Effect of potassium fertilization and soil moisture content on wheat grown in a high k-testing calcareous soil

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ABSTRACT

A pot experiment was conducted during 2003/2004 winter season in the green house at Faculty of Agriculture, Saba Bacha, Alexandria University to study the effect of five rates of potassium (0, 12, 24, 36 and 48 Kg K_2O / fed) as potassium sulphate fertilizer and four soil moisture contents (at 30, 40, 50 and 60% of field capacity) on wheat grown in a high K-testing calcareous soil. The experimental design was split-plots with four replicates. The treatments consisted of 20 combinations of the two factors.

The plant height, grain yield and straw yield significantly increased as soil moisture content increased up to 60 % of field capacity. The grain yield increased by 13.54, 11.46, 10.41 and 11.46 % relative to the control as potassium was increased from zero to 12, 24, 36 and 48 kg K_2O/fed, respectively. The maximum wheat grain production was obtained at K application rate of 24 kg K_2O/fed. and soil moisture at 60 % of field capacity. Increasing soil moisture content up to 60 % of field capacity significantly increased N and P concentrations and uptake of the tops of wheat plant. However, K concentration was markedly increased but its uptake was significantly increased. Potassium fertilization had a significant effect on K concentration and K uptake. However, N and P uptake were markedly increased as K rate increased but insignificantly. The interaction between soil moisture content and K fertilization rate had no significant effect on P and K concentration while only uptake of K was significantly increased. Nitrogen and protein content in grain increased with increasing soil moisture content from 30 up to 60 % of field capacity. The highest values of N or protein content in grains were recorded at soil moisture content 50 % of field capacity with 24 kg K_2O/fed. Water soluble-K, exchangeable-K and available-K in soil decreased significantly as a result of increasing soil moisture content from 30 to 60 % of field capacity. Increasing potassium fertilization rates, from 12 to 48 kg K_2O/fed., led to significant increase in water soluble-K, exchangeable-K and available-K under the current study. The maximum value of water soluble-K and available- K were recorded at 30 % of field capacity with 36 kg K_2O/fed while exchangeable-K was recorded at 30 % of field capacity with 24 kg K_2O/fed. The available-K was linearly correlated with K-fertilization rate for the different soil moisture levels. The findings obtained in this study suggest that soil available-K can be readily altered by adjusting the level of K fertilizer, for improving the plant growth an yield of wheat, especially under soil water stress condition.

INTRODUCTION

Wheat is considered one of the most important winter crops for human consumption in Egypt. The productivity of wheat is affected by many factors among which fertilization by macronutrients especially K (Yagodin, 1984, Arafa, 1985) and soil moisture content (Shahin *et al.,* 2002).

Water is considered an essential component for sustainable agricultural development. Without appropriate water control and management, maintaining agricultural development is simply not possiple. The increase in wheat yield per every unit of water is considered the national aim in both old and new lands in Egypt.

Potassium plays numerous roles in plant growth (Marschner, 1995). The role of K in plants includes cation transport, water economy, energy metabolism and enzyme activation (Mengle and Kirkby, 1980). Michael and Duke (1981) reported that fertilization with high level of K increased shoot number per alfalfa plant by 51 % and increased shoot dry weight by 20 % over the unfertilized control. Reneau *et al.* (1983) found that K application increased forage sorghum yield only in years with less than optimum moisture condtions. Fixen *et al.* (1986) found that cereal grain yield response to KCl fertilization has been reported on high K-testing soils in the Northern Plains. Minged *et al.* (1996) found that K increased plant growth and decreased the negative effects of water stress. Because of the role of K for improving plant water content and stomatal resistance after K application under water stress, high rates of K fertilizer often must be applied to attain normal growth (Minged *et al.*, 1996). El-Fouly and El-Sayed (2000) reported that even when Egyptian soils are rated as high in K, crops yields were 4% to 26 % higher by potash application. The objective of this work, therefore, was to evaluate the effect of potassium application, as K_2SO_4 , on straw and grains yield and nutrients content and uptake of wheat grown on a high K testing calcareous soil in relation to soil moisture content.

