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COMPARATIVE EFFECT OF POTASSIUM SULPHATE AND POTASSIUM CHLORIDE ON CROP PRODUCTION AND SOIL CHEMICAL PROPERTIES UNDER EGYPTIAN CONDTIONS

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Abstract

Two long term field trials were conducted at EL-Serw Research Station (heavy clay soils), Demeitta Governorate (North of Nile Delta) during four growing seasons (1995/1996 – 1998/1999) to compare the effect of potassium sulphate (SOP) and potassium chloride (MOP), each in two rates (70 and 140 kg K_2O / ha) under surface irrigation system . The crop sequence of the four growing seasons at the first trial (EL-Serw-1) was berseem-rice, berseem-rice, wheat-rice and berseem-rice, while it was wheat-sorghum, sugar beet-rice, berseem-rice and rape-sorghum at the second trial (EL-Serw-2). Soil samples were collected from each plot before starting the trials and yearly after summer crops to follow up the concentration of total soluble salts (TSS), chloride and the available K. The obtained results indicated that:

1. The grown crops showed sporadic responses to the applied potash fertilizers , may be due to the heavy clay soils of this area with high K content . Positive significant responses by SOP application were detected in one out of the two winter seasons for wheat, two out of four winter seasons for berseem and only one out of six summer seasons for rice. Most of these effects were found under low salinity, and there were slight advantages in favour of SOP for most crops
2. MOP showed no signification effects on the grown crops ; exception was found with rice grain yield which was adversely affected by the high MOP rate under high salinity condition during one out of two seasons, and berseem which responded positively only to the low MOP rate at both sites.
3. MOP also showed no adverse effects on rice; the compulsory grown crop in this area, especially under lower salinity; may be because it is grown on flooded soils and this consequently prevent salt and Cl accumulation .
4. At EL-Serw-1, with low salinity , both K rate and source showed no marked difference in both soil TSS and Cl concentrations, due to the leaching process under rice cultivation as preceding crop before collecting the soil samples, but when the preceding crop was sorghum, the TSS and Cl concentration were slightly higher . This was confirmed at EL-Serw-2, with high salinity of the soil samples taken after rice, however application of MOP induced higher soil contents of both TSS and CL than SOP .

5. Under this experimental condition, only chloride-free potash fertilizers (SOP) should be recommended not to aggravate salinity problems . However , MOP may be applied at low rate for rice ,berseem or sugar beet which has special requirements for Na and Cl.

INTRODUCTION

The importance of potassium fertilization in Egyptian agriculture has been arisen since the completion of the High Dam, because of the deposition of the suspended Nile silt in the upstream of the formed lake. This Nile silt was a source to enrich the Egyptian soils with K-bearing minerals during the seasonal floods. Though, in general, Egyptian soils are rich in potassium, sporadic responses of several crops to applied K even under higher availability have been reported (Abd El-Hadi, 1989 and Abd El-Hadi *et al.*, 1990). This is due to the existence of a dynamic equilibrium among the various forms of K in soil. However, continuous crop removal without replenishment is likely to cause an irreparable damage from the soil fertility point of view.

Sulphate of potash (SOP, 50% K_2O and 18% S) is the preferred form of potash fertilizer in Egypt on account of its sulphur content, low salt index, nonhygroscopicity and free of chloride. Compared to SOP, muriate of potash (MOP or potassium chloride, 60% K_2O) is a cheaper source of potash but it contains 48% chlorine which contributes to the phenomenon of soil salinization.

The question has been recently raised whether the introduction of MOP in Egypt would help to satisfy the growing demand of potash while costing the country less hard currency, and whether MOP can be used safely without detrimental long-term effects on crop yield and quality and soil conservation especially under prevailing conditions of increasing fertilizer rates.

