Zagazig J. Agric. Res., Vol. 32 No. (3) 2005 739 - 766

GROWTH, PLANT WATER RELATIONS AND CHEMICAL CONSTITUENTS OF POTATO PLANTS AS AFFECTED BY WATER QUANTITY AND SOME ANTITRANSPIRANTS UNDER SANDY SOIL CONDITIONS

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Accepted 6 / 4 / 2005

ABSTRACT : Two field experiments were carried out during two successive summer seasons of 2001 and 2002 at El-Khattara Experimental Farm, Fac. Agric., Zagazig Univ. on potato crop, to investigate the effect of water quantity and some antitranspirants (AT's); i.e., Kaolin at 4 and 6% , white wash ($CaCO_3$) at 4 and 6% and KCl at 1% as well as their interactions on plant growth, dry weight , plant water relations, leaf pigments, minerals content and their uptake/plant.

Water quantity at 2000 m^3/*fed* and Kaolin or $CaCO_3$ at 6% each showed enhancing effect on plant growth, dry weight, free and total water in leaf tissues as well as minerals concentrations and their uptakes. Meanwhile, chlorophylls, bound water and prolein were at their maximum values under water stress (500 m^3/*fed*). The interaction between Kaolin or $CaCO_3$ at 6% each and irrigation water at 2000 m^3/*fed* enhanced plant growth, dry weight/plant and both free and total water in leaf tissues. Spraying with AT (KCL) increased K concentration and its uptake.

Key words: Potato, water quantity, antitranspirants, prolein content, water stress.

INTRODUCTION

Potato (*Solanum tuberosum* L.) is, generally, enlisted as promising crop for both local consumption and exportation. It is one of the major and most important vegetable crops in Egypt. The cultivated area of potato during 2001 and 2002 were 189,764 and 196,640 feddans with total yield of 1,903,134 and 1,985, 317 tons, respectively.

Water quantity is considered as one of the main factors that greatly affect plant growth of potato particularly under sandy soil conditions. This may be due to that, sandy soil is very poor in its ability to preserve water against leaching. This soil, on the other hand, had a suitable texture for potato tubers growth and formation.

Application of some AT's became now as a practice to reduce water loss through evaporation and transpiration.

Increasing water supply increased plant height and dry weight of potato plants (Hang and Miller, 1986; Abdel-Razik, 1996; El-Banna *et al.*, 2001; Gameh *et al.*, 2000) and increased tuber dry weight (Foti *et al.*,1995).

Plant height, number of branches /plant, dry weight/plant, total and free water (%) in leaf tissues, N,P and K contents in plant tissues and their uptakes by potato plant cv Spunta increased with increasing soil moisture content (irrigation after the depletion of 20 % of available soil moisture), whereas chlorophyll a, b, and bound water and osmotic pressure in leaf tissues increased with reducing soil moisture content; irrigation after the depletion of 80 % of available soil moisture (Abdel-Rheem,2003).

Water stress reduced plant height and plant biomass (Chen *et al.*,1990; Jerez *et al.*, 1991; Nagarajan and Bansal,1991; Costa *et al.*, 1997), and reduced photosynthesis of potato plants (Costa *et al.*, 1997).

Spraying plants with Kaolin at 6% increased plant height and number of branches /plant of lentil, (Murari and Pandey, 1985) or at 4% increased plant dry weight of wheat (Upadhyaya and Mathur, 1992).

Spraying Roselle plants with calcium carbonate at 6% produced the highest values of plant height, number of branches /plant, leaf area and dry weight/plant (Mahfouz, 1997).

Foliar spray of plants with white wash ($CaCO_3$) at 6% increased plant height, number of branches /plant and leaf area (Malash and Gawish,1990 on cowpea; Gawish, 1992 on snap bean; Gawish, 1997 on potato), increased N and K in leaves (Gawish,1992) on snap bean and increased N,P and K in leaves (Gawish and Fattahallah, 1997 on Taro). Also, white wash at 6% increased relative water content in leaves of snap bean (Gawish, 1992).

In water–stressed plants of brinjal, the number of leaves/plant was reduced from 18.25in unsprayed plants to 17.5,17.25 and 13.25 in plants sprayed with lime wash, potassium chloride and chlormequate, respectively (Prakash *et al.*,1993).

Moftah (1997) found that white wash at 6% improved growth characters of soybean particularly at the lower irrigation levels.

In this respect, the supply of a suitable irrigation water quantity (economic rate) and the superior AT's to overcome the problems of poor sandy soils. Therefore, this work aimed to investigate the effect of water quantity and some AT's on plant growth, plant water relations and plant chemical constituents.

MATERIALS AND METHODS

Two field experiments were conducted out during two successive summer seasons of 2001 and 2002 at El-Khattara Experimental Farm, Fac. Agric., Zagazig Univ., Sharkia Governorate, to study the effect of irrigation water quantity and AT's on growth, plant water relations and plant chemical constituents under sandy soil conditions using drip irrigation system .

The physical and chemical analyses of the experimental soil , farmyard manure as well as irrigation water are presented in Tables 1a, 1b and 1c.

The monthly mean temperature, relative humidity and rain quantity during summer seasons of 2001 and 2002 are presented in Table 2.

This experiment included 24 treatments, which were the combinations between four irrigation water quantities and six AT's as follows:

Table 1a: The physical and chemical properties of the experimental soil

Soil properties	1st season	2nd season
Physical properties :		
Sand (%)	96.29	96.72
Silt (%)	2.40	1.15
Clay (%)	1.31	2.13
S.P.	14.2	14.3
F.C. (%)	7.1	7.7
W.P. (%)	2.9	2.8
Texture	Sandy	Sandy
Chemical properties:		
pH	8.21	8.16
E.C. (mmhos/cm)	2.08	1.99
O.M. (%)	0.04	0.06
Total N (%)	0.02	0.03
Available N (ppm)	4.11	3.88
Available P (ppm)	3.16	3.46
Available K (ppm)	10.66	9.81

O.M.: Organic matter, S.P.: Saturation percentage; F.C.: Field capacity; W.P.: Wilting point; and E.C.: Electric conductivity. Soil samples were taken from 25 cm soil surface.

