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Enhancement of Antioxidant Enzymes Activities, Drought Stress Tolerances and Quality of Potato Plants as Response to Algal Foliar Application

Hanaa H. Abd El Baky[1,*], Osama A. Nofal[2] and Gamal S. El Baroty[3]

[1]*Plant Biochemistry Department, National Research Centre, Dokki, Cairo, Egypt;* [2]*Plant Nutrition Department, National Research Centre, Dokki, Cairo, Egypt;* [3]*Biochemistry Department, Faculty of Agriculture, Cairo University, Cairo, Egypt*

H.H. Abd El Baky

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Abstract: ***Background:*** Different types of environmental stress may induce several physiological, biochemical and molecular responses in several crop plants. According to a patent study, several types of low antioxidant defense compounds and the activity of various antioxidant defense enzymes are induced in plants grown under various biotic and abiotic stress factors.

Methods: In this work, the responses of potatoes plant treated with algae extract to drought stress were examined by evaluating the crop yield of tuber, cellular biological compounds (total carbohydrates and proteins), mineral composition and enzyme and non-enzyme antioxidant systems and total oxidative compounds.

Results: The yield of tuber, concentration of low antioxidant defense compounds (glutathione, ascorbate, carotenoids, total phenol, flavonoids and tocopherols) and the activity of various antioxidant defense enzymes (catalase CAT; peroxidase POD; ascorbate peroxidase APX and superoxide dismutase SOD) in tuber of treated potato plants with algae extract were significantly increased compared with that in non-treated plants. In addition, essential elements: Fe, K, Ca, Mg and P were accumulated at high concentration in treated plant than that in untreated plants. The screening of antioxidant activity of the ethanolic extract of tubers potatoes treated with algae extracts using the di-(phenyl)-(2,4,6- trinitrophenyl) iminoazanium radical (DPPH) assay radical-scavenging showed an appreciable reduction of the stable radical DPPH with an IC50 of 75 µg/ml.

Conclusion: The results suggest that the algae foliar extracts application can improve non-enzymatic and enzymatic antioxidant defense systems in potatoes plant cultivated under drought stress conditions, and it may be recommended for application in arid and semiarid regions.

Keywords: Algal foliar application, antioxidant compounds, drought stress, potato plants, potato tuber quality.

INTRODUCTION

The abiotic stress (drought, high saltiness and warmth) had a contrarily impact the survival, biomass creation and yields of the nourishment products up to 70% [1, 2]. Thereupon, debilitate the sustenance security around the world. Drying out anxiety caused by drought and saltiness seriousness is considered as the most common abiotic stress that cutoff points plant development and profitability [2, 3]. However, these conditions will essentially abatement crop efficiency sooner rather than later because of worldwide environmental change. For example, in 2003, during the European heated, crop production was decreased by about 30% [4]. In this manner, advancement of technical systems to affect stress resilience in plants is indispensable and reserves extraordinary consideration. The create stress tolerant plants are including rearing, hereditary building, and the utilization of plant development controllers (PGRs) or like PGRs substances [5].

Drought stress is perceived as the environmental stresses, which leading to decrease agricultural crop production worldwide. Plants respond to drought stress and acclimatize through various physiological and biochemical changes. Drought induces oxidative stress in plants, in which reactive oxygen species are produced [6, 7], which causes the over decrease of photosynthetic electron chain [8, 9] and may produce of ROS principally in chloroplasts and mitochondria [10, 11]. ROS are delivered in cell organelles that are included in dynamic electron transport like, chloroplast, mitochondria, peroxisomes, apoplast and their layers. These exceedingly responsive substances can modify ordinary cell digestion system through oxidative harm to layers, proteins, and nucleic acids. They can likewise bring about lipid peroxidation, protein oxidation and to prevent sensitive cellular components from ROS-induced damages [12, 13]. This system comprises enzymatic and non-enzymatic antioxidants. Cell reinforcement compounds, for example, super oxide dismutase (SOD), glutathione reductase (GR), catalase (CAT) and peroxidase (POD) and low antioxidant compounds, for example, ascorbic acid, glutathione, α-tocopherol, flavonoids and carotenoids assume a key part in rummaging those actuated species [14-16]. Regulation of the action of these catalysts may be essential variables in the resilience of different product plants toward environmental anxiety [17]. The connection between salt anxiety and enzy-

*Address correspondence to this author at the Plant Biochemistry Department, National Research Centre, Dokki, Cairo, Egypt; Tel/Fax: 012-2220568; E-mail: abdelbakyh@hotmail.com

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matic prevention agent frameworks in plants has been reported [18-20]. The enzymes of catalase (CAT), peroxidase (POD), and superoxide dismutase (SOD) and glutathione reductase (GA), assume a defensive part in searching ROS are important antioxidant enzymes that play key roles in eliminating superoxide(O_2^-) and hydrogen peroxide (H_2O_2) [21, 22].

