Physiological Effect of Potato Genotypes and Salicylic Acid on Plantlets Growth and Microtuber Production under Salt Stress

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Abstract: This study was conducted to investigate the effectiveness of SA (10 and 100 µmol) for induction of salinity tolerance of two potato genotypes "Proventa" and line "97-980" during vegetative and micro-tuberization stages. Results showed that decreasing of plantlet weight and length as well as microtuber weight under saline conditions differed according to genotypes and SA concentration. Although line "97-980" had low percentage of decreasing in weight and length of plantlets compared to "Proventa" under saline condition, Proventa cv. Gave high microtubers weight. Line 97-980 recorded high reducing sugars, phenolics, proline, amino acids and proteins as well as high activity of peroxidase (POD). On contrary, "Proventa" had high concentration of total chlorophylls and high activity of superoxide dismutase(SOD) and catalase (CAT).The decrease in plantlets growth was lower in line 97-980 compared to" Proventa" under low concentration of SA. Microtubers weight in "Proventa" was higher with addition of 10 µmol through increment in most investigated biochemical compounds and high antioxidants enzymes activity. It may be concluded that high content of reducing sugars, phenolics, proline, amino acids, proteins as well as high activity of POD could work as selectable markers for *in vitro* potato tolerance to salinity. Addition of low concentration of SA had beneficial effect on physiological acclimation to salinity in potato plantlets.

Keywords: *Solanum tuberosum* L.,biochemical compounds, antioxidants activity, salt tolerance, microprpagation

INTRODUCTION

Potato (*Solanum tuberosum* L.) is one of the most important vegetable crops in Egypt for local consumption and exportation. The total area devoted for production in the year 2016in Egypt was439.328 fed., with total production of about 5 million tons (average 11.5 ton/fed.). Worldwide, potato is the fourth most important crop, with an annual production of about 377 million tons, (FAO state; 2016). In Egypt, about 135000 tons of tuber seeds were imported in the year 2016 for summer plantation from European countries. The seed tubers costs were about £62.1 million every year.

Salinity is a serious problem for commercial agriculture worldwide where about one billion ha are affected by salinity (Christiansen, 1982). In this regards, potato is classified as moderately salt sensitive crop, whereas its ECs threshold is about 1.7dS/m (= 1088ppm) (Katerji *et al.*, 2002). However, more information are needed regarding the tolerance or sensitive genotypes to salt stress, due to the significant variation in salt tolerance among potato genotypes (Khrais *et al.*, 1998). Abiotic stresses, such as high salinity often result in significant losses to the yields of economically important crops such as potato (Ahmed and Rashid, 1990).

Plants constantly exposed to capricious conditions have adapted at the molecular, cellular, physiological and biochemical levels, enabling them to survive and cope with adverse environmental stresses. Bouaziz *et al.* (2012) and Marcek *et al.* (2014) reported an increase in proline accumulation. Also, Asensia-Fabado *et al.* (2014) found increase in total free amino acids with salinity stress. However, Potluri and Prasad (1993) reported that the proline accumulation under salinity stress was cultivar-dependent. In most cases, antioxidant enzymes activity such as superoxide dismutase (SOD) and catalase (CAT) increased in salt tolerant potato genotypes (Daneshmand *et al.*, 2010; Sajid and Faheem, 2014), however, in another study, the activity of SOD decreased with salinity stress (Zhang *et al.*, 2007). El-Magawry *et al*. (2015) reported that the interaction between potato genotypes and salinity grown under *in vitro* conditions was significant in some biochemicals such as proline and free amino acids as well as the activity of CAT and SOD. In some cases, their results indicated that the tolerant genotypes had less proline content and low activities of SOD and CAT, however, the sensitive genotypes had high proline, free amino acids and the activities of SOD and CAT.

The usual method for evaluation of salinity stress tolerance in plants is examining the field performance, but, the results are often unconvincing. Field trial is normally associated with the spatial distribution of salt, non-uniform moisture availability and temperature fluctuations during the growing season. This method involves considerable space, time, labor, equipment and planting material resources (Arvin and Donnelly, 2008).

