4.38	4.55	5.30	5.39	5.07
General means		3.74	4.31	4.37		4.31	5.00	5.07	

LSD at 5%

	S	N	K	S*N	S*K	NK	S*N*K
2003/2004	0.09	0.09	0.09	0.16	0.16	0.16	0.28
2004/2005	0.10	0.10	0.10	0.17	0.17	0.17	0.29

Table (7): Effect of soil salinity levels, nitrogen fertilizer rates and potassium fertilizer forms on leaf spot disease% of sugar beet plants caused by Cercos porabatiocolaese In 2003/2004 and 2004/2005 seasons

Soil salinity levels	Nitrogen levels, Kg/fed	2003/2004 K-forms			Mean	2004/2005 K-forms			Mean
		0	MOP	SOP		0	MOP	SOP	
S_1	30	25	14	14	17.7	30	20	22	24
	60	22	10	11	14.3	26	16	18	20
	90	28	12	13	17.7	28	19	20	22.3
	Mean	25	12	12.7	16.6	28	18.3	20	22.1
S_2	30	27	16	15	19.3	33	21	22	25.3
	60	22	11	12	15	27	17	19	21
	90	30	13	14	19	30	20	21	23.7
	Mean	26.3	13.3	13.7	17.8	30	19.3	20.7	23.3
S_3	30	30	18	19	22.3	35	24	24	27.7
	60	26	13	13	17.3	30	18	20	22.7
	90	32	14	15	20.3	31	21	23	25
	Mean	29.3	15	15.7	20	32	21	22.3	25.1
Over all means of Nitrogen	30	27.3	16	16	19.8	32.6	21.7	22.6	25.6
	60	26	11.3	12	15.5	27.7	17	19	21.2
	90	28.3	13	14	19	29.7	20	21.3	23.7
General means		26.9	13.4	14		30	19.3	20.4	

2- Effect of N- fertilizer levels:

Regarding nitrogen fertilizer levels effect, results presented in Tables 1 to 7 showed that average of root length, fresh root weight and yield of top, root and sugar (ton/fed), significantly increased with increasing nitrogen fertilizer rate, in both seasons. In contrast with, sucrose percentage significantly decreased as nitrogen fertilizer level increased, under each soil salinity level in both seasons. Application nitrogen fertilizer at the rate of 90 kg N/fed, significantly increased all studied treats, except sucrose percentage, compared to treated plants with 30 and 60 kg N/fed, respectively in both seasons. In other words, applying nitrogen fertilizer at the rate of 90 kg N/fed, caused increases of 18.19, 15.76 and 14.96% in 2003/2004 season and 23.27, 13.80 and 10.70% in 2004/2005 season in top, root and sugar yield (ton/fad), respectively, as compared with those of 30 kg N/fad.

The increase of root and sugar yield (ton/fad), due to increasing nitrogen fertilizer levels, may be attributed to the favorable effects of nitrogen, on increasing size and number of leaves, which led to increasing leaf area, which in turn, led to higher photosynthetic activities. This was reflected in greater root and sugar production per unit area. These results are in agreement with those of Inal (1997) and El-Hawary (1999).

3- Effect of K- fertilizer forms:

Results presented in Tables (2 to 7) showed clearly, that average root length, fresh root weight, sucrose percentage, yield of top, root and sugar (ton/fad) of sugar beet plants, increased significantly with adding 24 kg

K_2O/fad in the form of potassium sulphate (SOP) and potassium chloride (MOP), without significant difference between them in both seasons.

Applying 24 kg K_2O/fed, achieved root and sugar yield 22.04 and 3.31 ton/fed, for MOP and 22.43 and 4.37 ton/fed for, SOP in 2003/2004 season, as compared with the untreated control treatment (20.66 and 3.74 ton/fed). While, in 2004/2005 season, these values were 25.39 and 5.00 ton/fed, for MOP and 25.63 and 5.07 for SOP, as compared with untreated control treatment (23.81 and 4.31 ton/fed).

The increase in root and sugar yields (ton/fed), caused by potassium fertilizer, could be attributed to the stimulating effect of potassium on rate of photosynthesis, as well as, transport of the photosynthetic product from the leaves to the storage root, which led to increasing in root and sugar yield. These results are in harmony with those obtained by El-Hawary (1999) and El-Kadi and Kamh (2001). Also, Abd El-Hadi at al.,(2002) reported that under North of Nile Delta region, which is characterized by high total soluble salts and Cl, only chloride-free potash fertilizers, such as SOP should be recommended in order to avoid salinity problems, however MOP may be applied for sugar beet which has special requirements for Na and Cl.

