Impact of irrigation Deficit, Soil Conditioner and Antitranspirant on Yield and Quality of Potato

Nada A. Abdel-Rehem[1], A. I. A. Abido[2], G. Abdel-Nasser[3], Mona M. Gaber[2]
[1]Postgraduate student
[2]Plant Production Dept., Faculty of Agriculture (Saba Basha)-Alexandria University
[3]Soil and Agricultural Chemistry Dept., Faculty of Agriculture (Saba Basha)-Alexandria University

ABSTRACT: This study was carried out in a private farm at El-Nobaria region, El-Beheira Governorate, Egypt, during the winter growing seasons of (2015 and 2016) to study the effect of irrigation deficit, (SAB) as soil conditioner and (protone) as plant antitranspirant on tuber yield and quality of potato crop. The experiments were carried out in a split-split plot design with three replicates. Three irrigation levels (100, 75 and 50 % of reference evapotranspiration) were arranged in main plots, soil conditioner (control, 4 and 8 kg/fed) were arranged in subplots and plant antitranspirant (control, 0.25 and 0.50 L/fed.) were arranged in sub-subplots. The collected data were analyzed using analysis of variance (ANOVA) with the aid of STATISTIX 8 package and significant means separated using Least Significant Difference (LSD) at 5% probability level. The results indicated that the potato yield and its components,significantly increased with increasing water supply up to 100%, application of the soil conditioner at 8 kg/fed., andthe plant antitranspirant at 0.50 L/fed.comparedto other treatments during 2015 and 2016growing seasons. Irrigation at 100% level increased tuber yield by (23.08 and 22.83%) and marketable tuber (3.68 and 3.7%) for both seasons, respectively. Application of soil conditioners increased the tuber yield by (19.21, 19.61%), and marketable tuber by (1.61 and 1.94%), for both seasons, respectively. In addition application of plant antitranspirant increases tuber yieldby 20.87 and19.61% and marketable tuber by about 1.70 and 1.88% for both seasons, respectively. All tuber characters such as (TSS, VC, total carbohydrates, total sugars, protein, N, P, K contents and protein content) increased significantly with irrigation level up to 100%, the soil conditioner(8 kg/fed.), and the antitranspirant (0.5 l/fed.) applications. Based on the present results,it could be recommended that irrigation of potato plants at 100% of ETo with application of soil conditioner (SAB) at 8 kg/fed., and spraying the plants with the antitranspirant (Protone) at rate of 0.5 l/fed. was the most efficient treatments for tuber yield and tuber quality of potato plants grown in loamy soil (El-Nobaria region).

Keywords: Potato, irrigation deficit, soil conditioner, antitranspirant, tuber yield, chemical composition

INTRODUCTION

Potato (*Solanum tuberosum* L.) belongs to Solanaceae family. It is a popular vegetable crop, which ranked the fourth among the most important food crops for a human being after rice, wheat, and maize. AOAD (2014)reported that total cultivated area in Egypt was 381,000 fed., with a total production of 4265,000 ton/year. Karam *et al.*(2009)reported that potato (*Solanum tuberosum* L.) is one of the major crops contributing to the world's food security. Potato is one of the most important field corps not only for its local consumption but also to its exportation to different countries around the world as described by Kandil *et al.*(2011). Abiotic stress factors, such as drought, have severe, adverse effects on potato growth and yield (Levy *et al.,* 2013). In particular, a regular water supply is necessary to achieve a high quality of the yield (Ierna *et al*., 2011; Levy *et al.,* 2013). In arid and semi-arid areas, early potato growing cycle often subjected to long periods of drought and its cultivation usually requires irrigation throughout the spring during the stage of tuber bulking and growth (Ierna *et al.,* 2011).

Potato response to water deficit can be very different among cultivars (Hassanpanah, 2010), as a function of water stress occurrence period (Kashyap and Panda, 2003). Among growth stages, early development stage, as compared with tuber formation and flowering stages, has shown to be the most sensitive to water stress, hence the most responsive to irrigation.

The soil conditioners, which added to soil is another factor to improve the soil's physical qualities, usually its fertility (ability to provide nutrition for plants) and sometimes its mechanics. Soil conditioners can be used to improve poor soils or to rebuild soils, which have damaged by improper soil management. Several approaches have investigated to increase the water use efficiency and maintain the productivity of the sandy soils in Egypt. The combined application of soil conditioners and mineral fertilizerswas recognized as an appropriate means for increasing fertility in water depleted soils, particularly in arid regions(Vanlauwe *et al.,* 2010).