The comparative effects of SOP and MOP have been studied in many countries other than Egypt. In Pakistan, Bakhsh *et al.* (1986) reported that both SOP and MOP were almost equally effective on wheat yield in calcareous soils, clay loam in nature, but SOP out-yielded MOP. However, in South Dakota, USA, spring wheat showed grain yield increase due to MOP fertilization on soils that tested very high in ammonium acetate extractable K. Soil and plant analyses indicated that the yield increases on a very high K-testing soils were due to the Cl in the MOP and not to the K (Fixen *et al.*, 1986a). In another experiment (Fixen *et al.*, 1986b) they reported a critical wheat plant Cl concentration of 1.5 g/kg for whole plant at head emergence assured 96% of maximum grain yield and soil Cl levels >43.5 kg/ha (60 cm depth) or 75 kg/ha (120 cm depth) were adequate for near maximum wheat yield.

On sandy soils in Morocco, Badraoui *et al.* (1997) , comparing the effect of MOP and SOP applied to sugar beet, found that both fertilizers had positive significant effects on root yield, sugar percentage and total extractable sugar. It was also reported that when designing a K fertilization programme one should not forget the influence of the accompanying anion which modifies the efficiency of K in its role in nutrients efficiency (Krauss, 1993). The accompanying anion of K fertilizer can interfere also with the availability and efficiency of those nutrients fixed at high pH such as phosphorus and micronutrients.

In view of this, two long-term experiments were set up at EL-Serw Research Station to evaluate the comparative effects of SOP and MOP on different annual crops as well as on soil salinization and soil contents of chlorine and NH_4OAc-extracted- K.

MATERIALS AND METHODS

Two long-term experiments were initiated in the winter growing season 1995/96 to be then continued through the summer season 1999 at EL-Serw Reseach Station (Heavy Clay Soils) , Dameitta Governorate (North of Nile Delta), Agricultural Research Center (ARC); aimed to compare the relative effectiveness of potassium sulphate (SOP) and potassium chloride (MOP) on various annual crops and soil contents of total soluble salts (TSS), soluble chloride and available potassium (NH_4OAc-K).

The two experiments were established on two different sites having the following soil contents of TSS, Cl and NH_4OAc-K ,Table 1.

Table 1. Soil analysis of the experimental sites (sampling of 1995).

Location-site	TSS (%)	Cl (meq/100 g soil)	NH_4OAc-K (ppm)
El-Serw-1	0.24	2.97	878
El-Serw-2	0.56	4.32	850

The two experiments had five treatments :

(1) control with no K fertilizer.

(2) 70 kg K_2O/ha in the form of SOP (50% K_2O).

(3) 140 kg K_2O/ha in the form of SOP (50% K_2O).

(4) 70 kg K_2O/ha in the form of MOP (60% K_2O).

(5) 140 kg K_2O/ha in the form of MOP (60% K_2O).

The treatments were arranged in Latin Square design with five replications with plot size 25 m^2. Potash fertilizer rates of both sources were applied for all crops in two equal doses, i.e., at planting and one month later. N and P fertilizers were applied in proper rate and form at the right time of application according to the cultivated crop.

The crop sequence implemented in the duration of the experiments is shown in Table 2. Crop yields of both winter and summer crops were recorded every year and statistically analysed.

Table 2. Crop sequence at each location during the experiment period.

Location	1995/96	1996	1996/97	1997	1997/98	1998	1998/99	1999
	Winter season	Summer season	Winter season	Summer season	Winter season	Summer season	Winter season	Summer season
El-Serw-1	Berseem	Rice	Berseem	Rice	Wheat	Rice	Berseem	Rice
El-Serw-2	Wheat	Sorghum	Sugar beet	Rice	Berseem	Rice	Rape	Sorghum

Representative soil surface (0-30 cm) samples were collected from each plot, after harvesting the summer crop every year to follow up the concentrations of TSS, soluble Cl and the available K. TSS was estimated by measuring the electrical conductivity (EC) of the 1:5, soil:water extract, in mmhos/cm and then multiplied by 0.32 to obtain the TSS percentage according to Jackson (1973). Soluble chloride was also determined by titration with silver nitrate according to Jackson (1973). The available K was extracted by neutral (1 N) ammonium acetate and determined by Flame photometer.