The development of methods/strategies to ameliorate deleterious effects of salt tolerance on plants has received considerable attention and the use of Salicylic acid (SA) one of these strategies (Hayat *et al*., 2010). SA is involved in the regulation of pathogenesis-related protein expression, leading to plant defense against biotrophic pathogens (Dempsey *et al*., 2011). It also plays an important role in the regulation of plant growth, development, ripening, flowering, and responses to abiotic stresses (Rivas-San Vicente and Plasencia, 2011; Hara *et al*., 2012). In general, low concentrations of SA may enhance the antioxidant capacity in plants, but high concentrations of SA may cause cell death or susceptibility to abiotic stresses (Hara *et al*., 2012). The results of Sajid and Aftab (2012) proved that SA application at high levels (0.5 and 0.75 mM) did not improve salinity tolerance,

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however low concentrations (0.125 and 0.25 mM) proved quite effective in enhancing *in vitro* shoot and root growth in Cardinal and Desiree cultivars. Regarding to antioxidant enzymes, the results of Daneshmand *et al.*, 2009 showed that the activities of SOD, POD and CAT increased under salinity stress and their activities more increased when wild species of potato treated with salt (80 mM NaCl) and low concentration (1 µm) of acetylsalicylic acid (ASA).

Most of the previous research works on induction of salinity tolerance of potato under *in vitro* conditions using SA were done during only vegetative stage. Therefore, the main objective of this study was to examine the effectiveness of SA for the induction of salinity tolerance in two potato genotypes during vegetative and micro-tuberization stages. The sub aim of the study was examination of the physiological and biochemical changes associated with the tolerance or sensitivity to salinity stress of two potato genotypes (salt tolerant and sensitive to salt) using SA application.

MATERIALS AND METHODS

The current investigation was conducted at the Plant Tissue Culture laboratory of the Horticulture Department, Suez Canal University, Ismailia, Egypt during the year of 2016, to study the effect of salicylic acid application on induction salinity stress tolerance during morphological and microtuber-forming capacity of two different potato cultivars under *in vitro* conditions. Potato tubers from both tested genotypes were cultivated in pots containing wet vermiculite under glasshouse conditions until sprouting. Sprout of 5 cm long were collected for sterilization with 10%commercial bleach (2.5% hypochlorite) for 10 min, and then washed with sterile distilled water three times in alaminar-air flow hood. Meristem tip explants (0.3 mm) were excised from sprout shoot tips under binuclear microscope. Cultures were incubated at 25±2°C with16/8h day/night at 40 µmol $m^{-2}s^{-1}$ photon flux density (cool white fluorescent light). For micropropagation, MS (Murashige and Skoog, 1962) basal salts and vitamin (Duchefa Biochemi, the Netherlands) was used, supplemented with 3% sucrose and 0.7% agar. The medium was adjusted to5.8 pH before the addition of agar.

In vitro grown plants were propagated by subculture with 4 weeks interval for three sub-cultures before starting the experiment. Ten single node explants (about 1 cm) were sub-cultured into 350 ml ca. jars containing 30 ml MS free-medium. The proliferated cultures of 4 weeks old and approximately 10 cm long, avoiding the top and bottom node segments were used as the starting materials for subsequent trials. Media were sterilized by autoclaving at 121ºC and 1.05 $kg/cm^2$for 20 min., then dispensed into the tissue culture jars. After three subcultures, six single-node explants from the tested potato genotypes were transferred to MS medium with or without 100 mM NaCl supplemented with two different SA concentrations (10 and 100 µmol) plus control (without SA) with five replicates for each treatment. After 6 weeks, plantlet samples (one plantlet/jar) were taken from each treatment for morphological data, such as plantlet length and plantlet fresh weight. For microtuberization, 30 ml sterilized liquid MS medium amended with high sucrose level (80 g/l) were added to each jar containing the growing plantlets. Cultures were incubated in the dark at 18-20ºC for 2 months. Microtubers produced from each treatment were harvested and data were taken on number and weight (yield) of microtuber/jar and the average single microtuber weight were calculated by dividing weight/number.