Plant antitranspirants are chemical compounds whose role is to train plants by gradually hardening them to stress as a method of reducing the impact of drought. There are different types of antitranspirants: film forming which stops almost all transpiration; stomatal, which only affects the stomata and reflecting materials(Nasraui, 1993).Reducing transpiration can play a useful role in this respect by preventing the excessive loss of water to the atmosphere *via* stomata (Khalil, 2006).The plant antitranspirants are materials involved in increasing drought resistance by tending to cause xeromorphy and/or stabilizing cell structure (Ouda*et al.*2007).

In this context, Bittelli *et al.* (2001) reported that occasional or episodic drought events might counteracted withantitranspirants. These compounds including both film-forming and stomata closing compounds are able to increase the leaf resistance to water vapor loss thus improving plant water use to assimilate carbon and in turn, the production of biomass or yield (Tambussi and Bort, 2007). Another approach to reduce water loss due to transpiration is by increasing the reflection of sunlight from leaves, through reflectingantitranspirants type, thus limiting the water loss deputed to evaporative leaf cooling (Gaballah and Moursy, 2004).The main objective of this workis to investigate the effect of irrigation deficit, (SAB) as soil conditioner and Protone as plant antitranspirant on potato productivity and yield quality under drip irrigation system.

MATERIALS AND METHODS

Two field experiments conducted in a private farm at El-Nobaria region, El-Behaira Governorate, Egypt (30° 48′ 17″ N and 29° 59′ 49″ E), during the winter growing seasons of 2015 and 2016 to study the effects of irrigation deficit, SAB(Super Absorbent Polymer, polyacrylamide as soil conditioner) and protone (growth hormon, ABA as a vital role in regulation of opening and closing of stomata) asplant antitranspirant on the yield and quality of potato crop.

A surface soil sample (0-30cm) collected before planting to identify some physical and chemical properties of the experimental site according to Carter and Gregorich (2008)and the reported data listed in Table (1).

Table (1).Some physical and chemical properties of the experimental soil used in the present study

Parameter	value
Particle-size distribution (%)	
Sand	42.42
Silt	36.56
Clay	21.02
Textural class	Loam
pH (1:2, water suspension)	8.25
EC(1:2, water extract), dS/m	0.59
OM (%)	2.04
$CaCO_3$ (%)	24.65
Soluble cations (meq/l)	
Ca^{2+}	2.40
Mg^{2+}	0.60
Na^{+}	2.23
K^{+}	0.23
Soluble anions (meq/l)	
HCO_3^{-}	0.10
Cl^{-}	2.00
SO_4^{2-}	3.36
Available nutrients (mg/kg)	
N	40.0
P	14.3
K	144.0
Fe	5.60
Mn	11.80
Zn	2.52
Cu	2.50

The cultivation is done in the $5^{th}$and $8^{th}$of January in both seasons. The seeds were planted as a whole at 0.25 m apart in the row, 25 m long and 0.6 m width. Each plot(45 m^2) consisted of three rows. The treatments of the two experiments were as follows;three irrigation levels(100, 75, and 50%) of reference evapotranspiration (ET_0), threesoil conditioner rates, SAP(control, 4 and 8 kg/fed.) and the antitranspirant rates, Protone 10% SL (control, 0.25 and 0.50 L/fed.)which applied during the two seasons of this investigation.

The sulfur powder was added at the rate of 100 kg/fed. at soil preparation. The following mineral fertilizers were added to the soil at preparation.Mono calcium phosphate (15.5%P_2O_5) at rate of 75 kg P_2O_5/fed., potassium sulfate (48% K_2O) at the rate of 96 kg K_2O/fed and nitrogen fertilizer (100 kg N/fed.)the form of ammonium nitrate (33.5% N) were added throughout the drip irrigation system. All of the other agricultural practices for potato productionwere followed as recommended in the area. Harvest has done at $27^{th}$and $30^{th}$of April in both seasons, respectively.