Potato is one of the four major cereal crops in the world. It is an important agricultural and economic crop in Egypt with a large planting area. However, most of the potato planting area is in shortage of water resources and the water deficiency influences greatly the growth and yield of potato. Therefore, this study was taken under to find out the effect of algal foliar application on antioxidant enzymes activities, drought stress tolerances of potato plant.

MATERIALS AND METHODS

Chemicals

All solvents and reagents used in these experiments were purchased from E-Merck (Darmstadt, Germany) or Sigma–Aldrich CO. (St. Louis, MO, USA).

Experimental Design

The experimental work of this investigation was carried on Nubaria district at the Agricultural Experimental station of National Research Centre, Behira Governorate, during summer season 2013 (7^{th} of March) to study the improving of antioxidant enzymes activities and drought stress tolerances of potato plant and crops quality as affected to application of algal foliar application. The experiment area as one feddan [1 fed = 4200 m^2] experimental plot was 700 m^2 (20 X35 m). Potato tubers planted in rows 75 on a part between rows on 1^{st} March with one ton tuber/fed using Sponta variety. The natural compost was connected at the rate 12 m^3/bolstered before crude building up, 75 Kg P_2O_5/sustained were applied during soil preparation. A 180 Kg N/fed was applied divided into 5 folds starting from sowing until 60 days after sowing, 48 Kg K_2O/fed were applied 60 days after sowing. Fresh green algae were applied as foliar application on the plants. The used rates were 0.0 and 1.5g/L respectively which equal zero and 300g/200L water/fed.

The experimental was established according to randomized complete piece plan with three recreates. The green growth was splashed two times, the first at vegetative development (50 days in the wake of sowing) and the second at tuber arrangement (60 days in the wake of sowing). Agent leaf tests were taken from fourth leaf from each reproduce following two weeks from the second shower leaf.

Potato Yield

At development, the tubers from each trial until were gathered, weighted and afterward individual from tuber/plant, average of tuber weight, tuber yield/plant as well as per Fadden were determined as shown in Table **3**. The tubers were stored in a controlled domain at 4°C until the tissue tests were readied for determination of antioxidant compounds (phenolics, flavonoids, vitamin A, vitamin E, and vitamin C), micro and macro- elements, total carbohydrates and protein Table (**3**). Meteorological data of experimental farm of National Research Centre from 1-10-2012 to 1-10-2013 were controlled and presented in Table **1**.

Table 1. Meteorological data of experimental farm of National Research Centre from 1/10/2012-1/10/2013.

Date	Air Temperature		ETo	Win Direct	Precipitate	HC Relative	
	[°C]		[mm/d]	[deg]	[mm]	[%]	
	Min	Max	Aver	Aver	Sum	Min	Max
01/10/2012	22.6	31.1	2.1	178	3.6	21	100
01/11/2012	17.2	26.4	2	182	802	24	100
01/12/2012	11.5	20.7	1.9	219	12.8	19	100
01/01/2013	10.1	16.7	1.8	213	19.8	18	100
01/02/2013	10.9	18.3	2.5	198	576.8	12	100
01/03/2013	13.8	23.2	4	174	115.2	7	100
01/04/2013	18.4	29.3	4.9	204	0	5	100
01/05/2013	23.7	33.2	6.1	215	0	6	100
01/06/2013	16.67	-6.1	27.1	262	0	5	100
01/07/2013	19.43	8.3	27.9	284	0	20	100
01/08/2013	20.38	8.8	27.7	262	0	21	100
01/09/2013	17.87	3.3	26	228	0	10	100
01/10/2013	13.96	3.3	24.1	251	0	10	100

Extraction of Cytosolic Fraction

A portion (300 mg) of potato leaves was homogenized in 10 ml of 0.4 M sucrose/ 25 mM buffer containing Tris (pH 7.2). Then, the homogenate was filtrate through 4 layers of trick material and centrifuged at 12,000 xg for 15 min at 4°C. The filtrate was utilized for determination of enzyme activity, lipid oxidation product and soluble protein.