Biochemical analysis

1-*Total chlorophylls:* A 0.5 g sample was ground with 10 ml 85% acetone and filtered (Arnon, 1949). Optical density was measured spectrophotometricaly at 644 and 662 nm. Concentration of total chlorophyll was calculated as mg 100 g^{-1}FW as follow: Total chlorophylls = 20.2 (A644) − 8.02 (A662).

2- *Reducing sugars* were determined (mg $1g^{-1}$FW) by Nelson's method with alkaline copper and arsenomolybdate reagents and measured spectrophotometricaly at 540 nm (described by Moore, 1974)

3- *Free phenolics* were determined (mg $100g^{-1}$FW) by a modified Folin-Ciocalteu method and measured spectrophotometricaly at 650 nm according to William *et al*. (1965).

4- *Free total amino acids* (mg $100g^{-1}$FW) were spectrophotometrically assayed by ninhydrin reagent at 570 nm according to the method described by Rosen (1957).

5-*Proline* (mg $100g^{-1}$FW) was estimated using the method described by Bates *et al.*, (1973).

6- Antioxidative enzymes assay: According to Urbanek *et al*. (1991), 0.2 g sample was homogenized by using a mortar and pestle with 0.1 M phosphate buffer (pH 6.5)at 4◦C and stirred for 20 min. The suspension obtained was filtered through one layer of muslin cloth and then centrifuged at 18,000g for 15 min at 4◦C. The supernatant was used to determine activity of enzymes and enzyme protein as follows:- Superoxide dismutase (SOD, E.C.: 1.15.1.1) was assayed by measuring the oxidation of nitroblue tetrazolium (75 mM) at 560 nm(Nakano and Asada, 1981). The SOD activity was expressed as unit per 1 mg of protein minute. Peroxidase (POD, E.C.: 1.11.1.7(activity was estimated by measuring the oxidation of O-dianisidine (0.1%) at 430 nm. One unit of peroxidase activity was taken as the change of 1.0 unit of optical density/mg protein min. Catalase (CAT, E.C.:1.11.1.6) activity was estimated by measuring the oxidation of H_2O_2(10%) at 240 nm in 30 s. intervals for 5 min. The unit of CAT activity was defined as the amount of enzyme which decomposes1 mM H_2O_2/mg protein min. at 25◦C (Urbanek *et al*., 1991).Total protein content (mg g^{-1}FW) was determined using 1 ml Bradford solution and 100^{-1}extract using bovine serum albumin as a standard (Bradford, 1976). All measurements were done using UV/VIS spectrophotometer, PG instrument Ltd, USA.

RESULTS

Effect of salinity and salicylic acid on plantlet growth using two different genotypes

The indicated results (Table 1) showed that the decreasing in plantlet fresh weight was 51.58% and 47.24% in "Proventa" and breed line "97-980", respectively by increasing salt concentration up to 100 mM NaCl comparing with control. However, the decreasing was 41.24% and 51.06%, in both genotypes, respectively by application of SA at low concentration. The decreasing percentage was 46.8% in "Proventa" plantlets grown on MS containing 100 mM NaCl +100 µM SA, however plantlets fresh weight of line "97-980" was increased under MS medium containing 100 mM NaCl + 100 µM SA comparing with plantlets grown on MS+100 mM NaCl. Regarding to shoot length, results (Table 1) showed that the decreasing in shoot length was 59.52% and 47.06% in cv. Proventa and breed line of "97-980", respectively by increasing salt concentration up to 100 mM comparing with control. At 10 µM SA, the decreasing was 41.24% and 43.29%, in both genotypes, respectively. However, the decreasing percentage in shoot length was 60.44% and 34.4% in both genotypes, respectively, in plantlets treated with 100 mM NaCl and 100 µM SA comparing with plantlets treated with only SA.