Data recorded

A) Yield and yield quality parameters

- **Average tuber weight (g)** calculated by dividing tuber yield of each plot by its tuber's number.
- **Tuber yield (ton/fed.)** was calculatedand attributed to the feddan

- **Tuber water content (%)**determined by oven dry of tuber potato pieces at 70°C for 48 hrs.
- **Percentage of marketable tubers (%):** all tubers characterized by its width 2 cm or more free from injuries, wounds, cracks or cuts, decays, insect infestations and secondary growth tubers are considered as acceptable for marketing.
- **Tuber dry matter (%)**was carried out by weighing a specific weight of fresh tubers and then dried at 70 °C for 48h, then tuber dry matter was calculated as follows:

Tuber dry matter (%)= (Dry weight/ Fresh weight)X100

B) Chemical composition

The N, P and K percentages were determined in the dry tubers. Their dry weights were determined after drying in a drying oven to a constant weight at 70^{o}C for 72 hours according to Tandon (1995). After dryness, the dry samples were milled and stored for analysis. However, 0.5g of the tubers powder was wet-digested with H_2SO_4–H_2O_2 mixture according to Lowther (1980) and the following determinations were carried out in the digested solution:

- **Nitrogen content (N%):** Total nitrogen was determined colorimetrically by Nessler`smethod (Chapman and Pratt, 1978). Nessler solution (35 IK/100 ml + 20g $HgCl_2$ / 500 ml +120 g NaOH/250 ml). Reading was achieved using wavelength of 420 nm and total N was determined as the percentage as follows: % N = NH_4 % x 0.78.
- **Phosphorus content (P%):** Phosphorus determined by the Vanadomolybdate yellow method as given by Jackson (1973).The intensity of color developed to read in the spectrophotometer at 405nm.
- **Potassium content (K%):**Potassium determined according to the method described by Jackson (1973)using Beckman Flame photometer.
- **Protein (%):** Protein was determined by estimating the total nitrogen content in the tubers and multiplied by 6.25 to obtain the protein percentage according to AOAC(1990).
- **Total soluble solids of tuber (TSS %)** determined in the tuber juice as the percentage by hand refractometer according to Chen and Mellenthin (1981).
- **Determination of reducing and non-reducing sugars percentages (%):**A known mass (5 g) of fresh tuber was taken to determine the reducing and non-reducing sugars, using sulphuric acid, phenol (5%) and Nelson arsenate–molybdate, then they were colorimetrically determined according to the method of Malik and Singh (1980).
- **Determination of vitamin C (mg/100g):** It determined by titration with 2, 6dichlorophenol-indo-phenol blue dye according to the methods of Jacobs (1951).
- **Total carbohydrates:** Total carbohydrates were determined quantitatively, in tubers by Anthron method according to Mahadevan and Sridhar (1986) as follows:Extraction carried out by grinding dry matter in Mahadavan buffer (sodium citrate buffer, pH 6.8). The extracts were homogenized for 3 minutes and centrifuged at 4000 rpm for 15 min and the supernatant then was used to determine total carbohydrates.

Experimental design and statistical analysis

The experimental layout arranged as split-splitplot design, with three replicates. Three irrigation levels (100, 75 and 50% ofreference evapotranspiration, ET_0) were assigned in the main plots, three soil conditioner rates (control, 4 and 8 kg/fed.)in the subplotsandthree antitranspirant rates (control, 0.25 and 0.50 L/fed.) in the sub-subplots.Collected data of the experiments were statistically, analyzed using the analysis of variance method(STATISTIX, 2003). Comparisons among the means of the different treatments were done, using the least significant differences (L.S.D) test procedure at p = 0.05 level of probability, as illustrated by Snedecor and Cochran (1980).

RESULTS AND DISCUSSIONS

A) Yield and yield components

The data recorded foryield and its components presented in Table (2). Theresults revealed that the gradually increasesnotes with increasing water supply up to 100% of ETo during the both seasons. Irrigation of potato plants with 100% of the reference evapotranspiration has the highest values of yield and its components. Treatment of 100% of ET_0 had superiority in all characters such as, average tuber weight (67.46 g), tuber yield/plant(857.71 g), gross tubers yield (22.81ton/fed.), tuber dry matter (25.14%) tuber water content (74.86%), and marketable tuber (93.38 %) as average of bothgrowing seasons,respectively compared with other treatments. The increases of 100% of ETo were 12.58, 20.76, 20.75, -0.63, 0.21 and 3.71%, respectively over the 50% of ETo irrigation treatment.