Materials and Methods

A pot experiment was conducted during winter 2003/2004 season in the green house at Faculty of Agriculture, Saba Bacha, Alexandria University. Plastic pots of 30 cm depth and 20 cm diameter with holes in their bottom were used. Ten kg soil was assigned for each pot. The used soil was collected from the upper soil layer (0-30 cm) of Abdel-Basset Abdel-Samad Village, Banger El-Sokkar region, west Burg El-Arab City, Alexandria. Governorate. The main chemical and physical parameters of the soil were determined according to the methods outlined by Black (1965) Page *et al.* (1982) as follows: pH in 1:1 soil- water suspension, electrical conductivity in 1:1 soil-water extract and measured by electrical conductivity meter, Ca^{++} and Mg^{++} by titration with Na_2EDTA, Cl^- by silver nitrate, $CO_3^{--}$and HCO_3^- by dilute HCl, $SO_4^{--}$by $BaCl_2$ method, Na^+ and K^+ by flamephotometer, organic matter by Walkley and Black method, total carbonate by calcimeter. Particle size fractions (sand, silt and clay) were determined by hydrometer and the field capacity by pressure membrane (Black, 1965). The data obtained are presented in Table 1.

Experimental Layout:

The experimental design was split-plots in both K virsus water stress with four replicates. The soil moisture treatments were in the main plots and rates of potassium were in the sub-plots. The treatments consisted of 20 combinations of the two factors. The first factor (potassium fertilizer) was applied at 5 rates: 0, 12, 24, 36 and 48 kg K_2O/fed in the form of potassium sulhpate (48 % K_2O) in two equal doses. The first dose was added after 21 days from planting, while the second dose was added after 20 days after the first dose. In the second factor (moisture content) irrigation water was applied to keep the soil moisture at 30 %, 40 %, 50 % and 60 % of field capacity all over the season (Dourgham, 1991 and Shahin *et al.*, 2002). Wheat (*Triticum aestivum,*L) seeds of Sakha 8 variety were grown on November 16, 2003. The plants were thinned, after one week from sowing, to twenty plants per pot. Superphosphate (15 % P_2O_5) was added and mixed with soil in each pot during the preparation of the experimental soil at a rate of 30 kg P_2O_5/fed, while nitrogen fertilizer was added in the form of urea (46.5 % N) at a rate of 100 kg N/fed in two equal doses. The first dose was added 21 days after planting (life irrigation) and the second was added after four weeks from the first dose.

Samples of plants (tops) were taken at tillering for dry matter determination and also N, P and K contents. At harvest, on April 7, 2004, plant height, straw yield and grain yield were estimated. Also, samples of grains were taken for the determination of N content. At tillering stage, samples of soil were taken for determination of the amount of water soluble, exchangeable and available K in soil according to method outlined by Page *et al* (1982).

Table (1): The mean values of the main chemical and physical characteristics of the used soil.

Properties	Values
pH (1:1 soil : water)	8.3
E.C. (1:1 soil : water), dS/m	0.9
Total Carbonate %	22.0
Organic matter %	0.85
Soluble cations, meq / L :	
Ca^{++}	3.20
Mg^{++}	1.40
Na^{+}	1.67
K^{+}	2.88
Soluble anions, meq / L:	
CO_3^{--}	n.d.
HCO_3^{-}	2.90
Cl^{-}	3.70
SO_4^{--}	2.35
Total potassium, mg/kg soil	3915.6
Available potassium, mg/kg soil	362.31
Particle-size distribution	
Sand %	56.7
Silt %	18.4
Clay %	24.9
Texture Class	Sandy clay loam
Field capacity %	18.34

The plant samples (top or grains) were washed with tap water followed by distilled water, then oven dried (at 65 C for 48 hrs) and ground to pass 1mm sieve. The plant material was wet digested (Lowther,1980) and analyzed for N, P and K according to Jackson (1973). Crude protein percentage was calculated by multiplying nitrogen percent with 5.75.

The obtained data were statistically analyzed for variance and means comparison to fulfill the significance according to Steel and Torrie (1982). Single and multiple linear regression were applied to fit the data using the method of Draper and Smith (1967).