RESULTS AND DISCUSSION

Soil Characteristics

Soils are heavy clay (CEC = 40 meq/100 g soil); the salinity and the chlorine content of El-Serw-2 is very high. Growing paddy rice every 2-3 years is compulsory in order to wash salts out. The soils are very rich in K. Surface irrigation is performed with Nile water. Drainage is uneasy due to the high clay content, but deep irrigation trenches were bordering the plot.

Crop Yield Data :

A. Winter Crops :

1. Berseem :

Except for the 1997/1998 winter crop season, berseem clover was the winter crop involved in the crop rotation in El-Serw-1 site during the experimental duration (1995/1996 –1998/1999), but it was involved only during 1997/1998 season in El-Serw-2. The obtained results in Tables 3 and 4 revealed that berseem dry yield was significantly affected by K fertilizer application starting from the second season (1996/1997) where only 70 kg K_2O/ha as SOP and 140 kg K_2O/ha as MOP showed significant increases by about 12% and 8.6%, respectively over that of the control treatment. Thereafter, both rates of SOP and only the low rate of MOP showed significant increases. The higher SOP rate produced the highest increases over the check treatment by about 13% and 14% in El-Serw-1 and 2, respectively; while the low MOP rate gave less increase on both fields at that location. It is worth to point out that the higher MOP rate showed no significant effect on berseem yield during the last two seasons. On the average of the two K rates, SOP out-yielded MOP especially in the last two seasons. This may be due to the Cl^- accumulation particularly in El-Serw-2 which was characterized by the high Cl content showing that when Cl is present in large quantities in the rhizosphere in arid soils an additional supply with K in the form of MOP can interfere in yield and quality developing processes (Krauss, 1993). Moreover, one of the reasons for the good effect of sulphate potash fertilizer on clover may be found in the effect of SO_4 on the nodule bacteria in improving fixation of atmospheric N and thus producing higher yields with much protein content (Kampfer and Zehler, 1967).

2. Wheat :

Wheat was grown as a winter crop during the first and the third seasons at El-Serw-1 and El-Serw-2, respectively. It was noticed that wheat grain yield was significantly increased by only SOP application on El-Serw-1 by about 16% and 18% for 70 and 140 kg K_2O/ha, respectively; while MOP showed no significant effect at the same field. Straw yield was also significantly affected by the high SOP rate at this filed which indicated an increase by about 18% over the control treatment. On the other hand, wheat grain and straw yields were not significantly affected by neither K source nor K rate at El-Serw-2 which is characterized by higher Cl content than El-Serw-1.

It is worth noting that lower grain and straw yields were recorded by MOP than SOP application by about 13% at El-Serw-1 which had less Cl content than El-Serw-2. However, the previous studies by Fixen *et al.* (1986a and 1987) reported wheat response to MOP fertilization on high K-testing soils and that was due to the Cl in the MOP and not due to the K. Also, Bakhsh *et al.* (1986) found that application of 45 kg K_2O/ha as MOP was found better for wheat yield in case of rice-wheat and fallow-wheat rotation but SOP at the rate of 90 kg K_2O/ha was better and economical. According to Bernstein (1975), all cereals can be regarded as fairly salt and chloride tolerant and this is confirmed by the fact that they are widely grown under arid, saline conditions. This could be the explanation of the harmless effect of MOP on wheat yield especially at El-Serw-2 where high level of soil Cl was detected.

3. Sugar beet :

Sugar beet was grown as a winter crop during one season only (1996/97) at El-Serw-2. It is known as a halophyte and has special requirements for Na and Cl. Therefore, it was observed that both the two K fertilizer sources were not effective for sugar beet root yield. The salt tolerance of sugar beet allowed it to absorb very large quantities of Na and Cl which are found in large quantities at El-Serw-2. Moreover, solution culture experiments by Hampe (1979) have demonstrated that when sugar beet plants were supplied with equivalent amounts of both Na and K, very young seedlings took up K preferentially, but as they developed further this preference was not no longer evident and both K and Na were taken up in proportion to their concentrations in the nutrient solution. Under conditions of K deficiency Na was largely able to substitute for

K; besides it was found that Na has specific effects on growth.