On the other hand, it is clear from the obtained data in the same Table (2) that application of soil conditioner at rate of 8 kg/fed. significantly improved yield and its components of potato plants. Treatment of 8 kg/fed.soil conditioner recorded the maximum values of average tuber weight (66.45 g), tuber yield/plant(850.94g), gross tubers yield (22.64ton/fed.), tuber dry matter(25.02 %),tuber water content (74.98%), and marketable tuber (92.75 %), respectively, as average of both seasons compared with control treatment, which gave the minimum values of these characters.

The data presented in Table (2) revealed thatapplication of plant antitranspirant up to 0.50 l/fed.significantly increased yield and its components of potato plants. Application of antitranspirant at rate of 0.50 l/fed., gave the highest mean values of yield and its components, such as average tuber weight (67.13g),tuber yield/plant (855.31 g), tubers gross yield (22.75ton/fed.), tuber dry matter (25.41%),tuber water content (74.59%) and marketable tuber (92.72%), respectivelyas average of two seasons compared with the control treatment,which gave the lowest mean values of these characters.

The interaction effects between irrigation levels and soil conditioner rates were highly significant with tuber yield and yield characters in both seasons.The other interaction effects are not significant for all yield characters except marketable tubers. The positive effect of 100% or 75% of the reference evapotranspiration on tubers yield and its components may attributed to the optimal or moderate soil moisture contents, which led to increase the nutrient availability and its uptake, as well as a reduction in soil salinity compared with low soil moisture. Higher values of soil moisture increased growth parameters, which reflected in higher rates of photosynthetic processes and carbohydrates production that increased final tubers yield. Whereas, the reduction in tuber yield due to water deficit may be attributed to the reduction in leaf area due to fewer and small leaves, and the increase in stomatal resistance for gas exchange, as well as the reduction in transpiration rate, which all resulted in a reduction in photosynthesis (Ghosh *et al.,* 2000).The higher yield production under 100% of ETo may be due to the proper balance of moisture in plants, which creates favorable conditions for nutrients uptake, photosynthesis and metabolites translocation (Kar and Kumar, 2007).These results are in harmony consistent with Abdallah (1996), Khalel(2003) and Al-Aubiady(2005).

The high reduction in total yield obtained by deficit irrigation at 50 % of ETo may have been due to a direct effect of water stress on growth and initial tuber development or to indirect effects of water deficit on decreasing water and nutrients uptake, consequently decreased the vegetative growth and limiting the tuber yield. Such results are in harmony with those obtained by Bradford and Hsiao (1982), Abdel Nasser, (1991and 1993) and Abdallah (1996).Karam*et al.* (2014) stated that potato plants subjected toirrigation deficit at tuber bulking achieved marketable yield12% lower than that obtained with well-irrigated control. Whereas, irrigationdeficit at tuber ripening stage reduced tuber yield by 42% as compared withthe control. However, yield reduction compensated by an increase intuber dry matter in the deficit-irrigated treatments.

Potato is relatively sensitive to soil water stress, therefore tooptimize yield, the total available soil water should not depleted morethan 30 to 50% (Onder *et al*., 2005 and Pereira and Shock, 2006).These findings agreed with those of several studies in different environments, which indicate that the soil moisture deficit in the potato crop leads to a reduction in the total yield (Shock *et al.,* 1992).

Many soil conditioners can used to improve soilproprieties, then improved growthand yield of vegetable crops (Croker *et al*., 2004). The application of soil conditioner increased the ability of soil to absorb large quantities ofwater, which led to more plant absorption of water, then improved the growth and yield of potato (Ding *et al*. 2009).The positive effect of soil conditioner on tuber yield may be due to:1) positive effect on soil water holding capacity (Iskander*et al*. 2011),2) reducingthe leaching of plant nutrientsthrough its higher colloid content (Sitthaphanit *et al*., 2010),3) stimulating themeristematic activity for producing more tissues and organs (Marisa *et al*.,2009),and 4) vital contribution in several biochemical processes that are related to plant growth.