Results and Discussion

Yield attributes:

Results in Table (2) show the effects of moisture content and K fertilization rates on growth and yield attributes i.e. plant height, grain yield and straw yield. The plant height, grain yield and straw yield significantly increased as soil moisture increased up to 60 % of field capacity. The reduction in growth and wheat yields due to skipping on irrigation might be attributed to lack of water absorbed and inhibition of photosynthetic efficiency under insufficient water conditions (Cooper,1980 and Sharma *et al.*, 1984). Moreover, skipping an irrigation affected grain yield through decreasing the reproductive organs of wheat plant, i.e. number of fertile tillers/plant, number of spikes/plant, number and weight of grain/spike (Moursi *et al.*, 1979).

Regarding the effect of K fertilization, Table (2) shows that all the studied characters of wheat increased as potassium rate increased but insignificantly. On the average, the grain yield increased by 13.54, 11.46, 10.41 and 11.46 % as the added potassium was increased from zero to 12, 24, 36 and 48 kg K_2O/fed., respectively, relative to the control. It is clear that any addition of potassium will increase markedly the grain yield up to 48 kg K_2O/fed.

Results in Table (2) show also that the interaction between soil moisture content and potassium fertilization had significant effects on the grain yield. Successive increment of potassium dose up to 24 kg K_2O/fed. with soil moisture at 60 % of field capacity produced the maximum grain yield (1.98 g/plant) compared with the minimal values, when wheat plant was subjected to the different rates of K and soil moisture at 30 % of field capacity. At 30 % of field capacity, the increase in grain yield/plant were 61.53, 23.08 and 38.46 % for K rates of 12, 24 and 36 kg K_2O/fed., respectively over the control treatment (without K application), but at 40 % of field capacity, the increases in grain yield/plant were 41.18, 1.47 and 5.88 % for K rates of 12, 24 and 48 kg K_2O /fed., respectively, while at 50 % of field capacity, the increase in grain yield/plant were 24.55, 33.36, 35.45 and 42.73 % for K rates of 12, 24, 36 and 48 kg K_2O/fed.,respectively. This high growth is due to the presence of high amounts of available-K in the original soil (Table 1) besides the K fertilization and adequate moisture absorption which enhanced the development of new tillers and maintained the survival ones as well as accelerating spike formation.

Table(2): The mean values of straw yield, grain yield and plant height of wheat as affected by soil moisture content and K-fertilization rates.

Treatments: Soil moisture content (of field capacity)	Rate of K (kg K_2O/fed)	Straw yield, g/plant	Grain yield, g/plant	Plant height, cm
30 %	0	0.36	0.13	30.70
	12	0.26	0.21	31.55
	24	0.28	0.16	25.58
	36	0.56	0.18	31.13
	48	0.36	0.12	27.86
Average		0.36	0.16	29.36
40%	0	0.63	0.68	52.20
	12	0.78	0.96	57.25
	24	0.69	0.69	53.85
	36	0.66	0.64	54.55
	48	0.66	0.72	55.37
Average		0.68	0.74	54.66
50 %	0	0.86	1.10	59.75
	12	0.81	1.37	60.45
	24	1.04	1.47	62.85
	36	1.03	1.49	64.25
	48	1.02	1.57	62 15
Average		0.95	1.40	61.91
60%	0	1.41	1.95	69.25
	12	1.27	1.82	67.45
	24	1.40	1.98	71.90
	36	1.28	1.91	67.10
	48	1.33	1.87	64.70
Average		1.35	1.91	68.08
Over all mean	0	0.82	0.96	52.99
	12	0.78	1.09	54.18
	24	0.85	1.07	53.57
	36	0.89	1.06	54.26
	48	0.84	1.07	52.52
Statistical significant $LSD_{0.05}$				
Soil moisture (M)		0.09	0.08	5.57
Potassium rates (K)		n.s.	n.s.	n.s.
K x M		n.s.	0.22	n.s.