Table 1: Effect of SA on *in vitro* plantlet growth of two potato genotypes under saline and non-saline conditions

Genotypes	Salinity levels mM	SA concentrations µm	Shoot length (cm)	Plantlet FW (mg/plantlet)
Proventa	0.0	0.0	8.40 c	467.22 b
		10	9.70 a	521.96 a
		100	9.10 ab	343.62 c
	100	0.0	3.40 g	226.22 de
		10	5.70 de	306.68 c
		100	3.60 g	182.66 d
97-980	0.0	0.0	8.50 bc	327.67 c
		10	9.17 ab	346.37 c
		100	6.10 d	115.95 f
	100	0.0	4.50 f	172.88 e
		10	5.20 e	169.52 e
		100	4.00 fg	154.30 ef

Values followed by the same letter within a column are not significantly different at the 5% level of probability according to Duncan's multiple range test.

Effect of salinity and salicylic acid on microtuberization using two different genotypes

Results in Table (2) showed that the significant highest microtuber weight and non-significant highest microtuber number were found in "proventa" genotype grown on MS medium containing 10 µM SA without NaCl, followed by Breed line of "97-980" in the same medium. The increasing was more than two fold. Under saline conditions, the application of SA at low concentration (Table 2) non-significantly improved microtuber weight and number per jar of both tested genotypes (cv. Proventa and breed line of "97-980").

Table 2: Effect of SA on *in vitro* microtuberization of two potato genotypes under saline and non-saline conditions

Genotypes	Salinity levels mM	SA concentrations (µm)	Microtuber weight (mg/Jar)	Microtuber No./Jar
Proventa	0.0	0.0	404.33 c	4.67 ab
		10	864.25 a	5.50 a
		100	547.60 b	3.00 b-d
	100	0.0	45.50 e	1.50 c-e
		10	58.60 e	2.00 c-e
		100	0.00 e	0.00 e
97-980	0.0	0.0	223.85 d	4.50 ab
		10	574.43 b	4.67 ab
		100	452.45 bc	3.75 a-c
	100	0.0	40.80 e	1.00 de
		10	64.25 e	1.5 c-e
		100	37.60 e	1.5 c-e

Values followed by the same letter within a column are not significantly different at the 5% level of probability according to Duncan's multiple range test

Effect of salinity and salicylic acid on total chlorophylls, reducing sugars and free phenolics using two different genotypes

Results (Table 3) showed that the significant highest chlorophylls was found in cv. Proventa treated with low SA concentration (10 µM), however, the significant highest reducing sugars and free phenolics content were measured in breed line of "97-980" using 10µM SA under non-saline conditions (0.0 mM NaCl). Under saline treatment (100 mM NaCl), the results (Table 3) showed that the chlorophylls, reducing sugars and free phenolics were increased significantly by application of SA at low concentration (10µM) comparing with control or high SA concentration (100µM).

Table 3: Effect of SA on total chlorophylls, phenolics and reducing sugars of two potato genotypes under saline and non-saline conditions

Genotypes	Salinity levels mM	SA concentrations µm	Total Chlorophylls mg/100 g FW	Free phenolics mg/100 g FW	Reducing Sugars mg/g FW
Proventa	0.0	0.0	24.60 f	35.30 j	8.50 f
		10	77.40 a	116.30 d	20.00 c
		100	32.83 d	80.90 f	12.20 e
	100	0.0	23.10 g	35.90 j	1.80 h
		10	35.80 b	82.20 f	14.50 d
		100	34.80 c	50.70 i	3.20 h
97-980	0.0	0.0	22.40 g	59.10 g	6.20 g
		10	31.80 e	314.20 a	40.27 a
		100	22.80g	226.50 b	26.70 b
	100	0.0	13.80 h	111.90 e	10.90 e
		10	24.60 f	162.50 c	19.20 c
		100	22.80 g	54.80 h	2.80 h

Values followed by the same letter within a column are not significantly different at the 5% level of probability according to Duncan's multiple range test

Effect of salinity and salicylic acid on proline, free amino acids and protein content using two different genotypes

With regard to the effect of triple interaction, the results presented in Table (4) showed that the treated breed line of "97-980" with high salt concentration (100 mM NaCl) and low SA concentration (10µM) had the significant highest proline content and non-significant highest protein content. However, the significant highest free amino acids was found also in breed line of "97-980" treated with low concentration of SA under non-saline medium. In most cases, the application of SA at low concentration (10 µM) increased significantly proline, free amino acids and protein content in both genotypes grown in MS medium containing NaCl.