Abdel-Nasser and EL-Gamal (1996) concluded that FoliCote antitranspirant (wax emulsion) could be minimize the moisture losses from leaf surface when sprayed on the foliageproducing thin film that prevent the escape of water vapor from stomata.Theyexplained that increasingsweet potato root yield and characteristics byFoliCote applications primarily referred to the effect of this material on improving the plant water potential at the time when the growth of plant was more dependent on water status than on photosynthesis. The authors added that root formation stage also more related to plant water status, which related with available moisture in the root zone. Antitranspirants are chemical compounds which favors reduction in transpiration rate from plant leaves by reducing the size and number of stomata and gradually hardening them to stress (El Khawaga, 2013 and Ahmed *et al*., 2014). Application of antitranspirant may improve growthand physiological response in water and high temperaturestress in plants (Leskovar *et al*., 2008, 2011).Water stresses at a flowering stage decrease the yield component of cropand hence the foliar spray of antitranspirant improve the photosynthesis and reduces thetranspiration rate, which causes a better production incrops.Antitranspirants commonly used to reduce leaf waterloss. Its increase the relative water content of leaves at different irrigation levels (Misra *et al*., 2009). The efficacy of antitranspirant films dependson economic parameters and on the number of new leavesformed after treatments. Generally, antitranspirants can be efficient up to one month (Plaut *et al*., 2004). Itsmay allow a reduction in water transpiration without greatly affecting photosyntheticactivity (Glenn *et al*., 2001). In addition to the beneficial effect of elevated CO_2 concentration on drought stress,antitranspirants can significantly improve drought tolerance(Del Amor *et al*., 2010).

Typically, an antitranspirant film mechanically reduces stomataland cuticle transpiration (i.e., water loss) as well as gaseous exchange (Osswald *et al*., 1984), although such a reduction inphotosynthetic activity and transpiration is generally perceivedto be accompanied by lower yield. It isalso impossible to reduce evapotranspiration without influencinggaseous exchange. Thus, the relationship between water andCO_2 rate could determine the efficacy and applicability of such an antitranspirant film.

B) Tuber chemical composition

Data presented in Tables (3 and 4) showed thatincreasing irrigation level from 50 to 100% of ET_o caused a significant increase in the tuber content of TSS (29.34%), vitamin C (29.18%),total carbohydrate (27.70%), total sugars (31.58 %), reducing sugars (36.36%), non-reducing sugars (28.26%), nitrogen content (26.35%), phosphorus content (5.17%), potassium content (56.77%) and protein (26.30%)compared to the control treatment (100% of ETo)for both seasons.

These results agreed with previous studies (Anita and Mauromicale, 2006; Erdem *et al*., 2006) which revealed that the reduced root development due to water stress limits the plant's ability for nutrients uptake. However, growing potato with 80% irrigation regime based on cumulative pan evaporation recorded significantly higher NPK contents when compared with lower irrigation levels (Jayramaiah *et al*., 2005).

The results also revealed that application of soil conditioner up to 8 kg/fed. significantly increased all chemical composition characters of potato tuber. Application of soil conditioner at 8 kg/fed. recorded the maximum values of TSS (5.29%), vitamin C (16.57 mg/100 g FW),total carbohydrate (63.10%), total sugars (0.72 %), reducing sugars (0.14%), non-reducing sugars (0.58%), nitrogen (1.73%), phosphorus (0.39%), potassium (2.06%) and protein content (10.82%) in potato tubers, compared with other treatmentsas average for both seasons, in which control treatment gave the minimum values of these characters.

On the other hand, data presented in Tables (3 and 4)clearly indicated thatapplication of plant antitranspirant up to 0.50 l/fed.significantly increased all chemical composition of potato tubers. The applications of antitranspirant at 0.50 l/fed.recorded the highest mean values ofTSS (5.39%), vitamin C (17.16 mg/100 g FW),total carbohydrate (62.29%), total sugars (0.72 %), reducing sugars (0.15%), non-reducing sugars (0.57 %), nitrogen (1.85%), phosphorus (0.40%), potassium (2.19 %) and protein content (11.55%), compared with other treatmentsas average of both seasons, in which the control treatment gave the minimum values of these characters.

Most of interaction effects between irrigation levels, soil conditioner and plant antitranspirant are highly significant with TSS, VC,total sugars, N, P, K and protein in both seasons, but the third interactions are not significant. On the other hand, increasing water stress caused a significant reduction in tuber starch and total carbohydrate contents. Such effects may be due to that water stress conditions increased the enzymatic pathway that breaks down the starch into glucose-fructose (reducing sugars) or may be due to decrease the rate of sugars transport (Zhongchum and Stutte, 1992). The decrease in tuber total carbohydrates because of water stress may be due to the reduction in leaf total chlorophyll content, thereby reduced the photosynthetic activity, and consequently decreased the tuber yield.