It could be concluded, therefore, that under the experimental conditions the maximum wheat grain production was obtained at K application rate of 24 kg K_2O/fed. and keeping soil moisture at 60 % of field capacity. Also, the grain yield (Y) was correlated with the soil moisture content (X1) and K application rate (X2). The regression equation for this relationship can be represented as follows:

$$Y = -1.64 + 0.059 X_1 + 0.001 X_2$$

$$R^2 = 0.974 \qquad (P < 0.01)$$

These analyses indicated that the grain yield were strongly affected by the two variables especially by the soil moisture level under the experimental conditions. The slight effect of K fertilization on the grain yield could be due to the high amounts of available-K (362.3 mg/kg soil) in the original soil (Table 1).

Elements concentration and uptake:

Elements concentration and uptake of wheat plants as affected by soil moisture content and K fertilization rate are presented in Table (3). Increasing soil moisture content up to 60 % of field capacity significantly increased N, P and K contents and uptake (Table 3). The values of relative K uptake were 240.02, 315.46 and 497.26 % for 40 %, 50 % and 60 % of field capacity soil moisture content, respectively as compared with the value at 30 % of field capacity. The corresponding relative values were 244.35, 344.21 and 512.35 % for N and 265.51, 370.76 and 563.73 % for P.

Decreasing soil moisture content reduced P and K uptake by plant because of decreasing the diffusion rate of these elements to roots (Oliver and Barber, 1966; Marais and Wiersma, 1975 and Mackay and Barber, 1985). Decreasing K uptake with decreasing soil moisture content could be due to both root length and K influx which were reduced. However, drying the soil decreased the volumetric water content and impedance factor for diffusion K (Stefen *et al.,* 1995).

Potassium fertilization had a significant effect on K and P concentrations and increased insignificantly nitrogen content. Also, the potassium fertilization had significant effect on K uptake (Table 3). Also, N and P uptake were increased as K rate increased but insignificantly. These results are in agreement with those of Jensen (1982), Bansal (1992) and Bhardwaj and Tyagi (1994).

The interaction between soil moisture content and K fertilization rate had no significant effect on N concentration and N, P and K uptake, but it has a significant effect on P and K concentration (Table 3).

The highest value of K uptake were recorded for soil water content at 60 % of field capacity with 48 kg K_2O/fed., but the highest value of N and P uptake were recorded for soil water level at 60 % of field capacity and 36 kg K_2O/fed. On the other hand, the minimum value of either N, P and K uptake was observed for soil moisture content at 30 % of field capacity without potassium fertilization (Table 3).

The K uptake (Y) was regressed against the soil moisture content (X_1) and K application rate (X_2). The K uptake was positively correlated with the two variables and the regression equation for the relationship can be presented as follows:

$$Y = -36.60 + 1.43 X_1 + 0.23 X_2$$

$R^2 = 0.95$ ($P < 0.01$)

Thus, the efficiency of soil moisture content : K application rate would be equal to 1.43 : 0.23 or 6.36 : 1.00. This equation can be used to predict soil moisture content and K level to attain the optimum K uptake related to the maximum yields of soils with similar conditions to the tested soil.

Table (3): The mean values of N, P and K concentrations (%) and uptake (mg/plant) of wheat as affected by soil moisture content and potassium fertilization rates.