4- Interaction effects:

Results presented in Tables (2 to 7) indicated that, all the interaction effects between soil salinity levels, nitrogen and potassium fertilizer, were significant on all studied treats in both seasons.

As can be indicated from the obtained results, soil salinity S_3 (> 12 dS/m) severely reduced both growth and yield of the sugar beet, even under using 90 kg N/fad, while soil salinity level of S_1 (2.8 - 5 dS/m), gave the highest and commercial yield, even under using 30 kg N/fed. Soil salinity levels of S_1 (2.8 - 5 dS/m) with 90 kg N/fed, gave the highest root yield (27.80 and 31.88 ton/fed), and sugar yield (5.32 and 6.17 ton/fed), as compared with all other treatments in 2003/2004 and 2004/2005 seasons, respectively.

Concerning the interaction effect between soil salinity levels and potassium fertilizer forms, it can be stated, that applying both MOP and SOP, enhanced the yield of both root and sugar of sugar beet, under each soil salinity levels in both seasons.

Regarding the interaction effect between nitrogen and potassium fertilizers, it can be noticed, that adding both MOP and SOP, increased root and sugar yield, with increasing N fertilizer levels (Tables 5 and 7), comparably no potassium additions.

The results exhibited significant effect on all studied treats owing to the interaction among soil salinity levels, N and K fertilizers in both seasons. Sugar beet planted in soil with salinity level S1 (2.8 - 5 dS/m), and received 90 kg N/fed and 24 kg K_2O, in the form of MOP or SOP, gave the heaviest root yield (28.25 and 28.58 ton/fed, in 2003/2004 season and 32.41 and 32.69 ton/fed in 2004/2005 season), and sugar yield (5.54 and 5.60 ton/fed, in 2003/2004 season and 6.46 and 6.50 ton/fed, in 2004/2005 season) as compared with all other treatments in both seasons, respectively.

However, and despite of these above high values, commercial yield of both root and sugar yields could be obtained in soil salinity of S_2 level (6-10 dS/m), by applying 90 kg N/fed and 24 kg K_2O/fed, in the form of SOP or MOP.

It is worth noting that the two K fertilizer sources were equal in their effects for root and sugar yields, in soil salinity levels of S_1 and S_2. While in soil salinity level of S_3 (> 10 dS/m), SOP was better in its effective on root and sugar yields than that of MOP, because its characterized by high Cl content, than that of soil salinity levels of S_1 and S_2, respectively. The same results were reported by Abd El Hadi *et al.*, (2002). They mentioned that, the choice of Potash form is not of great important, for crop rotation in soil having low TSS and Cl contents, maintaining an adequate K supply, while only chloride-free potash fertilizers, such as SOP could be recommended at locations having the trait oh high TSS and Cl contents.

5-Disease severity%

Seasonal data and their average of disease severity percentage of leaf spot caused by Cercospora beticola Sacc are shown in Table (7). In general, raising soil salinity level and increasing nitrogen fertilizer levels, did resulted in obvious increase of the disease severity. In contrast wiyh, addition of potassium fertilizer (24 kg K2O/fed), either as MOP or SOP did resulted in obvious reduction of the disease severity%, comparably, no potassium additions under all the three soil salinity levels and the three N fertilizer rates. This means that potassium element not only play an important role in sugar synthesis and their translocation, but also reduces such disease severity% in sugar beet plants. These results are in accordance with the reports of Perrenoud (1977) and Tendon and Sekhon (1989), who reported that the fungal disease severity was reduced, by adding K fertilizers in average of 48% in soils tested low K. They added that the mode of action is primarily through plant metabolism and morphology. The K-deficient have impaired protein synthesis and accumulate simple N compound (e.g., amides), which are good nutrient sources for invading pathogens, tissue hardening and stomata opining patterns are closely related to infestation intensity. Also, Mengel and Kirkby (1982) concluded that, the nature of the action of K in controlling the severity of plant disease may relate, in part to the effect of K in promoting the development of thicker outer walls in epidermal cells, thus influenced by K and metabolism associated with low K content in the plant.