Table 4: Effect of SA on proline, free amino acids and protein of two potato genotypes under saline and non-saline conditions

Genotypes	Salinity levels mM	SA concentrations µm	Proline mg/100 g FW	Free amino acids mg/100 g FW	Protein mg/g FW
Proventa	0.0	0.0	15.80 j	168.00 h	15.50 f
		10	14.50 j	152.40 i	16.60 ef
		100	14.10 j	248.80 e	16.40 ef
	100	0.0	62.30 h	178.20 gh	24.20 b
		10	91.30 f	187.90 g	25.90 a
		100	80.40 g	74.40 k	16.00 ef
97-980	0.0	0.0	50.70 i	216.00 f	16.20 ef
		10	134.40 d	831.43 a	17.60 de
		100	140.60 c	429.70 b	27.40 a
	100	0.0	165.20 b	329.20 d	22.40 c
		10	208.20 a	392.20 c	26.10 a
		100	125.70 e	133.30 j	18.90 d

Values followed by the same letter within a column are not significantly different at the 5% level of probability according to Duncan's multiple range test

Effect of salinity and salicylic acid on antioxidant enzymes using two different genotypes

Concerning to the effect of triple interaction, the results presented in Table (5) showed that the treated breed line of "97-980" with high salt concentration (100 mM NaCl) and low SA concentration (10 µM) had the significant highest peroxidase activity. However, the significant highest catalase and superoxide dismutase were found in cv. Proventa treated with low concentration of SA grown in non-saline MS medium. Generally, the plantlets from both tested genotypes grown on MS medium containing SA at low concentration (10 µM) with or without salt (NaCl at 100 mM) increased the antioxidant activities and this effect was at significant level in some cases.

DISCUSSION

Plant growth parameters of potato plantlets such as plantlet length and plantlet fresh weight decreased with the salt treatment (100 mM NaCl) in the tissue culture medium. Under salt treatment plantlet length and plantlet fresh weight decreased by 47.7% and 43.7%, respectively. The observed reduction in growth parameters under salinity treatment could be the results of NaCl induced alteration in cell expansion and cell growth, as well as enzyme activities as cited by Silva *et al*. (2001). These effects also may lead to the development of other types of stresses such as oxidative damage to plants that may be responsible for reduced plant growth (Zhu, 2001).Recent report showed evidence for dormant (quiescent) state in the epidermal cell layers of roots under salinity stress, associated with

changes in ABA or GA biosynthesis, resulting in root growth restriction (Duan *et al*., 2013). Our results also indicated signification decline in total chlorophyll contents under high salinity level, which may lead to decreased net assimilation rate in micro shoots. It was concluded by Cui *et al*. (2007) that reductions in chlorophylls were the main reason affecting plantlet growth *in vitro*. Our results are in accordance with those of Daneshmand *et al*. (2009 &2010), Khenifi *et al*. (2011) and El-Magawry *et al*. (2015). Results also showed a reduction in microtuber induction and development at the salinity treatment (100 mM NaCl) compared to the control. Salinity negatively affected microtuber weight more than microtuber number. The finding that salt stress induced restriction in microtuberization may be attributed to several factors. Firstly, it is possible that under salinity stress, translocation of sugars, or biosynthesis of hormones responsible for microtuber induction might be restricted, whereas the high sucrose concentration in the medium serve as a signal for microtuber formation (Donnelly *et al*., 2003). Secondly, the increase in salt concentration in the medium resulted in reduction in plantlet growth and rooting capacities, which may lead to decreased nutrient uptake from the medium into potential site of microtuber formation (Dobranszki *et al*., 2005).The observed decreases in microtuberization under salt stress are in agreement with the results of Zhang and Donnelly (1997), Zhang *et al*. (2005) and El-Magawry *et al*. (2015). Under the conditions of this study, microtuber weight/jar decreased by 88.75% and 81.77% in "proventa" and line 97-980, respectively in response to *in vitro* salt stress comparing with control. The less reduction in microtuber weight in line 97-980 may be due to more accumulation of free phenolics, proline and free amino acids in their shoots under normal and stress conditions (Tables 4). Also, could be due to increasing the content of sugars and activity of peroxidase under stress treatment comparing with control, however "proventa" had less reducing sugars and low activity of peroxidase under salinity treatment comparing with control (Tables 3 and 5).