4. Rape :

Rape is one of the crops with large requirements for both K and S. Thus S deficiency could be expected when rape appears often in the rotation. It was grown during one growing season only (1998/99) on El-Serw-2. Due to its large requirements of both K and S, only the high SOP rate (140 kg K_2O/ha) induced significant increase in rape seed over the control treatment by about 26%, while the same rate of MOP caused a slight decrease by about 8%. This might be due to the high TSS and Cl content in the soil of the expremint. In this regard Maraby (1968) reported that when the two forms of potash were applied in autumn in combination with increasing rates of P, SOP greatly outyielded MOP and interacted with P.

B. Summer Crops :

1. Rice :

Growing rice every 2 or 3 years at Demeitta Governorate is compulsory in order to wash out the salts from the soil . It was comprised in the crop sequence as a summer crop during all growing seasons at El-Serw-1 and during two summer seasons (1997 and 1998) at El-Serw-2. The obtained results in Tables 3 and 4 showed inconsistent response to K fertilizers, while it responded positively to both SOP rates as well as the low MOP rate. The significant increment occurred by SOP during 1998 season at El-Serw-1 which is characterized by relatively low salinity. The grain yield increase due to K fertilization during this season was accompanied by a significant reduction in the straw yield. On the other hand, the high MOP rate (140 kg K_2O/ha) caused adverse effects on rice grain yield particularly at El-Serw-2 in 1997 where a significant reduction by 16.7% was detected compared to the control treatment. This could be attributed to that rice crop is sensitive to salinity . In this connection, Lam and McLean (1979) reported that chloride salts were most detrimental to yield and N and P contents while the sulphate salts were beneficial when the electrolyte concentration and P in the soil were not high.

Generally, during all growing seasons at both fields, there was only a slight advantage in favour of SOP, except in 1998 where the response was significant. The IPI

Research Topics (1981) mentioned that, while up to now the potash fertilizer used in rice growing has been almost entirely MOP, there is a case for considering the use of SOP to supply rapidly available S where it is required.

2. Sorghum :

Sorghum was included in the crop sequence at El-Serw- 2 during the summer seasons 1996 and 1999. The results quoted in Table 4 showed that only the higher SOP rate induced significant grain yield increase by 11.6% over the control in 1999. It is worth to point out that SOP generally showed a slight advantage compared to MOP.

Soil Analysis :

To follow up the soil contents of TSS, Cl and available K during the long-term experiment, surface soil samples (0 - 30 cm) were collected after each summer crop and were subjected to chemical analysis to compare the effect of MOP and SOP on these parameters. The obtained results in Tables 5 and 6 showed variations between the two fields according to the kind of grown crop and soil contents of TSS and Cl. Regarding El-Serw-1, although TSS and Cl concentrations were fluctuated from year to another and this possibly due to the management practices especially the amount of irrigation water. Both K rate and source showed no marked differences in both parameters. This could be attributed to that the summer crop was always rice which was grown on flooded soil and this consequently prevent salt and Cl accumulation because of the vertically down and predominant percolation of irrigation water taking the dissolved salts and chloride within it. This shows that the choice of potash form is not of great importance for crop rotation includeding rice; maintaining an adequate K supply is the prime consideration.

Interestingly, surface soil samples taken after rice at El-Serw-2 in 1997 and 1998 showed lower contents of TSS and Cl confirming the above-mentioned results on El-Serw-1. However, application of MOP induced higher soil contents of TSS and Cl compared with SOP. On average of years at El-Serw-2, TSS percentage increased from 0.30 and 0.29 for the low and the high rate of SOP respectively to 0.37 and 0.41 for the corresponding rates of MOP, while Cl content (meq/100 g soil) increased from 2.65 and 2.82 for the low and the high rate of SOP respectively to 3.22 and 3.47 for the same rates of MOP (Table, 6).

The extractable NH_4OAc-K was also fluctuated from year to year possibly due to the kind of crop preceding soil sampling or due to the existence of dynamic equilibrium among the various forms of K in the soil. Also, availability of K is controlled by its release from K bearing minerals and fixation by partially weathered minerals (Akhtar, 1993). On the average of the four years crop rotation, it was noticed that applying both K rates and sources caused slight increases in NH_4OAc-K possibly due to the heavy clay soils of El-Serw location with high K content. The advantage of the heavy soils is that, provided it contains enough K as in our case, it will be able to maintain the solution K at a steady level through the growing of the crop from year to year.