6- Elements concentrations in beet roots:

Data in Table (8) show the effect of soil salinity levels, N and K fertilizers application on K, Na and Cl% in the beet roots, in the two seasons. It was recognized that K% in beet roots decreased by raising soil salinity levels, while it increased with increasing N fertilizer rates, and adding both MOP and SOP under each soil salinity level. On the other hand, Na% increased by raising soil salinity levels, however, it decreased with increasing N fertilizer rates and adding both MOP and SOP. Regarding Cl%, results showed that raising soil salinity levels increased Cl%, while increasing N fertilizer rates decreased its contents, under each soil salinity level. On the other hand, adding MOP increased Cl%, while adding SOP, decreased its content under the three levels of soil salinity, and the three levels of N fertilization.

Table (8): Effect of soil salinity levels, nitrogen fertilizer rates and potassium fertilizer forms on K%, Na% and Cl% in roots of sugar beet plants during 2003/2004 and 2004/2005 seasons

Soil salinity levels	N Fert. rates, kg/fed	K%			Na%			Cl%		
		K-forms			K-forms			K-forms		
		0	MOP	SOP	0	MOP	SOP	0	MOp	SOP
2003/3004 season										
S1	30	1.45	1.82	1.80	1.48	1.37	1.36	1.32	1.35	1.30
	60	1.52	1.92	1.90	1.36	1.31	1.28	1.27	1.30	1.27
	90	1.65	2.42	2.40	1.30	1.26	1.22	1.22	1.25	1.15
S2	30	1.38	1.78	1.80	1.62	1.56	1.52	1.51	1.54	1.49
	60	1.46	1.81	1.84	1.58	1.50	1.48	1.46	1.50	1.42
	90	1.55	1.94	1.97	1.50	1.47	1.45	1.42	1.46	1.38
S3	30	1.34	1.66	1.70	1.80	1.78	1.74	1.68	1.70	1.68
	60	1.38	1.71	1.75	1.78	1.71	1.68	1.65	1.68	1.62
	90	1.46	1.78	180	1.72	1.68	1.60	1.60	1.64	1.60
2004/2005 season										
S1	30	1.48	1.85	1.87	1.43	1.36	1.32	1.30	1.32	1.29
	60	1.62	1.94	1.96	1.33	1.29	1.27	1.25	1.28	1.25
	90	1.68	2.46	2.46	1.28	1.23	1.20	1.20	1.24	1.13
S2	30	1.41	1.81	1.83	1.60	1.54	1.51	1.49	1.51	1.47
	60	1.48	1.83	1.85	1.56	1.50	1.47	1.40	1.43	1.39
	90	1.60	1.96	1.99	1.48	1.45	1.43	1.38	1.42	1.35
S3	30	1.38	1.70	1.73	1.77	1.75	1.73	1.65	1.68	1.63
	60	1.40	1.74	1.76	1.74	1.67	1.64	1.61	1.64	1.58
	90	1.50	1.81	1.84	1.70	1.64	1.58	1.59	1.61	1.56

Conclusion

According to the above illustrated results and discussion, it can be generally concluded that, fertilization of sugar beet plants by nitrogen at the rate of 90 k N/fed and potassium at the rate of 24 kg K_2O/fed, in the form of potassium sulphate (SOP) or potassium chloride (MOP), are necessary for producing maximum sugar beet root yield, of satisfactory quality and tolerant for disease severity, under salt affected soils in Eastnorthern Delta of Egypt.

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تأثير مستويات ملوحة التربة والتسميد الآزوتي وصور الأسمدة البوتاسية على نمو ومحصول بنجر السكر في شمال شرق الدلتا بمصر

محمود حسن محمود الخولي[1] ، مجدي توفيق عبد الحميد[2] و السيد حسن حسن سليم[3]
١- معهد بحوث الأراضي والمياه والبيئة- مركز البحوث الزراعية- جيزة-مصر
٢ - المركز القومي للبحوث- الدقي- القاهرة- مصر
٣- معهد بحوث المحاصيل السكرية- مركز البحوث الزراعية - جيزة-مصر

أقيمت تجربتان حقليتان على محصول بنجر السكر في محطة بحوث السرو الزراعية بمحافظة دمياط - شمال شرق الدلتا بمصر في موسمي ٢٠٠٣ /٢٠٠٤ و ٢٠٠٤ /٢٠٠٥ بهدف دراسة ثلاثة مستويات من التسميد الآزوتي (٣٠ ، ٦٠ ، ٩٠ كجم أزوت/فدان) ومعدلين من التسميد البوتاسي (صفر و ٢٤ كجم بو٢أ/فدان) من مصدرين مختلفين (كبريتات البوتاسيوم وكلوريد البوتاسيوم) وذلك في ثلاثة مواقع ذات درجات ملوحة مختلفة (٢،٨ - ٥ ، ٦ - ١٠ ، ١١ - ١٢ ديسيسيمنز/متر) على نمو ومحصول بنجر السكر ومدى مقاومته لمرض تبقع الأوراق الذي يسببه فطر .Cerrospora beticola Sacc .