Table 5: Effect of SA on antioxidant enzymes of two potato genotypes under saline and non-saline conditions

Genotypes	Salinity levels mM	SA concentrations µm	Peroxidase U/mg protein.min	Catalase U/mg protein.min	Superoxide dismutase U/mg protein.min
Proventa	0.0	0.0	6.00 e	0.400 c	0.100 c
		10	11.70 c	1.300 a	0.600 a
		100	10.40 cd	0.200 de	0.200 b
	100	0.0	2.70 f	0.100 e	0.100 c
		10	10.00 d	0.400 c	0.200 b
		100	5.90 e	0.200 de	0.100 c
97-980	0.0	0.0	9.90 d	0.300 cd	0.200 b
		10	10.60 cd	0.600 b	0.200 b
		100	1.90 fg	0.200 de	0.100 c
	100	0.0	13.60 b	0.100 e	0.200 b
		10	16.30 a	0.200 de	0.200 b
		100	1.00 g	0.100 e	0.100 c

Values followed by the same letter within a column are not significantly different at the 5% level of probability according to Duncan's multiple range test

The indicated results demonstrated that the line 97-980 was more salt tolerant compared to "proventa", this may be due to higher accumulation of biochemical compounds i.e., reducing sugars, phenolics, proline, amino acids and proteins as well as high activity of peroxidase (POD). These results were agreed with Aloni and Rosenshtein (1984) who cited that proline plays an important role as osmoregulator under salinity conditions, proteins stabilizer, prevention of denaturation of enzymes and conservation of nitrogen and energy for a post-stress period. In addition, phenolics were protective agents as well as it had strong antioxidant properties that prevent cellular damage from oxidative stress generated by ROSs during salt stress. Amino acids were a precursor of different growth regulator compounds in plants (Taiz and Zeiger, 2006). PODS catalyze the breakdown of H_2O_2 to H_2O and O_2 in presence of ascorbic acid (Chang *et al*., 1984).

In "Proventa", high activity of SOD which transform superoxide free radicals ($O_2^{\cdot-}$) to hydrogen peroxide (H_2O_2) which directly converted to water and molecular oxygen (O_2) led to higher accumulation of total chlorophylls in plantlets under saline conditions. Our results supported by the results of Daneshmand *et al*. (2009) who reported that the wild potato species containing high photosynthetic pigments and antioxidant enzymes activities (POD, SOD and CAT) under salinity stress conditions (Zhu, 2001).

In the present study, treatment of salt-stressed "proventa" and line "97-980" plants with low concentration (10 µM) of salicylic acid (SA) resulted in increased growth and microtuberization of both the tested potato cultivars. These results supported the previous studies in which increase in salt tolerance in potato plants was observed by the application of salicylic acid at low concentrations (Daneshmand *et al*., 2009; Sajid and Aftab, 2012). It enhanced the growth parameters such as shoot length and shoot dry weight in plants as compared to only salt stressed-plants. Similar results have also been reported earlier in salt-stressed cucumber and maize plants where SA application resulted in higher values for plant growth parameters (Khodary, 2004; Yildirim *et al*., 2008). These ameliorative effects of SA on growth of stressed plants

may be due to the fact that SA potentiates the generation of reactive oxygen species and increases the production of H_2O_2 in plants that in turn reduce the oxidative damage under saline stress, as described, for example, in case of wheat (Wahid *et al*., 2007).