Table 1b: The chemical properties of farmyard manure

Chemical properties	1st season	2nd season
pH	7.11	6.99
OM %	13.66	12.97
Total N %	0.58	0.63
Available N (ppm)	299	311
Available P (ppm)	46	43
Available K (ppm)	1080	1113

O.M. : Organic matter

Table 1c:Analysis of irrigation water

Characters		Values
EC	dsm^{-1}	1.41
pH	g.ionH/l	8.03
Ca^{++}	mol/l	1.22
Mg^{++}	mol/ l	1.09
Na^{+}	mol/ l	12.20
K^{+}	mol/ l	0.12
$SO_4^{=}$	mol/ l	1.43
$CO_3^{=}$	mol/ l	0.00
Cl^{-}	mol/ l	5.79
HCO_3^{-}	mol/ l	7.39
SAR	mol/ l	11.40

E.C. : Electric conductivity

Table 2: The monthly mean air temperature, relative humidity and rain quantity during the two summer seasons

Month	First season			Second season		
	Temperature (^{0}C)	Relative humidity (%)	Rain (mm)	Temperature (^{0}C)	Relative humidity (%)	Rain (mm)
Jan.	13.13	65.13	0.00	12.73	69.66	0.075
Feb.	14.08	59.31	0.00	15.36	64.91	0.450
Mar.	19.51	61.21	0.05	17.84	57.58	0.025
Apr.	21.35	54.32	0.30	20.16	54.48	0.026
May.	24.90	51.57	0.00	24.14	53.46	0.000
Jun.	29.72	54.19	0.00	26.88	54.79	0.000

a-Water quantities (m^3 */fed*) ; 500, 1000, 1500 and 2000 m^3/ feddan.

b. AT's; unsprayed (check), Kaolin (aluminum silicate) at 4%, and 6%, calcium carbonate (white wash) at 4% and at 6% and potassium chloride at 1%.

These treatments were arranged in a split plot design with three replicates .The water quantities were randomly arranged in the main plots and AT's were randomly distributed in the sub plots.

All experimental units received equal amounts of water during germination (100m^3water/*fed.)* The irrigation treatments started 30 days after planting and were added by two days intervals. The water was added using water counter and pressure gauge at 0.5 bar.

The amounts of added water at different treatments were calculated and expressed in terms of time based on the rate of water flow through the drippers (2 L/h.) to give such amounts of water. The irrigation treatments were stopped 15 days before harvesting time.

Irrigation numbers, the time (min.) and water quantity (m^3) in every irrigation are shown in Schedule 1.

Tuber seeds of potato cultivar (Diamont) was sown on January 15th, in summer in both seasons at 20 cm apart.

Schedule 1: The time (minute) and amounts of applied irrigation water (m^3/*fed* as well as /plot) in every irrigation during the growth period of potato via dripper lines with discharge of 2 L/h for dripper at 0.5 bar

Water quantity (m^3/*fed*)	Irrigation numbers	Irrigation time in every irrigation (min.)	Water quantity (m^3/*fed*) / in every irrigation	Water quantity (m^3/plot) /12.6 m^2 in every irrigation
500	36	21	13.88	0.04164
1000	36	42	27.77	0.08331
1500	36	63	41.66	0.12498
2000	36	84	55.55	0.16650

Potato plants were sprayed by the AT's solutions at 50 and 70 days after planting. AT's were applied using a hand pressure sprayer. Distilled water was used to dilute oll AT's. Plants were sprayed with a fine mist of AT's till run- off, with care being taken to cover oll plant parts. Control plants were sprayed with distilled water. Each plot received 2L aqueous solution of AT's using spreading agent (reflecting materials). The untreated (check) were sprayed with distilled water and spreading agent (reflecting).

The experimental plot area was 12.6 m^2. It contains three dripper lines with 6m length each and 70 cm distance between each two dripper lines. One line was used to measure the vegetative growth parameters and the other two lines were for yield determination. In addition, one row was left between each two experimental plots as a guard area to avoid the overlapping infiltration of irrigation or spraying solutions.

All experimental units received equal amounts of commercial fertilizers (kg/*fed*) at the rates of 120 kg N, 80 kg P_2O_5 and 100 kg K_2O as ammonium sulfate (20.6 % N), triple superphosphate (37 % P_2O_5) and potassium sulfate (48 % K_2O), respectively. One third of the commercial fertilizers was added at soil preparation along with FYM (40 m^3 /*fed*). The rest of commercal fertilizers (two thirds) were added as fertigation by 7 days

intervals beginning one month after planting.

The normal agricultural practices were carried out as commonly followed in the district.

Data Recorded

1. Growth parameters

A random sample of five plants was taken from every plot at 90 days after planting, in both seasons of study, for measuring the growth characters of potato plants expressed as follows: Plant height (cm), number of main stems / plant, number of leaves / plant, dry weight of roots / plant, dry weight of shoots / plant, total dry weight (roots + shoots), number of tubers / plant, and weight of tubers /plant.

2. Dry matter (%)

One hundred grams of the grated mixture were dried at 105 ^{0}C till constant weight and DM (%) was recorded.

3. Photosynthetic pigments

Disc sample from the fourth upper leaf of potato plant was randomly taken from every experimental unit 90 days after planting, in the two growing seasons, to determine chlorophyll a and b as well as total chlorophyll (a+b), according to the method described by Wettestein (1957).

4. Plant water relations

Total, free and bound water in the fourth leaf of potato plants were determined for every experimental unit at 90 days after planting, in bothseasons, according to the method described by Gosev (1960).

5. Plant chemical composition

a. Contents of N, P and K

The dry matter of aerial parts 90 days after planting were finely ground and wet digested for N,P and K determination. Total nitrogen, phosphorus and, potassium were determined according to the methods described by Bremner and Mulvaney (1982), Olsen and Sommers (1982) and Jackson (1970), respectively.

b. Proline amino acid content

This amino acid was determined in potato leaves at 90 days after planting in both seasons of study according to Bates (1973).

Statistical Analysis; the data of this experiment were subjected to proper statistical analysis of variance according to Snedecor and Cochran (1980) and mean separations were done according to LSD at 5 % level.

RESULTS AND DISCUSSION

Plant Growth

a. Effect of water quantity

Data presented in Table 3 show that water quantity significantly affected the vegetative growth characters and dry weight of different parts /plant, except number of aerial stems and root dry weight /plant in the first and second seasons, respectively. In addition, water quantity reflected significant effect on tubers weight in both seasons and number of tubers/plant in second season only. Increasing water quantity levels, in general, significantly increased the plant growth characters, the dry weight of different parts and total /plant, and weight of tubers / plant. The highest water quantity; i.e., 2000 m^3/*fed* came in the first rank in this respect. This treatment was the most superior one for enhancing plant growth and dry weight of potato plant. It is seen also, from the same data, that all the plant growth characters and dry weight of different plant parts and total dry weight /plant were at the lowest values under water stress; i.e.,500 m^3/*fed* in both seasons.