In the present study, vitamin C content significantly affected by the application of soil conditioner over the experimental period.The study demonstrated that the soil conditioner applied to potatoes had a positive effect on starch content and vitamin C content in their tubers. In another study with soil conditioner, Zarzecka *et al*. (2014) recorded an increased nitrogen and magnesium amounts in potato tubers compared with control. soil conditioner is a well-established product which is popular with farmers as it improves soil properties, boosts crop yields and is cost-effective (Trawczyński and Bogdanowicz, 2007; Piotrowska *et al*., 2012).

Antitranspirants regulates stomatal movement by influencing the guard cells around the stomatal pores and reduces loss of water but not intake of CO_2.The most efficient and desirable antitranspirants are those which closes stomata while transpiration but produce no phytotoxic effects to plants (Gale and Hagan, 1966). Based on the present results, it could be recommended that irrigation of potato plants at 100% of ETo with application of soil conditioner (SAB) at 8 kg/fed.and spraying the plants with antitranspirant (Protone) at rate of 0.5 l/fed. was the most efficient treatment for tuber yield and tuber quality of potato plants grown in loamy soil (El-Nobaria region).

Table (2). Average values of potato yield and yield componentsfor the two seasons as affected by irrigation deficit, soil conditioner, antitranspirant and their interactions

Treatments	Average tuber weight (g)	Tuber yield/plant (g)	Gross tuber yield (ton/fed.)	Tuber dry matter (%)	Tuber water content (%)	Marketable tuber (%)
			A)Main effect of irrigation (% of ETo)			
100	67.46	857.71	22.81	25.14	74.86	93.38
75	64.10	795.27	21.15	25.02	74.98	92.52
50	59.92	710.25	18.89	25.30	74.70	90.04
LSD (0.05)	0.49**	5.93**	0.16**	0.40	0.39	0.35**
			B)Main effect of soil conditioner (g/fed.)			
0	60.67	720.31	19.16	25.19	74.81	91.13
4	64.35	791.97	21.07	25.25	74.75	92.06
8	66.45	850.94	22.64	25.02	74.98	92.75
LSD (0.05)	0.63**	6.99**	0.19**	0.23	0.22	0.33**
			C)Main effect of plant antitranspirant(l/fed.)			
0	61.04	725.92	19.31	24.66	75.34	91.15
0.25	63.30	782.00	20.80	25.38	74.62	92.07
0.50	67.13	855.31	22.75	25.41	74.59	92.72
LSD (0.05)	0.93**	11.36**	0.30**	0.36	0.36	0.32**
			Interactions effect			
A X B	**	**	**	**	*	**
A X C	ns	ns	ns	ns	ns	**
B X C	ns	ns	ns	ns	ns	**
A X B X C	ns	ns	ns	ns	ns	ns

Means followed by same letter (s) within each column are not significantly different at 0.05 level of probability.
* Significant at 0.05 level of probability, ** Significant at 0.01 levels of probability and ns: not significant

Table(3).Average chemical composition of potato tuber for the two seasons as affected by irrigation deficit, soil conditioner, antitranspirant and their interactions

Treatments	TSS (%)	VC (mg/100g FW)	Total carbohydrates (%)	Total sugars (%)	Reducing sugars (%)	Non-reducing sugar (%)
A)Main effect of irrigation (% of ETo)						
100	5.51	17.53	63.80	0.75	0.15	0.59
75	4.85	15.42	55.94	0.65	0.13	0.52
50	4.26	13.57	49.96	0.57	0.11	0.46
LSD (0.05)	0.004**	0.03**	2.05**	0.004**	0.003**	0.02**
B)Main effect of soil conditioner (g/fed.)						
0	4.42	14.14	50.43	0.59	0.12	0.46
4	4.90	15.79	56.17	0.65	0.13	0.52
8	5.29	16.57	63.10	0.72	0.14	0.58
LSD (0.05)	0.02**	0.10**	1.34**	0.005**	0.002**	0.02**
C)Main effect of plant antitranspirant(l/fed.)						
0	4.37	13.90	50.43	0.59	0.12	0.47
0.25	4.85	15.45	56.99	0.65	0.13	0.52
0.50	5.39	17.16	62.29	0.72	0.15	0.57
LSD (0.05)	0.002**	0.01**	1.30**	0.003**	.006**	0.02**
Interactions effect						
A X B	**	**	**	**	**	*
A X C	**	**	ns	**	ns	ns
B X C	**	**	**	**	**	ns
A X B X C	**	*	ns	ns	ns	ns