Treatments							
Soil moisture content (of field capacity	Rate of K (kg K_2O/fed)	K content	P content	N content	K uptake	P uptake	N uptake
		%			mg / plant		
30 %	0	2.30	0.57	3.64	7.52	1.85	12.04
	12	2.24	0.63	3.65	7.62	2.48	13.75
	24	2.38	0.64	4.66	8.55	2.30	16.80
	36	2.52	0.68	4.76	10.84	2.92	19.80
	48	2.72	0.57	5.08	11.05	2.27	20.24
Average		2.40	0.62	4.36	9.12	9.12	16.54
40%	0	2.47	0.67	4.09	24.38	6.55	40.24
	12	2.48	0.62	4.34	30.12	7.53	52.91
	24	2.67	0.74	4.86	31.30	9.51	62.42
	36	2.78	0.74	5.04	31.30	8.37	57.21
	48	2.42	0.72	4.62	37.93	11.19	72.01
Average		2.57	0.70	4.59	31.01	8.63	56.96
50 %	0	2.52	0.83	5.06	35.64	11.17	71.45
	12	2.65	0.78	4.97	32.53	9.25	58.54
	24	2.70	0.76	4.73	38.59	11.56	72.82
	36	2.94	0.68	5.18	40.33	10.74	81.09
	48	2.55	0.69	4.68	42.38	12.35	83.47
Average		2.68	0.75	4.93	37.89	11.11	73.47
60%	0	2.33	0.74	5.04	43.53	13.88	93.39
	12	2.51	0.76	5.16	51.22	15.69	105.49
	24	2.52	0.78	4.81	53.59	16.62	103.09
	36	2.81	0.79	4.84	61.68	17.25	106.21
	48	2.89	0.70	4.53	62.33	14.91	98.24
Average		2.61	0.75	4.88	54.47	15.66	101.28
Over all mean	0	2.41	0.70	4.46	27.76	8.49	54.28
	12	2.47	0.70	4.53	30.37	8.73	57.67
	24	2.57	0.73	4.77	33.01	9.99	63.78
	36	2.74	0.72	4.96	36.04	9.81	67.00
	48	2.64	0.67	4.73	38.42	10.17	68.49
Statistical significant $LSD_{0.05}$							
Soil moisture (M)		n.s.	0.02	0.25	4.97	1.54	10.97
Potassium rates (K)		0.14	0.04	n.s.	4.05	n.s.	n.s.
K x M		0.23	0.08	n.s.	n.s.	n.s.	n.s.

Nitrogen and protein content in wheat grains.

Data in Table (4) show the effect of soil moisture content and K fertilization rate on N and protein content in grain. The results indicated significant difference in N or protein content in grains with the different soil moisture contents. The nitrogen or protein content increased with increasing soil moisture content from 30 up to 60 % of field capacity. The increases of N content in grain were 12.16, 32.43 and 14.86%, respectively

Table (4): The mean values of N and protein contents in grain of wheat plant as affected by soil moisture content and K- fertilization rates.

Treatments			
Soil moisture content (of field capacity	Rate of K (kg K_2O/fed)	N content of grain, %	Grain protein content, %
30 %	0	1.19	6.79
	12	1.33	7.59
	24	1.58	9.06
	36	1.60	9.15
	48	1.72	9.82
Average		1.48	8.48
40%	0	1.74	9.97
	12	1.73	9.92
	24	1.48	8.49
	36	1.70	9.73
	48	1.65	9.44
Average		1.66	9.51
50 %	0	1.77	10.10
	12	1.73	9.89
	24	1.87	10.68
	36	1.51	8.66
	48	1.65	8.69
Average		1.96	9.66
60%	0	1.81	10.37
	12	1.77	10.12
	24	1.59	9.12
	36	1.56	8.92
	48	1.80	10.28
Average		1.70	9.76
Over all mean	0	1.63	9.30
	12	1.64	9.38
	24	1.63	9.34
	36	1.59	9.11
	48	1.68	9.63
Statistical significant $LSD_{0.05}$			
Soil moisture (M)		0.10	0.54
Potassium rates (K)		n.s.	n.s.
K x M		0.17	0.97

The corresponding increases of protein contents were 12.15, 13.92 and 15.09 %, for 40 %, 50 % and 60 % of field capacity soil moisture levels respectively as compared to the soil moisture at 30 % of field capacity. Similar results were reported by El-Monayeri *et al.*(1983), Hefni *et al.* (1983) and Dourgham (1991). Increasing soil moisture in the root zone may lead to increasing the free protein concentration and abcisic acid formation, which caused the stomata closure during the stress and reducing the photosynthesis activity and carbohydrate accumulation in the plant and then increased the nitrogen compounds concentration. Regarding the main effect of K fertilization on N or protein content in grain (Table 4), the data showed no significance response to K fertilization under the experimental conditions.

The interaction between soil moisture content and K fertilization rate was significant for N and protein contents in grains (Table 4). The highest values of N and protein contents in grains were recorded at 50 % of field capacity with 24 kg K_2O/fed., while the lowest value were recorded at 30 % of field capacity without K application.

Available potassium.