It could be suggested that increasing water quantity applied to potato plant led to keep higher moisture content in the soil and this in turn might favoured the plant metabolism that leads to increase the plant growth characters and to produce higher dry matter . Water stress, on the other hand, led to cause a reduction in the uptake of nutritional elements that might causes a disturbance in the physiological processes need for plant growth (Salter and Goode, 1967).

Water stress also affects carbohydrate metabolism, protein synthesis and the activities of many enzymes that may reflect a change in the balance between rates of synthesis and degradation leading to decrease in plant growth and dry matter accumulation (Hamlyn, 1986).

On the other hand, Marschner (1995) reported that, under sufficient water conditions, there were decrease in ABA and increase in CYT, GA and IAA reflecting good growth and dry matter content.

Obtained results are in harmony with those reported by Hang and Miller (1986), Chen *et al.* (1990), Jerez *et al.*(1991), Nagarajan and Bansal (1991), Foti *et al.* (1995), Abdel-Razik (1996),

Costa *et al.* (1997)), Gameh *et al.* (2000), El-Banna *et al.* (2001) and Abdel-Rheem (2003).

b. Effect of antitranspirants (AT's)

Data in Table 4 reveal that AT's had signif-icant effect on vegetative growth and dry weight of potato plant parts and total dry weight per plant, except number of aerial stems and tuber dry matter perce-ntage in the first season only. In addition, AT's reflected significant effect on both number and weight of tubers/ plant 90 days after planting.

Application of AT's ; i.e., Kaolin and $CaCO_3$ showed, in general, favourable effect on stem length, number of leaves/ plant and weight of tubers/plant when compared with control.

It is evident from the same data in Table 4 that AT's were different in their effects on plant growth characters and dry weight. Where Kaolin and $CaCO_3$ both at 6% were the superior treatments regarding stem length and number of leaves/plant without significant difference between them. Spraying plants with either Kaolin solution at 6% or KCl at 1% gave the highest dry weight values of roots, shoots and total/plant without significant difference between them. Such results were true in the first season only. Whereas, in the second season, the highest values of roots dry weight, shoots and total dry weight/plant were obtained after spraying plants with KCl at 1%, Kaolin at 6% and $CaCO_3$ at 4%, respectively.

It could be suggested that foliar spray with AT's ; i.e., Kaolin and $CaCO_3$ led to reduce the transpiration rate, and this in turn led to keep higher water content in the plant tissues and hence might favoure the plant metabolism, the physiological processes, photosynthetic rate, carbohydrate metabolism and many other important functions that directly affect plant growth.

Increases in growth resulted from AT's treatments were attributed primarily to their effect on increasing plant water potential at a time when the growth of that particular plant part was more dependent on water status than on photosynthesis (Boyer, 1970).

The reduction in transpiration by reflecting material such as white wash was reported to be due to increase in the reflectivity of incident radiation as especially in the visible region, this would lead

to reduction of net energy uptake, lower temperature and subsequently decrease in transpiration rate (Abou-Khaled *et al.*,1970).

Obtained results are agreeable with those reported by Murari and Pandey (1985), Upadhyaya and Mathur (1992) with respect to Kaolin; Mahfouz (1997), Malash and Gawish (1990), Gawish (1992, 1997), and Gawish and Fattahallah (1997) with respect to white wash ($CaCO_3$).

c. Interaction effect (water quan-tity x antitranspirants)

Illustrated data in Table 5 indicate that the interaction between water quantity and AT"s had significant effect on vegetative growth and dry weight of potato plant 90 days after planting, except number of aerial stems and number of tubers/ plant as well as weight of tubers/plant, in the first season, and stem length , number of both leaves and tubers/plant in the second one.

The effect of AT's, in general, was more pronounced under the highest level of applied water. It is also clear that the interaction between water quantity at 2000 m^3 */fed* and Kaolin at 6% was the superior one regarding stem length, number of leaves/plant, total dry weight/plant and weight of tubers /plant.

As it has been mentioned above, higher water quantity applied to plants, besides treating with AT"s led to keep more water content in plant tissues due to lowering evaporation and transpiration rates, and this in turn led to enhance and favour the growth rate, photosynthesis and enzymes activities that finally led to increase dry matter (total dry weight / plant).

In this connection, Prakash *et al.* (1993) reported that number of leaves/plant is reduced in water stressed plants of brinjal sprayed with lime wash or potassium chloride compared with unsprayed. Also, Moftah (1997) found that white wash at 6% improved growth characters of soybean particularly at the lower irrigation levels.

2. Plant Water Relations and Prolein Content

a. Effect of water quantity

As for the effect of water quantity, it is obvious from the data in Table 6 that increasing water quantity applied to potato plants up to the highest used level (2000 m^3*/fed*) significantly

enhanced both free and total water (%) in potato leaf tissues. Similarly, irrigation with 1500 m^3/*fed* significantly increased both free and total water in leaf tissues without significant differences between 1500 and 2000 m^3/*fed*, in case of free water, in first season only. In this connection, 2000 m^3/*fed* was superior and came in first rank, followed by 1500 m^3/*fed*, which came in the second rank.

Concerning bound water (%), maximum values were obtained under water stress or irrigation with 500 m^3/*fed* and this trend was opposite to that of free or total water percentages. Meanwhile, prolein amino acid content in leaf tissues was at the highest value under lower values of applied water (500 or 1000 m^3/*fed*). In other words, the highest the applied water quantity to the plants, the highest the free and total water content, and the lowest the bound water and prolein content in leaf tissues, and vice versa under water stress. Thus, prolein content in leaf tissues can be considered as an indicator for water stress.

It has been reported that prolein oxidation proceeds readily in turgid tissues, and this process stimulated by higher concentration of prolein. This suggests that prolein oxidation could function as a control mechanism for maintaining low cellular levels of prolein in turgid cells. However, prolein oxidation is reduced to negligible rate under water stress. It seems likely that, inhibition of prolein oxidation is necessary in maintaining high levels of prolein found under water stress (Stewart, 1977).Moreover, the increase in bound water and the decrease in free water under water stress was mainly due to the increases in cell sap concentration and its osmotic pressure resulted from the convertion of starch into soluble carbohydrates (Lancher, 1993).

These results agree with those reported by Abdel-Rheem,(2003) with respect to free, bound and total water (%)in leaves tissues.

a. Effect of antitranspirants (AT's)

Data in Table 6 reveal that different used AT's reflected significant effect on plant water relations and prolein content in potato leaf-tissues.