Our presented results showed that the contents of total chlorophylls, free phenolics, reducing sugars, free amino acids as well as the activities of CAT and SOD decreased under salinity treatment, however the application of SA at low concentration (10 µM) alleviated this reduction. Therefore, the higher microtuberizaion, especially under control (without salt) using low concentration of SA was due to the improvement of physiological and biochemical parameters mentioned before. In another side, the proline accumulation and the activity of POD increased by salinity and a further increasing was found in treated plantlets with low concentration of SA. Our results regarding the increase activity of POD in line "97-980" are supported by the results Sajid and Aftab (2009) who found that the activity of POD increased under salinity stress conditions (80 mM NaCl) and a further increasing were measured using acetyl Salicylic acid at low concentration, in comparison with high concentration.

SA at 100 µM was unfavorable concentration for increasing plant growth and microtuberization (Table 1 and 2) comparing with low concentration (10 µM). The presented results showed that the biochemical and physiological measured parameters such as total chlorophylls, free phenolics, reducing sugars, proline, free amino acids, protein and antioxidant enzymes were decreased in potato plantlets treated with high SA in comparison with low SA concentration (Tables 3-5). These finding were supported by the results of Daneshmand *et al*. (2009) and Sajid and Aftab (2012). Also, Miura and Tada (2014) summarized in their review article that the effectiveness of SA is dependent on the concentration of the applied SA. Generally, low concentrations of applied SA alleviate the sensitivity to abiotic stresses, and high concentrations of applied induce high levels of oxidative stress, leading to a decreased tolerance to abiotic stresses. In Arabidopsis, lee *et al*. (2010) found that the lower concentrations of SA (<50 µM) reduced the inhibitory effect of high salinity, while higher concentrations of SA (>100 µM) enhanced this effect.

CONCLUSION

Increment of reducing sugars, proline, amino acids, phenolics and protein as well as high activity of peroxidase may be selectable markers for salt tolerant genotypes in potato. Addition of 10 µmol of SA enhanced the growth and microtubers production of potato under saline condition. SA had beneficial effect on plantlets through increment of most biochemical compounds and high activity of antioxidant enzymes.

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التاثير الفسيولوجى للتركيب الوراثى واضافة حمض السالسيلك على نمو النباتات الصغيرة وانتاج الدرنات الصغيرة تحت ظروف الملوحة

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تم دراسة تاثير اضافة حمض السالسيلك بتركيز ١٠ و ١٠٠ ميكرومول لتحسين تحمل صنفين من البطاطس اثناء مرحلتى النمو الخضرى وتكوين الدرنات الصغيرة. اوضحت النتائج ان النمو الخضرى للنباتات الصغيرة وانتاج الدرنات الصغيرة يختلف تبعا للتركيب الوراثى وتركيز حمض السالسيلك. اظهر الصنف "line 97-980" مقاومة اعلى للملوحة من خلال نموه الخضرى وزيادة مقارنة بالصنف "٩٨٠ - ٩٧ line" . هذا التاثير ارتبط بزيادة تركيز السكريات المختزلة والبرولين والاحماض الامينية والفينولات ونشاط انزيمات البيروكسيديز. على العكس اظهر الصنف proventa ارتفاع تركيز الكلوروفيلات الكلية ونشاط انزيم السوبراوكسيد ديسميوتيز والكتاليز. اضافة التركيز المنخفض لحمض السالسيلك ادى لزيادة النمو الخضرى للنباتات الصغيرة وتكوين الدرنات فى كلا الصنفين من خلال زيادة تركيز معظم المركبات الكيميائية المقدرة ونشاط الانزيمات المضادة للاكسدة . يمكن التوصية بامكانية استخدام صفة زيادة تركيز السكريات المختزلة والبرولين والاحماض الامينية والفينولات ونشاط انزيمات البيروكسيديزكصفات انتخابية للنباتات المتحملة للملوحة فى البطاطس كما ان اضافة تركيز منخفض من حمض السالسيلك للبيئة يؤدى الى زيادة المقاومة الفسيولوجية لنباتات البطاطس تحت ظروف الملوحة.