Table (5) shows that water soluble-K, exchangeable-K and available-K decreased significantly as a result of increasing soil moisture content from 30 to 60 % of field capacity. There was sensible decrease in the water soluble-K, exchangeable-K and available-K after using the irrigation treatments. Such behavior may be referred to the effective role of irrigation treatments on the solubility of K, soil chemical properties, plant growth and K uptake. The highest value of available-K was at the lower soil moisture level, while the lowest value was obtained at the higher soil moisture content.

Increasing potassium fertilization rates, from 12 to 48 kg K_2O/fed., led to a significant increase in water soluble-K, exchangeable-K and available-K under the current study (Table 5). The more pronounced significant increase has been detected after applying the 36 kg K_2O/ fed. rate. Also, Table (5) indicated that the interaction effect of soil moisture content and potassium fertilization rate led to a significant differences in water soluble-K, exchangeable K and available-K depending on the rate of K application and soil moisture content. The maximum value of available- K was recorded at 30 % of field capacity with 36 kg K_2O/fed., while the minimum value was recorded at 60 % of field capacity without potassium application. The highest value of exchangeable-K was recorded at 30 % of field capacity soil moisture with 24 kg K_2O/fed., but the lowest value was recorded for soil moisture at 60 % of field capacity without potassium. Maximum value of water soluble-K concentration was recorded at 30 % of field capacity soil moisture with 36 kg K_2O/fed while the minimum value was recorded at 40 % of field capacity soil moisture without potassium. These results are consistent with other results carried out under the current study conditions and cope with those stated by Mengel and Kirkby (1982), Glinski and Lipiec (1990) and Jones *et al.,* (2002).

The available-K linearly correlated with the K-fertilization rate for the different soil moisture contents (r = 0.85*, 0.98**, 0.93* and 0.97 for soil photosynthesis activity and carbohydrate accumulation in the plant and then increased the nitrogen compounds concentration. Regarding the main effect of K fertilization on N or protein content in grain (Table 4), the data showed no significance response to K fertilization under the experimental conditions.

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The available-K linearly correlated with the K-fertilization rate for the different soil moisture contents (r = 0.85*, 0.98**, 0.93* and 0.97 for soil moisture contents at 30, 40, 50 and 60 % of field capacity, respectively). The relation was very close at 60 % of field capacity soil moisture content. Also, the available-K (Y) was regressed against the soil moisture contents (X_1) and the K-fertilization rates (X_2). The regression equation for this relationship was:

$Y = 353.32 - 1.96 X_1 + 2.46 X_2$

R^2=0.78 (P<0.01)

Table (5): The mean values of water soluble, exchangeable and available-K (mg/kg soil) in soil as affected by soil moisture content and K-fertilization.

Treatments				
Soil moisture content (of field capacity	Rate of K (kg K_2O/fed)	Water soluble K	Exchangeable K	Available K
		(mg / kg soil)		
30 %	0	90.9	240.8	331.5
	12	92.4	278.3	370.9
	24	92.4	285.2	377.9
	36	133.4	248.3	381.4
	48	117.00	231.7	384.7
Average		105.34	256.85	369.28
40%	0	42.1	193.1	237.9
	12	44.1	210.1	254.3
	24	71.0	234.9	305.4
	36	101.4	269.2	370.5
	48	80.3	234.9	385.5
Average		68.46	228.43	310.7
50 %	0	48.0	217.5	267.5
	12	52.3	240.0	280.8
	24	64.7	219.8	284.7
	36	71.0	264.5	335.4
	48	71.0	226.6	397.6
Average		61.89	233.60	313.2
60%	0	45.6	187.0	232.8
	12	51.5	218.9	270.7
	24	58.9	235.4	294.5
	36	76.8	280.7	357.6
	48	77.6	281.4	359.2
Average		62.28	240.67	302.95
Over all mean	0	57.99	209.60	267.59
	12	60.23	236.83	297.06
	24	71.96	243.81	315.63
	36	95.70	265.69	361.38
	48	86.60	243.63	381.75
Statistical significant $LSD_{0.05}$				
Soil moisture (M)		5.57	16.06	17.09
Potassium rates (K)		7.35	15.57	18.95
K x M		14.70	31.13	37.92

The overall goal of this work is to find strategies that growers can improve the efficiency of K use while safeguarding the environment and for improving plant water content maintaining profitability. The findings obtained so far suggest that the available-K can be readily altered by adjusting the level of fertilizer K for improving the plant growth an yield of wheat especially under soil water stress conditions.