It is obvious from the same data that both free and total water were at the highest level after spraying with either Kaolin or

$CaCO_3$ at 6%. However, Kaolin seemed to be the superior one compared to all other treatments. It also clear that, both Kaolin and $CaCO_3$ at 4% each, and KCl at 1% were more or less similar in their effects on both free and total water (%). Whereas, the effect of AT's on both bound water and prolein amino acid content was opposite to that of their effects on both free and total water. Thus, it could be concluded, from such data in Table 6, that the AT's treatments which showed maximum content of free and total water showed in the meantime the least values of bound water and prolein content. The plants that received no AT's attained maximum values of bound water and prolein content.

The decrement in the amount of prolein in leaf tissues after spraying with AT's may be attributed to that AT's led to decrease water loss from plants through evaporation and transpiration, and this in turn increase the amount of water content in the tissues, resulting in decrease in prolein content.

Similar findings were reported by Gawish (1992) on snap bean, who found that white wash ($CaCO_3$) at 6% increased relative water content in leaves.

c. Interaction effect (water quantity X antitranspirants)

With respect to the interaction between water quantity and AT's, it is evident from the data in Table 7 that all plant water relations; i.e., free, bound and total water (%) as well as prolein amino acid content were significantly affected by the interaction treatments.

It is quite clear that treating potato plants with Kaolin or $CaCO_3$ at 6% each were the superior under all irrigation water quantities when compared with other interaction treatments regarding both free and total water content in the leaf tissues. Meantime, the highest values of both free and total water were obtained after spraying plants with Kaolin and /or $CaCO_3$ at 6%each under higher levels of irrigation water applied (1500 or 2000 m^3/ *fed*). However, the lowest values were obtained when plants received no AT's (distilled water) under the lowest irrigation water quantity (500m^3/*fed*).

As for bound water (%) and prolein amino acid content, it is quite clear that both the two traits were at the highest level when plants received no AT's (sprayed with distilled water) under low

irrigation water quantity 500 or 1500 m^3/*fed* when compared with other interaction treatments. Meantime, spraying with distilled water under 500 m^3/*fed* irrigation water quantity was the superior one. It is of great interest to notice that, spraying plants with Kaolin and /or $CaCO_3$ at 6% each recorded the lowest values of both bound water and prolein content especially under 1500 m^3/*fed* irrigation water quantity.

Thus, it could be concluded that plants that received no AT's under water stress (500 m^3/*fed*) showed lower free and total water and higher bound water and prolein amino acid contents in leaf tissues.

3. Photosynthetic Pigments and NPK Content and Uptake / Plant

a. Effect of water quantity

Regarding photosynthetic pigments, they were significantly affected by irrigation water quantity as shown in Table 8. More intensive leaves were observed under lower water quantity levels; i.e., 500 m^3/*fed*. Moreover, as increasing water quantity applied to plants, the chlorophyll content decreased because both of free and total water in the leaf tissues were higher under the highest water quantity level (2000 m^3/*fed*) as shown in Table 6. Whereas, low water quantity applied to potato plants resulted in lowering the water content in leaf tissues, and this in turn increased the intensity of the chlorophylls of leaves.

As for NPK contents and uptake by aerial parts, it is evident from the data illustrated in Table 8 that water quantity reflected significant effect on N,P and K contents and their uptake/plant, except N content in the first season.

The highest level of water quantity (2000 m^3/*fed*), in general, showed enhancing effect on minerals concentrations, while they were minimum under water stress (500 m^3/ *fed*). That was true in the first season, but the effect was not so in the second one. Nitrogen, P and K uptakes/plant were enhanced by increasing applied water quantity level up to 1500 m3/*fed* and the uptake of nitrogen, phosphorus and potassium were minimum under water stress (500m^3/*fed*).

As it was previously mentioned, increasing the applied water to the soil increased the

moisture content that makes minerals more available to the plant, factor that led to enhance mineral concentration and their uptake .These results agree with those reported by Abdel- Rheem (2003) with respect to N, P and K contents and uptake /plant.

b. Effect of antitranspirants (AT's)

Data in Table 9 reveal that AT's had significant effect on leaf pigments (chlorophyll a, b, and (a+b) and NPK concentrations as well as their uptake/plant. It is quite clear that leaf pigments contents were maximum after spraying plants with either Kaolin or $CaCO_3$ at 6% each without significant differences between them. That was true in both seasons. In addition, spraying potato plants with 1% KCl enhanced chlorophyll content in leaves. This enhancing effect of KCl on photosynthetic pigments may be due to that potassium plays an important and vital role in promoting the assimilation rate of CO_2 and photosynthetic capacity (Mengel and Kirkby, 1978). While minimum values, in general, were obtained after spraying with distilled water.

As for NPK concentrations as well as their uptake in aerial parts, however results reflected significant effect, but the values were not fixed and flactuated between the two seasons. In addition, K concentration as well as its uptake/ plant were maximum after spraying with 1% KCl compared with other treatments. It is also clear, in the second season, that the uptake of the three elements was favoured after spraying with Kaolin at 6% and $CaCO_3$ at 4% without significant differences between them.

In this connection, spraying plants with white wash ($CaCO_3$) at 6% increased N,P and K in leaves (Gawish,1992 on snap bean and Gawish and Fattahallah, 1997 on Taro).

c. Interaction effect (water quantity X antitranspirants)

The results in Table 10 indicate that the uppermost values of chlorophylls were obtained after treating with AT's under water stress, while the lowermost values, in general, were obtained with AT's under the highest level of irrigation water; i.e., 2000 m^3/*fed.* However, such effect did not reach the level of significance.

Moreover, it is of great interest to notice that the interaction between KCl at 1% and water quantity at different levels

showed enhancing effect on chlorophyll. Furthermore, Kaolin and /or $CaCO_3$ at 6% each under all levels of irrigation water showed the same trend to that of KCl at 1%.

The interaction treatments did not reflect any significant effect on minerals concentrations and their uptake/plant.