In conclusion, under this location condition which is characterized by high TSS 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 rice, berseem or sugar beet which has special requirements for Na and Cl.

Table 3. Effect of different sources and levels of potassium on crop production (t/ha) during four years crop rotation (1995/1996-1998/1999) at El-Serw Res. Station (El-Serw-1).

K-level (kg/ha)	K-source	1995/96 Winter crop	1996 Summer crop	1996/97 Winter crop	1997 Summer crop		1997/98 Winter crop		1998 Summer crop		1998/99 Winter crop	1999 Summer crop	
		Berseem	Rice	Berseem	Rice		Wheat		Rice		Berseem	Rice	
		DY*	Grain	DY*	Grain	Straw	Grain	Straw	Grain	Straw	DY*	Grain	Straw
0		11.90	5.90	9.53	7.42	12.46	5.22	9.62	5.67	11.84	13.86	7.22	8.36
70	K_2SO_4	12.40	6.24	10.67•	7.75	12.62	6.06•	10.70	6.39•	8.86•	15.22•	7.61	8.86
140	(SOP)	12.10	6.36	9.87	7.81	12.46	6.16•	11.36•	6.69•	8.30•	15.69•	8.25	9.33•
Mean		12.25	6.30	10.27	7.78	12.54	6.11	11.03	6.54	8.58	15.45	7.93	9.09
70	KCl	12.50	6.16	9.70	7.56	12.94	5.47	10.06	6.10	9.36•	14.62•	7.79	8.26
140	(MOP)	11.80	5.64	10.35•	6.98	12.12	5.28	9.28	6.02	8.90•	13.78	7.14	8.04
Mean		12.15	5.90	10.02	7.27	12.53	5.37	9.67	6.06	9.13	14.20	7.46	8.15
L.S.D. 5%•		N.S.	N.S.	0.48	N.S.	N.S.	0.57	1.12	0.65	1.58	0.35	N.S.	0.56
C.V. %		7.31	12.42	3.45	10.07	5.82	7.36	7.88	7.67	12.15	11.73	7.57	4.70

• : Significant compared to 0 K level (control treatment)

* DY : Dry Yield.

Table 4. Effect of different sources and levels of potassium on crop production (t/ha) during four years crop rotation (1995/1996-1998/1999) at El-Serw Res. Station (El-Serw-2).

K-level (kg/ha)	K-source	1995/96 Winter crop		1996 Summer crop	1996/97 Winter crop	1997 Summer crop		1997/98 Winter crop	1998 Summer crop		1998/99 Winter crop	1999 Summer crop
		Wheat		Sorghum	Sugar beet	Rice		Berseem	Rice		Rape seed	Sorghum
		Grain	Straw	Grain Yield	Yield	Grain	Straw	DY•	Grain	Straw	Yield	Grain Yield
0		5.65	8.12	9.20	49.6	5.67	9.66	13.90	4.92	8.04	2.62	8.36
70	K_2SO_4	5.83	8.37	9.82	50.96	6.18	8.94	15.17	5.76	8.48	2.90	8.86
140	(SOP)	5.95	8.40	9.70	53.60	5.96	10.54	15.87*	5.62	8.00	3.30*	9.33*
Mean		5.89	8.38	9.76	52.28	6.07	9.74	15.52	5.69	8.24	3.10	9.09
70	KCl	5.99	8.47	9.34	51.12	5.98	9.90	14.63	5.12	8.40	2.80	8.26
140	(MOP)	5.77	8.35	9.42	51.36	4.72	10.38	13.54	5.04	7.15	2.40	8.04
Mean		5.88	8.41	9.38	51.24	5.35	10.14	14.08	5.08	7.77	2.60	8.15
L.S.D. 5%		N.S.	N.S.	N.S.	N.S.	0.63	N.S.	0.36	N.S.	N.S.	0.53	0.56
C.V. %		7.65	4.03	3.52	8.70	7.98	9.14	11.78	11.32	15.51	13.79	4.70

* : Significant compared to 0 K level. (control treatment)

• DY : Dry Yield.