Table(4). Average Chemical composition of potato tuber for the two seasons as affected by irrigation deficit, soil conditioner, antitranspirant, and theirinteractions

Treatments	N (%)	P (%)	K (%)	Protein (%)
A)Main effect of irrigation (% of ETo)				
100	1.87	0.45	2.43	11.67
75	1.66	0.36	1.94	10.38
50	1.48	0.29	1.55	9.24
LSD (0.05)	0.01**	0.001**	0.01**	0.08**
B)Main effect of soil conditioner (g/fed.)				
0	1.61	0.33	1.89	10.82
4	1.66	0.37	1.97	10.39
8	1.73	0.39	2.06	10.82
LSD (0.05)	0.01**	0.002**	0.02**	0.06**
C)Main effect of plant antitranspirant(l/fed.)				
0	1.50	0.32	1.77	9.34
0.25	1.66	0.36	1.97	10.39
0.50	1.85	0.40	2.19	11.55
LSD (0.05)	0.002**	0.001**	0.002**	0.03**
Interactions effect				
A X B	**	**	*	**
A X C	*	**	**	*
B X C	**	**	**	**
A X B X C	ns	*	*	ns

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الملخص العربي

تأثير نقص الري، محسن التربة، ومثبط النتح على محصول وجودة البطاطس

[1]ندي عبد العزيز عبد الرحيم ،[2]على ابراهيم على حسن عبيدو ،[3]جمال عبد الناصر خليل
[2]منى محمد يسرى جابر
[1]طالبة دكتوراه بقسم الإنتاج النباتي
[2]قسم الإنتاج النباتي–كلية الزراعة (سابا باشا) –جامعةالإسكندرية
[3]قسم الأراضي والكيمياء الزراعية – كلية الزراعة (سابا باشا) – جامعة الإسكندرية

أجريت تجربتان حقليتان في مزرعة خاصة بمنطقة النوبارية، محافظة البحيرة بمصر، خلال موسمي النمو في فصل الشتاء (٢٠١٥ و٢٠١٦) لدراسة استجابة البطاطس للإجهاد المائي، محسنللتربة (الساب) ومضاد النتح (البروتون) على محصول وجودة درنات البطاطس. وكان تصميم التجربة قطع منشقة مرتين مع ثلاث مكررات، معاملات الري (٥٠، ٧٥، ١٠٠% من البخر نتح المرجعي المحسوب من بيانات الارصاد الجوية) كانت هي القطع الرئيسية، معاملات اضافة محسن التربة (كنترول، ٤ كجم/ فدان، ٨ كجم/ فدان) كانت تحت القطع تحت الرئيسية أما معاملات مضاد النتح (كنترول، ٠.٢٥ لتر/فدان، ٠.٥٠ لتر/فدان) فكانت تحت القطع الرئيسية.

أوضحت النتائج ان الري بمعدل ١٠٠% من جهد البخر–نتح ومحسن التربة بمعدل ٨ كجم/ فدان ،ومثبط النتح بمعدل ٠.٥٠ لتر/ فدان قد أدي إلي الحصول علي أفضل القيم لصفات المحصول ومكونات المحصول (متوسط وزن الدرنة، المحصول /فدان، نسبة كل من المحتوي المائي للدرنة ،المحتوي المادة الجافة للدرنة ،الدرنات الصالحة للتسويق)، أيضاً أعلي القيم للمكونات الكيماوية(نسبة المواد الصلبة الذائبة الكلية، محتوي فيتامين سي (ملجم/١٠٠جم وزن طازج)، نسبة كل من الكربوهيدرات الكلية ,السكريات الكلية ،السكريات المختزلة، NPK والبروتين في الدرنات) مقارنة بالمعاملات الأخرى والكنترول في كلا الموسمين.