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Table 3: Effect of water quantity on vegetative growth and dry weight of potato plant 90 days after planting

Treatment	Stem length (cm)	Number/plant		Dry weight/ plant (gm)			Tuber dry matter (%)	Number of tubers/ plant	Fresh weight of tubers/ plant (gm)
		Aerial stems	leaves	Root	Shoot	Total			
Water quantity m^3/*fed*					**2001 season**				
500	23.19	2.86	28.18	4.48	25.35	29.83	17.90	8.49	295.02
1000	26.60	3.12	29.82	4.49	27.27	31.76	18.08	8.75	345.80
1500	27.32	3.31	28.79	4.81	27.96	32.77	18.26	8.53	399.59
2000	30.15	3.34	31.64	5.05	31.79	36.84	18.19	8.22	438.82
LSD at 0.05 level	2.98	NS	1.73	0.22	1.24	1.78	NS	NS	18.94
					2002 season				
500	17.93	2.56	17.58	4.21	21.51	25.72	18.51	6.90	314.22
1000	19.36	2.93	18.55	4.21	26.10	30.31	18.48	7.34	352.66
1500	20.52	2.40	21.71	4.58	26.63	31.21	18.62	7.58	418.50
2000	20.82	2.88	25.87	4.76	26.06	30.82	17.76	6.86	486.88
LSD at 0.05 level	1.59	0.31	1.07	NS	1.42	1.65	NS	0.40	13.37

Table 4: Effect of antitranspirants on vegetative growth and dry weight of potato plant 90 days after planting

Treatment	Stem length (cm)	Number/ plant		Dry weight /plant (gm)			Tuber dry matter (%)	Number of tubers/ plant	Fresh Weight of tubers/plant (gm)
		Aerial stems	leaves	Root	Shoot	Total			
Antitranspirants						**2001 season**			
Unsprayed (Check)	23.33	3.13	27.30	4.60	27.44	32.04	18.14	8.97	292.91
Kaolin 4%	25.76	3.08	28.82	4.30	29.42	33.72	18.44	8.61	360.08
Kaolin 6%	28.78	3.30	32.59	4.98	29.41	34.39	17.80	8.05	426.96
$CaCO_3$ 4%	25.66	3.24	29.15	4.70	26.41	31.11	18.24	8.65	364.39
$CaCO_3$ 6%	30.56	3.21	31.10	4.08	27.17	31.25	17.87	7.91	407.54
K Cl 1%	25.90	2.99	28.70	5.59	28.72	34.31	18.15	8.80	366.98
LSD at 0.05 level	1.47	NS	1.56	0.47	1.29	1.72	NS	0.45	17.18
						2002 season			
Unsprayed (Check)	17.36	2.55	18.65	4.34	25.95	30.29	18.27	8.49	342.75
Kaolin 4%	19.51	3.10	21.09	4.12	23.58	27.70	18.64	8.16	378.91
Kaolin 6%	21.66	2.89	22.71	4.63	29.31	33.95	18.69	6.27	447.83
$CaCO_3$ 4%	19.23	2.54	20.25	4.45	28.37	32.83	17.89	6.63	375.66
$CaCO_3$ 6%	20.86	2.35	22.22	3.74	20.67	24.41	17.90	6.30	437.00
K Cl 1%	19.50	2.72	20.65	5.35	22.58	27.93	18.67	7.19	376.25
LSD at 0.05 level	1.77	0.42	2.04	0.68	1.87	2.06	0.75	0.55	9.13

Table 5: Effect of interaction between water quantity and antitranspirants on vegetative growth and dry weight of potato plant 90 days after planting

Water quantity m^3/*fed*	Antitranspirants		Stem length (cm)	Number/ plant: Aerial stems	Number/ plant: leaves	Dry weight/plant (gm): Root	Dry weight/plant (gm): Shoot	Dry weight/plant (gm): Total	Tuber dry matter (%)	Number of tubers/ plant	Fresh weight of tubers/plant (gm)
						2001 season					
500	Unsprayed (Check)		17.96	2.77	25.20	4.40	21.91	26.31	18.72	9.22	223.94
	Kaolin	4%	20.30	2.55	26.63	3.85	29.25	33.10	18.44	8.66	283.95
	Kaolin	6%	26.63	3.44	30.63	3.37	27.23	30.60	16.90	7.99	335.40
	$CaCO_3$	4%	20.66	2.88	26.55	4.84	23.16	28.00	18.82	8.33	285.28
	$CaCO_3$	6%	31.36	2.77	31.36	4.87	24.34	29.21	17.31	7.77	327.53
	K Cl	1%	22.71	2.77	28.71	5.57	26.24	31.81	17.24	9.00	314.00
1000	Unsprayed (Check)		22.90	2.77	26.72	3.64	27.97	31.61	17.13	9.66	280.81
	Kaolin	4%	24.72	2.88	29.43	3.90	28.01	31.91	19.49	8.44	314.87
	Kaolin	6%	28.45	3.22	32.60	4.74	28.88	33.62	17.95	8.44	420.97
	$CaCO_3$	4%	28.34	3.33	28.76	6.22	27.22	33.44	18.14	9.18	323.56
	$CaCO_3$	6%	29.50	3.10	32.36	3.83	24.90	28.73	16.63	8.44	396.90
	K Cl	1%	25.69	3.44	29.09	4.62	26.66	31.28	19.15	8.33	337.70
1500	Unsprayed (Check)		24.78	3.55	28.11	5.31	28.33	33.64	17.50	8.99	324.66
	Kaolin	4%	27.64	3.55	29.21	4.41	28.56	32.97	17.99	8.66	396.13
	Kaolin	6%	28.57	3.44	33.12	6.01	28.96	34.97	17.61	7.88	445.00
	$CaCO_3$	4%	27.38	3.44	29.66	3.53	25.64	29.17	18.93	9.11	408.29
	$CaCO_3$	6%	29.30	2.99	26.71	3.69	27.80	31.49	19.27	7.55	432.24
	K Cl	1%	26.28	2.88	25.94	5.91	28.50	34.41	18.24	8.99	391.25
2000	Unsprayed (Check)		28.17	3.44	29.17	5.03	31.58	36.61	19.23	8.00	342.24
	Kaolin	4%	30.40	3.33	30.02	5.05	31.86	36.91	17.84	8.66	445.35
	Kaolin	6%	34.48	3.10	34.00	5.80	32.56	38.36	18.74	7.88	506.47
	$CaCO_3$	4%	29.81	3.33	31.66	4.20	29.62	33.82	17.09	8.00	440.42
	$CaCO_3$	6%	32.10	3.99	33.97	3.93	31.66	35.59	18.27	7.88	473.51
	K Cl	1%	28.93	2.88	31.04	2.77	33.46	36.23	17.98	8.88	424.97
LSD at 0.05 level			2.93	NS	3.12	0.94	2.59	3.43	1.06	NS	NS

Table 5: cont.