وقد أظهرت نتائج التحليل التجميعي لمواقع ملوحة التربة الثلاثة لموسمي الدراسة الاتجاهات الأتية:

١- كان هناك تأثير سلبي ومعنوي لزيادة مستويات ملوحة التربة على انتاجية محصول بنجر السكر في كلا الموسمين.

٢- كانت أعلى القيم لانتاجية وخواص محصول بنجر السكر مع مستوى الملوحة الأول (٢،٨ - ٥ ديسيسيمنز/متر) مقارنة بالمستويين الأخرين (٦ - ١٠ ، ١١ - ١٢ ديسيسيمنز) على التوالي.

٣- كان مستوى ملوحة التربة الأكثر من ١٠ ديسيسيمنز/متر هو مستوى الخطورة المؤثر على نمو وانتاجية بنجر السكر في منطقة شمال شرق الدلتا.

٤- أدت زيادة معدل الاضافة من السماد النتروجينى من ٣٠ الى ٩٠ كجم ازوت/فدان الى زيادة معنوية في طول الجذر ووزن الجذر الغض ومحصول العرش ومحصول السكر طن/فدان في ظل مستويات ملوحة التربة المختلفة بينما نقصت النسبة المئوية للسكروز معنويا بزيادة معدل السماد الأزوتي في كلا الموسمين. وقد أعطى معدل ٩٠ كجم ازوت/فدان الى زيادة معنوية بمقدار ١٥،٧٦ و ١٣،٩٦ % في انتاج الجذر (طن/فدان) ، ١٤،٩٦ و ١٠،٧ % في انتاج السكر (طن/فدان) مقارنة بمعاملة الكنترول (٣٠ كجم أزوت/فدان) في كلا موسمي الدراسة على التوالي.

٥- ازدادت معنويا قيمة كل الصفات المدروسة باضافة ٢٤ كجم بو٢أ/فدان مقارنة بمعاملة الكنترول (عدم اضافة السماد البوتاسي) بدون وجود فرق معنوي بين تأثير كل من كبريتات البوتاسيوم وكلوريد البوتاسيوم في كلا موسمي الدراسة.

٦- أظهر التفاعل الثنائي والثلاثي بين مستويات ملوحة التربة والتسميد الأزوتي والبوتاسي تأثيرا معنويا على كل الصفات المدروسة في كلا موسمي الدراسة، حيث اعطت معاملة مستوى ملوحة حتى ٥ ديشيسيمنز/متر ، ٩٠ كجم أزوت/فدان + ٢٤ كجم بو٢أ/فدان من كل من مصدري السماد البوتاسي أعلى القيم لكل الصفات المدروسة في كلا موسمي الدراسة مقارنة بالمعاملات الأخرى.

٧- أدى اضافة السماد البوتاسي في كلتا صورتيه من كبريتات البوتاسيوم وكلوريد البوتاسيوم الى زيادة المقاومة المستحثة لمرض تبقع أوراق بنجر السكر مقارنة بمعاملة الكنترول وذلك مع كل مستويات ملوحة التربة ومستويات التسميد الأزوتي الثلاث.

٨- أظهر مستوى ملوحة التربة الثالث (١٠ - ١١ ديسيسيمنز/متر) أعلى نسبة مئوية من الصوديوم والكلوريد في جذور بنجر السكر بينما أدى زيادة معدل التسميد الأزوتي الى نقص واضح في تلك القيم تحت كل مستويات الملوحة، أيضا أدى التسميد البوتاسي من كل من مصدريه الى أقل قيم في النسبة المئوية الصوديوم في جذور البنجر.ومن ناحية أخرى أدى اضافة سماد كبريتات البوتاسيوم الى أقل القيم في النسبة المئوية للكلوريد في جذور البنجر

٩- توصي الدراسة بتسميد بنجر السكر تحت ظروف الأراضى المتاثرة بالأملاح بشمال شرق الدلتا بمعدل ٩٠ كجم ازوت/فدان + ٢٤ كجم بو٢أ/فدان من كلا مصدري السماد البوتاسي (كبريتات البوتاسيوم وكلوريد البوتاسيوم) للحصول على أعلى محصول من العروش والجذور والسكر طن/فدان.