Enzyme Activity Assays

Catalase (CAT, EC 1.11.1.6) activity was assayed in a 1 mL reaction mixture containing 50 mM potassium phosphate buffer (pH 7.0), 10 mM H_2O_2 and 0.05 mL of enzyme extract. The subsequent decomposition of H_2O_2 was determined spectrophotometeracally at 240 nm (λ=240 nm every 10 sec for 5 min at 22°C, E= 0.0394 $mM^{-1}cm^{-1}$) [23].

Ascorbate peroxidase (APX, EC 1.11.1.11) activity was determined in a 1 mL enzyme extract containing 25 mM potassium phosphate buffer (pH 7.0), 0.25 mM ascorbic acid, 0.1 mM EDTA, 0.1 327 mM H_2O_2 and 0.05 mL of enzyme extract. The subsequent decrease in ascorbic acid was determined spectrophotometeracally at 290 nm (E=2.8 $mM^{-1}cm^{-1}$) [24]. A unit of APX is defined as the amount necessary to oxidize 1 µmol of ascorbate min^{-1} at 25°C (290 nm extinction coefficient of 2.8 L $mmol^{-1}cm^{-1}$).

Total superoxide dismutase (SOD; EC, 1.15.1.1) activity was determined by the inhibition of the photochemical reduction of the chloride nitroblue tetrazolium (NBT) at 560 nm. The enzyme activity was expressed as unit (U) mg^{-1} protein and one SOD unit was defined as the quantity required to inhibit 50% of photoreduction rate of NBT inhibited 50% of NBT [25].

Total peroxidase (POD, EC 1.11.1.7) activity was spectrophotometrically determined by measuring the oxidation rate of *o*-dianisidine (3,3'-dimethoxybenzidine) at 460 nm [24]. The reaction mixture contained 20 mM phosphate buffer (pH 5.0), 1 mM dianisidine, 3 mM H_2O_2 and 50 µl of enzyme extract. POD specific activity was expressed as units (µmol of dianisidine oxidized per minute) per mg of protein.

Determination of Soluble Protein

To normalize the enzyme activity the soluble protein in potato cytosolic extracts was spectrophotemtric determined at 595 nm, using comassein blue G 250 as a binding dyes [26]. Cow-like serum egg whites (BSA) was utilized as a protein standard.

Determination of Total Carotenoids

The total carotenoides were spectophotometrically determined at 450 nm as recorded by Lichtenthaler method [27]. ß-Carotene was used to preparation of the calibration curve (2–30 g/ml).

Determination of Total Tocopherols and Ascorbic Acid

The total tocopherols and ascorbic acid contents in potato plant were spectrophotometrically determined as mentioned in methods of AOAC [28] and Augustin *et al.* [29], respectively.

Determination of Total Phenolic Content

Total phenolic contents were assayed using the Folin–Ciocalteu reagent [29]. An aliquot (0.125 ml) of a suitable diluted methanolic potato extract was added to 0.5 ml of deionised water and 0.125 ml of the Folin–Ciocalteu reagent. The mixture was shaken and allowed to stand for 6 min, and then 1.25 ml of 7% Na_2CO_3 solution was added. The volume was adjusted with deionised water to a final volume of 3 ml and mixed thoroughly. After incubation for 90 min at 23°C, the absorbance versus prepared blank was read at 760 nm. Total phenolic contents (three replicates per treatment) were expressed as mg gallic acid equivalents per gram (mg GAE/g) through the calibration curve with gallic acid standard phenolic compounds.

Total Flavonoid Content

Total flavonoid contents were measured using $AlCl_3$ reagent [30]. A total of 250 µl of methanolic extract was mixed with 75 µl $NaNO_2$ (5%). After 6 min, 150 µl of 10% $AlCl_3$ and 500 ml of NaOH (1M) were added to the mixture and adjusted to 2.5 ml with distilled water. The absorbance was recorded at 510 nm against blank sample. Catechin was used to preparation of the calibration curve (50–500 mg/ml).

Determination of Total Carbohydrates

Total carbohydrates were estimated by phenol/ sulfuric acid reagent using the method of Dubois *et al.* [31].

Micro and Macro Elements Determination

Advanced Microwave Digestion System was used for digestion plant samples. The concentrations of micro and macro elements were determined by using Inductively Coupled Plasma (ICP-AES), Thermo Sci., model: ICAP 6000 series.

Determination of Total Protein Content

Crude protein content was determined as total nitrogen content in fresh matter (ca. 0.2 g) of potato tubers multiplied by a factor of 6.25. Total nitrogen content was determined after digested using a micro Kjeldahl apparatus [AOAC, 28].