Water quantity m^3/*fed*	Treatment		Stem length (cm)	Number/ plant: Aerial stems	Number/ plant: leaves	Dry weight/plant (gm): Root	Dry weight/plant (gm): Shoot	Dry weight/plant (gm): Total	Tuber dry matter (%)	Number of tubers/ plant	Fresh weight of tubers/plant (gm)
	Antitranspirants						2002 season				
500	Unsprayed (Check)		14.63	2.10	14.16	4.07	25.45	29.52	18.66	9.66	246.00
	Kaolin	4%	17.80	3.06	17.70	3.49	22.87	26.36	19.07	6.99	295.33
	Kaolin	6%	20.90	2.10	19.93	3.04	17.24	20.28	18.83	6.44	381.66
	$CaCO_3$	4%	17.10	2.53	16.86	4.53	22.56	27.09	17.46	5.77	289.33
	$CaCO_3$	6%	19.50	2.50	19.36	4.53	19.39	23.92	18.83	5.33	374.33
	K Cl	1%	17.70	3.06	17.50	5.61	21.55	27.16	18.21	7.21	298.66
1000	Unsprayed (Check)		17.16	2.93	15.50	3.32	32.49	35.81	17.40	8.99	300.00
	Kaolin	4%	19.20	3.43	18.26	3.56	24.93	28.49	19.60	8.77	333.66
	Kaolin	6%	21.26	3.76	20.66	4.39	29.11	33.50	18.92	6.66	413.33
	$CaCO_3$	4%	19.26	2.00	17.90	6.25	32.37	38.62	18.13	6.22	333.33
	$CaCO_3$	6%	20.43	2.20	20.40	3.48	15.68	19.16	17.67	6.11	404.33
	K Cl	1%	18.86	3.30	18.60	4.26	22.06	26.32	19.15	7.33	331.33
1500	Unsprayed (Check)		18.03	2.10	20.43	4.97	25.07	30.04	18.65	7.88	381.66
	Kaolin	4%	20.10	2.73	21.93	4.74	21.15	25.89	18.09	8.44	410.00
	Kaolin	6%	22.60	2.73	22.86	5.67	37.64	43.31	18.51	6.66	463.33
	$CaCO_3$	4%	20.33	2.10	21.40	3.18	25.54	28.72	18.91	7.44	408.33
	$CaCO_3$	6%	21.33	2.53	22.40	3.35	28.50	31.85	18.31	7.77	446.00
	K Cl	1%	20.73	2.20	21.26	5.57	21.89	27.46	19.28	7.33	401.66
2000	Unsprayed (Check)		19.63	3.10	24.50	5.02	20.78	25.80	18.37	7.44	443.33
	Kaolin	4%	20.96	3.20	26.46	4.69	25.37	30.06	17.78	8.44	476.66
	Kaolin	6%	21.90	2.96	27.40	5.95	33.26	39.21	18.53	5.33	533.00
	$CaCO_3$	4%	20.23	3.53	24.86	3.84	33.03	36.87	17.08	7.10	471.66
	$CaCO_3$	6%	21.46	2.20	26.73	3.59	19.10	22.69	16.78	5.99	523.33
	K Cl	1%	20.73	2.33	25.26	5.95	24.82	30.77	18.03	6.88	473.33
LSD at 0.05 level			NS	0.84	NS	1.36	3.73	4.12	1.51	NS	18.26

Table 6: Effect of water quantity and some antitranspirants on the plant water relations (%) and prolein amino acid content in potato leaf tissues 90 days after planting

Treatments	2001 season				2002 season			
	Free water	Bound water	Total water	Prolein Content (mg/gm DW)	Free water	Bound water	Total water	Prolein content (mg/gm DW)
Water quantity (m^3/*fed*)	**Effect of water quantity (m^3/*fed*)**							
500	34.97	45.66	80.63	4.30	43.02	37.89	80.91	8.33
1000	40.92	43.58	84.50	5.03	48.14	34.54	82.68	7.26
1500	43.64	42.41	86.05	2.48	52.84	32.45	85.29	4.21
2000	43.66	43.23	86.89	2.53	54.82	31.78	86.60	5.82
LSD at 0.05 level	0.28	0.21	0.49	0.19	0.20	0.27	0.41	0.42
Antitranspirants	**Effect of some antitranspirants**							
Unsprayed (Check)	37.26	45.75	83.01	6.16	46.00	36.12	82.12	8.67
Kaolin 4 %	40.38	44.01	84.39	3.87	48.74	34.78	83.52	6.04
Kaolin 6%	43.27	42.74	86.01	2.23	51.83	33.52	85.35	4.42
$CaCO_3$ 4%	40.46	43.75	84.21	4.33	49.59	33.82	83.41	6.47
$CaCO_3$ 6%	42.82	42.81	85.63	2.53	52.51	32.86	85.37	4.90
K Cl 1%	40.60	43.29	83.89	2.39	49.57	33.84	83.41	7.94
LSD at 0.05 level	0.45	0.59	0.33	0.30	0.49	0.42	0.87	0.43

Table 7: Effect of interaction between water quantity and some antitranspirants on the plant water relations (%) and prolein amino acid content in potato leaf tissues 90 days after planting

Treatments			2001 season				2002 season			
Water quantity (m^3/*fed*)	Antitranspirants		Free water	Bound water	Total water	Prolein content (mg/gm DW)	Free water	Bound water	Total water	Prolein content (mg/gm DW)
500	Unsprayed (Check)		30.33	48.23	78.56	7.74	37.15	41.95	74.10	13.23
	Kaolin	4%	34.14	46.28	80.42	5.57	42.98	37.35	80.33	8.20
	Kaolin	6%	37.33	45.33	82.66	2.26	45.52	37.21	82.73	4.87
	$CaCO_3$	4%	36.09	44.26	80.35	4.98	43.38	37.10	80.48	9.18
	$CaCO_3$	6%	36.43	45.53	81.96	2.35	46.45	36.25	82.70	4.46
	K Cl	1%	35.50	44.45	79.85	2.91	42.65	37.50	80.15	10.05
1000	Unsprayed (Check)		36.24	46.20	82.44	7.52	44.20	36.08	80.28	12.07
	Kaolin	4%	40.42	44.20	84.62	6.01	47.33	35.22	82.55	7.62
	Kaolin	6%	44.33	42.21	86.54	2.37	50.25	34.28	84.53	4.32
	$CaCO_3$	4%	39.64	44.30	83.94	7.57	47.99	34.10	82.09	6.47
	$CaCO_3$	6%	44.38	41.23	85.61	3.46	51.45	33.27	84.72	5.64
	K Cl	1%	40.53	43.36	83.39	3.28	47.65	34.32	81.99	7.43
1500	Unsprayed (Check)		40.32	44.20	84.52	4.41	49.30	34.14	83.44	4.50
	Kaolin	4%	43.65	42.23	85.88	1.72	50.52	34.10	84.62	2.99
	Kaolin	6%	46.26	41.28	87.54	1.88	56.05	31.05	87.10	3.64
	$CaCO_3$	4%	42.64	43.18	85.82	2.02	52.35	32.21	84.56	4.59
	$CaCO_3$	6%	46.28	41.38	87.66	2.50	55.63	31.36	86.99	3.46
	K Cl	1%	42.73	42.26	84.99	2.32	53.24	31.87	85.11	6.09
2000	Unsprayed (Check)		42.18	44.34	86.52	4.96	53.35	32.52	85.87	4.87
	Kaolin	4%	43.32	43.32	86.64	2.18	54.14	32.48	86.62	5.33
	Kaolin	6%	45.17	42.15	87.32	2.38	55.53	31.57	87.10	4.85
	$CaCO_3$	4%	43.47	43.27	86.74	2.76	54.66	31.89	86.55	5.63
	$CaCO_3$	6%	44.21	43.15	87.36	1.83	56.52	30.57	87.09	6.03
	K Cl	1%	43.65	43.19	86.84	1.06	54.77	31.69	86.46	8.20
	LSD at 0.05 level		0.91	1.17	1.67	0.60	0.98	0.85	1.74	0.86