Table 5. Soil contents of TSS, available K and soluble chloride after summer crop harvesting during four years crop rotation (1995/1996-1998/1999) at El-Serw Res. Station (El-Serw-1).

Treatment	Control (zero-K)			Potassium Sulphate (SOP) (70 kg K_2O/ha)			Potassium Sulphate (SOP) (140 kg K_2O/ha)			Potassium Cloride (MOP) (70 kg K_2O/ha)			Potassium Cloride (MOP) (140 kg K_2O/ha)		
Soil Analysis / Year	TSS* (%)	Avail. K ppm	Cl (meq/ 100 g soil)	TSS* (%)	Avail. K ppm	Cl (meq/ 100 g soil)	TSS* (%)	Avail. K ppm	Cl (meq/ 100 g soil)	TSS* (%)	Avail. K ppm	Cl (meq/ 100 g soil)	TSS* (%)	Avail. K ppm	Cl (meq/ 100 g soil)
1995**	0.24	878	2.97	0.24	878	2.97	0.24	878	2.97	0.24	878	2.97	0.24	878	2.97
1996	0.17	850	1.43	0.16	854	1.43	0.15	930	1.40	0.16	860	1.47	0.17	880	1.49
1997	0.14	770	1.35	0.13	864	1.26	0.11	900	1.26	0.14	880	1.43	0.16	895	1.46
1998	0.19	486	1.54	0.24	516	2.05	0.20	602	1.17	0.23	706	1.57	0.25	604	1.52
1999	0.35	688	2.58	0.37	694	2.77	0.40	794	2.08	0.31	702	2.27	0.38	752	2.42
Mean	0.21	670	1.73	0.23	732	1.88	0.22	807	1.48	0.21	787	1.69	0.24	783	1.72

* TTS = Total Soluble Salts.

** : 0-Time

Table 6. Soil contents of TSS, available K and soluble chloride after summer crop harvesting during four years crop rotation (1995/ 1996-1998/1999) at El-Serw Res. Station (El-Serw-2).

Treatment	Control (zero -K)			Potassium Sulphate (SOP) (70 kg K_2O/ha)			Potassium Sulphate (SOP) (140 kg K_2O/ha)			Potassium Cloride (MOP) (70 kg K_2O/ha)			Potassium Cloride (MOP) (140 kg K_2O/ha)		
Soil Analysis / Year	TSS* (%)	Avail. K ppm	Cl (meq/ 100 g soil)	TSS* (%)	Avail. K ppm	Cl (meq/ 100 g soil)	TSS* (%)	Avail. K ppm	Cl (meq/ 100 g soil)	TSS* (%)	Avail. K ppm	Cl (meq/ 100 g soil)	TSS* (%)	Avail. K ppm	Cl (meq/ 100 g soil)
1995**	0.56	850	4.32	0.56	850	4.32	0.56	850	4.32	0.56	850	4.32	0.56	850	4.32
1996	0.43	840	3.06	0.39	858	3.15	0.37	862	3.15	0.43	900	3.21	0.46	930	3.40
1997	0.19	800	1.53	0.13	850	1.26	0.10	860	1.63	0.22	850	1.98	0.25	920	2.43
1998	0.20	-	1.98	0.22	-	2.06	0.18	-	1.59	0.28	-	3.11	0.40	-	3.45
1999	0.50	774	4.37	0.45	810	4.14	0.50	870	4.91	0.55	819	4.58	0.53	1287	4.59
Mean	0.33	805	2.74	0.3	839	2.65	0.29	864	2.82	0.37	856	3.22	0.41	1046	3.47

* TTS = Total Soluble Salts.