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الملخص العربي

تأثير التسميد البوتاسى والمحتوى الرطوبي على نبات القمح النامي في أرض جيرية ذات محتوى عالي من البوتاسيوم

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أجريت تجربة أصص خلال الموسم الشتوي ٢٠٠٣ / ٢٠٠٤ بكلية الزراعة – سابا باشا – جامعة الإسكندرية لدراسة تأثير التسميد البوتاسي والمحتوى الرطوبي على نبات القمح النامي في أرض محتواها عالي من البوتاسيوم. كان التصميم الإحصائي للتجربة هو القطع المنشقة بأربعة مكررات. وكانت معدلات التسميد البوتاسي صفر، ١٢، ٢٤، ٣٦ و٤٨ كجم بو٢أ / فدان. كما كانت مستويات الرطوبة في التربة ٣٠ ، ٤٠ ، ٥٠ و ٦٠ % من السعة الحقلية وذلك لدراسة تأثير التسميد البوتاسي على النمو والمحصول والمحتوى النيتروجيني لمحصول القمح وعلاقة ذلك بالمحتوى الرطوبي في التربة.

وقد أوضحت النتائج زيادة طول النبات ومحصول الحبوب ومحصول القش زيادة معنوية بزيادة المحتوى الرطوبي في التربة إلى ٦٠ % من السعة الحقلية. كما أوضحت النتائج زيادة محصول الحبوب بنسبة ١٣,٥٤ ، ١١,٤٦ ، ١٠,٤١ و ١١,٤٦ بزيادة مستوى التسميد البوتاسي من صفر إلى ١٢ ، ٢٤ ، ٣٦ و ٤٨ كجم بو٢أ / فدان على الترتيب وكانت أقصى قيمة لمحصول الحبوب عند مستوى ٢٤

كجم بو٢أ / ف ومحتوى رطوبي ٦٠ % من السعة الحقلية. وزيادة المحتوى الرطوبي في التربة إلى ٦٠ % من السعة الحقلية يزيد من تركيز النتروجين والفسفور و البوتاسيوم كما أدى إلى زيادة معنوية في النتروجين والفسفور والبوتاسيوم الممتص. وقد أدى زيادة التسميد البوتاسي إلى زيادة معنوية في تركيز البوتاسيوم والفسفور والبوتاسيوم الممتص وزيادة غير معنوية في تركيز البوتاسيوم والنتروجين والفسفور الممتص. وكان تأثير التفاعل بين المحتوى الرطوبي للتربة والتسميد البوتاسي غير معنوي على كلا من تركيز النتروجين والنتروجين الممتص في النبات.

وقد زاد المحتوى النتروجيني والبروتيني للحبوب بزيادة المحتوى الرطوبي إلى ٦٠ % من السعة الحقلية وكانت أعلى قيمة لهذا المحتوى في الحبوب عند محتوى رطوبي ٥٠ % من السعة الحقلية ومعدل تسميد بوتاسي قدره ٢٤ كجم بو٢أ / فدان . وقل البوتاسيوم الذائب والمتبادل والمتاح معنويا بزيادة المحتوى الرطوبي للتربة من (٣٠ – ٦٠ % من السعة الحقلية) ولكن زاد بزيادة إضافة السماد البوتاسي من ١٢ – ٤٨ كجم بو أ٢ / فدان زيادة معنوية وكانت أقصى قيمة للبوتاسيوم الذائب والمتاح عند محتوى رطوبي ٣٠ % من السعة الحقلية ومعدل تسميد بوتاسي ٣٦ كجم بو أ٢ / فدان. وقد ارتبط البوتاسيوم المتاح ارتباطا خطيا بمعدل التسميد البوتاسي عند مختلف مستويات المحتوى الرطوبي.

وتقترح هذه الدراسة أن مستوى البوتاسيوم المتاح في التربة يمكن أن يتغير بسهولة بتعديل مستوى التسميد البوتاسي لتحسين نمو ومحصول القمح خاصة تحت ظروف نقص المحتوى الرطوبي في التربة.