Table 8: Effect of water quantity on photosynthetic pigments in leaf tissues and NPK content and uptake of aerial parts of potato plant 90 days after planting

Treatments	Chlorophyll (mg/gm D.W.)			Minerals/plant (%)			Uptake (mg)		
	a	b	Total (a+b)	N	P	K	N	P	K
Water quantity m^3/*fed*				**2001 season**					
500	2.57	1.57	4.14	2.98	0.307	5.16	752.68	[illegible]	1313.24
1000	2.49	1.48	3.97	3.25	0.313	5.50	887.71	85.30	1495.49
1500	2.37	1.37	3.74	3.02	0.280	5.50	845.71	78.22	1541.42
2000	2.32	1.32	3.64	3.28	0.339	5.43	1045.95	107.90	1734.83
LSD at 0.05 level	0.02	0.02	0.04	NS	0.021	0.16	104.89	7.81	62.29
				2002 season					
500	2.47	1.47	3.94	3.87	0.411	5.86	834.63	88.20	1263.94
1000	2.36	1.36	3.72	3.37	0.386	6.20	881.16	100.66	1610.95
1500	2.37	1.38	3.75	3.50	0.356	6.45	930.36	94.47	1726.58
2000	2.31	1.31	3.62	3.44	0.267	6.03	899.23	70.03	1579.10
LSD at 0.05 level	0.01	0.03	0.04	0.23	0.013	0.23	57.75	5.71	74.39

Table 9: Effect of antitranspirants on photosynthetic pigments in leaf tissues and NPK content and uptake of aerial parts of potato plant 90 days after planting

Treatments	Chlorophyll (mg/gm D.W.)			Minerals/plant (%)			Uptake (mg)		
	a	b	Total (a+b)	N	P	K	N	P	K
Antitranspirants				**2001 season**					
Unsprayed (Check)	2.43	1.43	3.86	3.34	0.329	5.30	919.59	91.06	1487.21
Kaolin 4%	2.43	1.43	3.86	3.14	0.315	5.26	926.65	92.69	1550.19
Kaolin 6%	2.50	1.50	4.00	3.21	0.332	4.46	945.56	98.52	1324.04
$CaCO_3$ 4%	2.42	1.42	3.84	3.10	0.298	5.06	816.47	78.30	1327.57
$CaCO_3$ 6%	2.50	1.50	4.00	3.09	0.296	5.74	834.38	80.25	1547.51
KCl 1%	2.51	1.48	3.99	2.92	0.289	6.59	855.40	82.90	1887.94
LSD at 0.05 level	0.03	0.02	0.04	0.18	0.014	0.21	60.16	4.99	85.68
				2002 season					
Unsprayed (Check)	2.36	1.35	3.71	3.44	0.322	6.07	888.55	85.09	1565.74
Kaolin 4%	2.38	1.38	3.76	3.67	0.367	5.92	868.70	86.21	1395.67
Kaolin 6%	2.41	1.41	3.82	3.49	0.365	6.43	1021.25	104.03	1894.91
$CaCO_3$ 4%	2.37	1.39	3.76	3.55	0.358	6.14	996.40	99.94	1743.42
$CaCO_3$ 6%	2.41	1.41	3.82	3.45	0.343	6.38	716.86	70.92	1343.24
KCl 1%	2.42	1.45	3.87	3.67	0.374	6.88	826.30	83.85	1927.87
LSD at 0.05 level	0.03	0.03	0.03	0.23	0.020	0.34	97.35	8.77	155.91

Table 10: Effect of interaction between water quantity and antitranspirants on photosynthetic pigments in leaf tissues and NPK content and uptake of aerial parts of potato plant 90 days after planting

Treatments		Chlorophyll (mg/gm D.W.)			Minerals/plant (%)			Minerals/plant Uptake (mg)		
Water quantity (m^3/fed)	Antitranspirants	a	b	Total (a+b)	N	P	K	N	P	K
					2001 season					
500	Unsprayed (Check)	2.63	1.63	4.06	3.20	0.315	3.53	701.19	69.04	774.13
	Kaolin 4%	2.57	1.57	4.14	3.08	0.312	4.80	902.13	91.28	1402.62
	Kaolin 6%	2.67	1.67	4.34	3.04	0.398	3.82	824.33	81.09	1041.83
	$CaCO_3$ 4%	2.54	1.54	4.08	3.27	0.312	5.50	756.96	72.22	1274.27
	$CaCO_3$ 6%	2.63	1.63	4.26	3.32	0.304	6.20	808.69	73.71	1509.43
	K Cl 1%	2.61	1.63	4.24	1.99	0.301	7.15	522.77	79.01	1877.16
1000	Unsprayed (Check)	2.49	1.49	3.98	3.35	0.312	5.96	935.33	87.09	1667.94
	Kaolin 4%	2.50	1.49	3.99	3.24	0.354	5.24	908.45	98.94	1470.05
	Kaolin 6%	2.53	1.53	4.06	3.43	0.317	3.41	993.02	91.55	985.20
	$CaCO_3$ 4%	2.49	1.48	3.97	2.83	0.290	5.21	770.59	78.93	1419.39
	$CaCO_3$ 6%	2.54	1.54	4.08	3.37	0.304	6.13	841.00	75.74	1526.23
	K Cl 1%	2.39	1.88	4.27	3.28	0.299	7.09	877.84	79.53	1892.12
1500	Unsprayed (Check)	2.37	1.36	3.73	3.35	0.276	5.89	949.55	78.23	1669.85
	Kaolin 4%	2.32	1.33	3.65	3.04	0.287	5.46	870.91	81.92	1563.16
	Kaolin 6%	2.44	1.43	3.87	3.08	0.281	5.38	892.60	81.50	1561.28
	$CaCO_3$ 4%	2.35	1.35	3.70	3.32	0.301	5.17	852.02	77.23	1324.68
	$CaCO_3$ 6%	2.43	1.43	3.86	2.71	0.279	5.42	752.85	77.17	1508.27
	K Cl 1%	2.49	1.39	3.88	2.65	0.256	5.68	756.32	73.22	1621.27
2000	Unsprayed (Check)	2.25	1.25	3.50	3.45	0.411	5.81	1092.27	129.87	1836.93
	Kaolin 4%	2.33	1.33	3.67	3.21	0.309	5.54	1025.12	89.57	1764.92
	Kaolin 6%	2.37	1.37	3.74	3.29	0.430	5.24	1072.30	139.96	1707.84
	$CaCO_3$ 4%	2.31	1.32	3.63	2.99	0.287	4.36	886.33	84.83	1291.95
	$CaCO_3$ 6%	2.39	1.39	3.78	2.95	0.298	5.20	934.97	94.36	1646.12
	K Cl 1%	2.38	1.37	3.75	3.77	0.298	6.45	1264.69	99.83	2161.23
LSD at 0.05 level		NS	NS	NS	NS	NS	NS	NS	NS	171.35