** : 0-Time

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مقارنة تأثير كل من كبريتات البوتاسيوم وكلوريد البوتاسيوم على إنتاجية المحاصيل والخواص الكيميائية للتربة تحت الظروف المصرية

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أقيمت تجربتان حقليتان طويلتا المدى في محطة بحوث السرو (تربة طينية ثقيلة)، محافظة دمياط أثناء أربعة مواسم للنمو (١٩٩٥/١٩٩٦ ،١٩٩٨ / ١٩٩٩) لمقارنة تأثير كل من كبريتات البوتاسيوم وكلوريد البوتاسيوم عند معدلي ٧٠ ، ١٤٠ كجم بو٢أ / هكتار تحت نظام الري السطحي . كان تتابع المحاصيل في مواسم النمو الأربعة في التجربة الأولى (السرو - ١) هو برسيم / أرز ، برسيم/ أرز ، قمح / أرز ثم برسيم / أرز بينما كان تتابع المحاصيل قمح / سورجم ، بنجر السكر / أرز ، برسيم / أرز ثم ريب/ سورجم في التجربة الثانية (السرو - ٢) . أخذت عينة تربة من كل قطعة تجريبية من التجربتين قبل بداية التجربة ثم بعد حصاد المحصول الصيفي سنوياً لمتابعة تركيز الأملاح الكلية والكلوريد والبوتاسيوم الصالح للاستفادة في التربة . كانت النتائج المتحصل عليها كما يلي :

١- أظهرت المحاصيل المنزرعة استجابات متفرقة أو متقطعة لإضافة الأسمدة البوتاسية وربما يرجع ذلك إلى وجود التربة الطينية بهذه المنطقة والغنية في محتواها من البوتاسيوم ، فقد تم الحصول على استجابة معنوية موجبة لمحصول القمح لإضافة كبريتات البوتاسيوم في موسم واحد من موسمين وموسمين فقط من ستة مواسم زراعية للأرز ، ومعظم هذه الاستجابات كانت في التجربة الأولى حيث كانت ملوحة التربة منخفضة .

٢- لم تظهر إضافة كلوريد البوتاسيوم تأثيرات معنوية على المحاصيل المنزرعة باستثناء محصول الحبوب للأرز الذي أظهر نقصاً بإضافة المعدل العالي من كلوريد البوتاسيوم تحت ظروف التربة الملحية في التجربة الثانية وحدث ذلك في موسم واحد فقط من موسمي زراعة ، بينما أظهر البرسيم زيادة معنوية في المحصول بإضافة المعدل المنخفض من كلوريد البوتاسيوم في كل من التجربتين .

٣- لم تظهر إضافة كلوريد البوتاسيوم تأثيرات عكسية على محصول الأرز الذي يزرع إجبارياً في هذه المنطقة - خاصة تحت ظروف ملوحة التربة المنخفضة وربما يرجع ذلك إلى ظروف زراعة الأرز في الأرض المغمورة بالماء وبالتالي منع تراكم الأملاح والكلوريد بالتربة .

٤- في التجربة الأولى (السرو - ١) ذات الملوحة المنخفضة لم تظهر فروق واضحة في تركيز كل من الأملاح الكلية والكلوريد بين كل من مصدري أو معدلى السماد البوتاسى بسبب حدوث عملية الغسيل تحت ظروف زراعة محصول الأرز كمحصول سابق لأخذ عينة التربة للتحليل ولكن عندما كان المحصول السابق لأخذ عينة التربة هو السورجم كان هناك زيادة طفيفة في تركيز الأملاح الكلية والكلوريد وقد تأكد هذا في التجربة الثانية (السرو - ٢) بالنسبة لعينات التربة

المأخوذة بعد الأرز ومع ذلك فقد أدي إضافة كلوريد البوتاسيوم إلى زيادة محتوى التربة من الأملاح الكلية والكلوريد عن إضافة كبريتات البوتاسيوم .

٥- تحت هذه الظروف فأنة يوصي بإضافة أسمدة البوتاسيوم الخالية من الكلوريد (مثل كبريتات البوتاسيوم) حتى نتجنب تفاقم مشكلة ملوحة التربة ومع ذلك فأنة يمكن إضافة سماد كلوريد البوتاسيوم عند المعدل المنخفض (٧٠كجم بو٢أ /هكتار) للأرز ، البرسيم وكذلك بنجر السكر الذي له احتياجات خاصة من الصوديوم والكلوريد