Table 10: Cont.

Treatments		Chlorophyll (mg/gm D.W.)			Minerals/plant (%)			Minerals/plant Uptake (mg)		
Water quantity (m^3/fed)	Antitranspirants	a	b	Total (a+b)	N	P	K	N	P	K
					2002 season					
500	Unsprayed (Check)	2.45	1.45	3.90	3.67	0.392	5.67	936.68	100.09	1452.22
	Kaolin 4%	2.48	1.48	3.96	4.03	0.420	6.18	996.88	96.21	1418.35
	Kaolin 6%	2.50	1.50	4.00	3.65	0.425	6.10	630.80	73.24	1053.98
	$CaCO_3$ 4%	2.46	1.46	3.92	3.85	0.411	6.00	871.32	92.61	1358.32
	$CaCO_3$ 6%	2.50	1.51	4.01	3.94	0.420	5.73	764.67	81.46	1111.94
	K Cl 1%	2.41	1.43	3.84	4.07	0.497	5.51	877.47	85.60	1188.82
1000	Unsprayed (Check)	2.36	1.33	3.69	3.17	0.349	5.54	1029.83	113.20	1800.78
	Kaolin 4%	2.36	1.36	3.72	3.70	0.402	6.16	922.32	100.22	1536.75
	Kaolin 6%	2.38	1.38	3.76	3.20	0.402	6.59	931.52	116.96	1918.89
	$CaCO_3$ 4%	2.36	1.37	3.73	3.36	0.383	6.16	1090.01	123.96	1994.22
	$CaCO_3$ 6%	2.37	1.38	3.75	3.04	0.348	6.26	477.31	54.69	979.64
	K Cl 1%	2.35	1.36	3.71	3.78	0.430	6.50	835.96	94.89	1435.44
1500	Unsprayed (Check)	2.33	1.33	3.66	3.44	0.312	6.67	862.66	78.00	1673.31
	Kaolin 4%	2.37	1.36	3.73	3.29	0.374	6.05	696.19	79.25	1280.27
	Kaolin 6%	2.42	1.42	3.84	3.41	0.367	6.26	1286.97	137.82	2358.55
	$CaCO_3$ 4%	2.35	1.43	3.78	3.73	0.350	6.38	956.27	88.82	1636.28
	$CaCO_3$ 6%	2.43	1.43	3.86	3.36	0.343	7.44	959.82	98.04	2119.28
	K Cl 1%	2.33	1.33	3.66	3.75	0.388	5.89	820.27	84.88	1291.78
2000	Unsprayed (Check)	2.30	1.27	3.58	3.48	0.237	6.42	725.05	49..05	1336.66
	Kaolin 4%	2.32	1.32	3.64	3.66	0.273	5.31	929.41	69.14	1347.32
	Kaolin 6%	2.35	1.35	3.70	3.69	0.265	6.77	1235.72	88.10	2248.21
	$CaCO_3$ 4%	2.31	1.31	3.62	3.24	0.287	6.01	1068.03	94.35	1984.87
	$CaCO_3$ 6%	2.34	1.34	3.68	3.48	0.259	6.09	665.65	49.51	1162.11
	K Cl 1%	2.38	1.28	3.56	3.11	0.252	5.62	771.51	70.01	1395.44
	LSD at 0.05 level	NS	NS	NS	NS	NS	NS	NS	NS	NS

تأثير كمية مياه الرى وبعض مضادات النتح على النمو والعلاقات المائية والمحتوى الكيماوى لنباتات البطاطس تحت ظروف الأراضى الرملية

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أجريت تجربتان حقليتان خلال موسمى صيف ٢٠٠١ و٢٠٠٢ فى مزرعة التجارب الزراعية بالخطارة التابعة لكلية الزراعة – جامعة الزقازيق على محصول البطاطس، بهدف دراسة تأثير كمية مياة الرى وبعض مضادات النتح (الكاؤلين بتركيزى ٤، ٦%، وكربونات الكالسيوم بتركيزى ٤، ٦%، وكلوريد البوتاسيوم بتركيز ١% بالإضافة للرش بالماء المقطر) والتفاعل بينهما على النمو والمادة الجافة، والعلاقات المائية، وصبغات الكلوروفيلات، ومحتوى النبات من العناصر وامتصاصها.

أدى الرى بمعدل ٢٠٠٠م^{٣}/فدان وكذلك رش النباتات بالكاؤلين أو كربونات الكالسيوم بتركيز ٦% من كل منهما الى زيادة كلا من نمو النبات، والمادة الجافة، والماء الحر والكلى فى أنسجة الأوراق،وتركيز العناصر وامتصاصها.

ازداد محتوى الأوراق من كل من الكلوروفيلات والماء المرتبط والبرولين تحت أقل معدل لمياه الرى (٥٠٠ م^{٣}/فدان).

أدى التفاعل بين الكاؤلين او كربونات الكالسيوم بتركيز ٦ % من كل منهما والرى بمعدل ٢٠٠٠م^{٣}/ فدان الى زيادة نمو النبات، والمادة الجافة، والماء الحر والكلى فى الورقةكما أدى الرش بكلوريد البوتاسيوم إلى زيادة تركيز البوتاسيوم وامتصاصه.