Antioxidant Activity of Potato against DPPH Scavenging Radical

The antioxidant capacity of the obtained potato extracts was measured by bleaching of the purple-coloured solution of the DPPH radical according to the method of Tagashira and Ohtake [32]. A total of 1 mL of different concentrations of extracts prepared in 80% methanol was added to 0.5 ml of a 0.2 mmol/l DPPH methanolic solution. The mixture was shaken vigorously and kept at room temperature for 30 min. The absorbance of the resulting solution was then measured at 517 nm after 30 min. The antiradical activity was expressed as IC_{50} (lg/ml), the concentration required to cause 50% DPPH inhibition. The ability to scavenge the DPPH radical was calculated using the following equation:

$$\text{DPPH scavenging effect \%} = [A_o\text{-}A_1/ A_o] \text{ X } 100$$

where A_0 is the absorbance of the control at 30 min, and A_1 is the absorbance of the sample at 30 min.

Statistically Analysis

The data were statistically analyzed according to Snedecor and Cochran [33].

RESULTS AND DISCUSSION

Effect of Drought Stress on Potato Leaves Antioxidant Enzymes Activities

The study area lies in Nubaria district, a west desert of Egypt. The Meteorological data illustrated in Table **1** shows: the mean maximum temperatures recorded from 16.7°C to 36.6°C in January and August, respectively, and the mean minimum air temperatures vary from 10.1°C to 27.9 in January and July respectively. The average sum of precipitate was ranging between 0.0 mm in Feb. to 576.8 mm in April (2013). The average wind direct (deg) ranged between 174 in March to 284 in July. Most the minimum values of HC Relative (%) occurred during March to June. The daily potential evapotranspiration [ETO (mm/d) ranged between 1.8 mm/d in Jan and 6.4 mm/d in June. All these information indicated the presence of drought condition in Nubaria district where potato crop grown.

Effect of Drought Stress on Potato Leaves Antioxidant Enzymes Activities

The antioxidant enzymes are play important physiological roles as the defensive system in plants (internal protective enzyme-catalyzed clean up system against of active oxygen, ROS), which is fine and expound enough to evade wounds of ROS ($^1O_2$, $OH^{\cdot}$ and $^{\cdot}O_2$), in this way ensuring ordinary cell capacity [34]. To minimize the effect of ROS anxiety, plants have enhanced developed a complex of antioxidant enzyme systems including superoxide dismutase (SOD), peroxidase (POD), catalase (CAT), ascorbate peroxidase (APX) [35]. In this study, spraying of potato plant grows under drought stress with algal foliar led to increasing enzymes activity of SOD, POD, APX and CAT with values of 34.65, 41.21, 285.32 and 28.34 U/mg protein /min, respectively. These values were found to be 31.43, 37.76, 267.32 and 24.23U/mg protein /min in un-treated potatoes tuber as shown in Table **2**. These enzymes assume a key part in searching or disposal of from ROS items in the mitochondrion, cytoplasm and peroxisome [14]. Thus, help in improving the impending impacts of oxidative anxiety. Therefore, antioxidant enzymes play a role in maintaining plant against oxidative damage [36]. The capability of antioxidant enzymes to scavenge ROS and reduce the damaging effects may correlate with the drought resistance of plants. Ahmad *et al.* [37] reported that, the changes of antioxidant enzymes activity were identified in numerous types of plants in light of antagonistic natural conditions, for example, abiotic, biotic and formative jolts. Sofo *et al.* [38] found that the increased of SOD (is play an important role to convert superoxide radicals to H_2O_2 and O_2 in the cytosol, mitochondria and chloroplast), APX, CAT (is one of the key enzymes for converting H_2O_2 to H_2O and O_2) and POD in olive plants grown under salt and drought stress. Similar results for CAT and APX activities induced in salt-tolerant tomato, sugar beet and rice have been reported [37]. On the other hand, keeping up a larger amount of antioxidant enzymatic and non-enzymatic systems may add to dry spell affectation by expanding the limit against oxidative damage [37]. Similar results have been obtained in relation to the effect of salt and drought on the activity and levels of the various antioxidant enzymes.

The Effect of Drought Stress on Tuber Yield

It is realized, the potato genotypes fluctuated in their response to dry spell stress, the most prominent misfortune in tuber yield was seen in potatoes plant developed under drought stress. The decline of yield was not out of the ordinary since the dry season is a standout amongst the most critical abiotic hassles constraining the efficiency of harvest plants [40]. Plants need adequate water for their development, or more all photosynthesis is connected with water use [41]. Potatoes were found to be extremely sensitively towards drought stress [42]. The yield of tuber in the plant was less purported inside of drought focused on plants (101.59 g/plant) and total potato yield (12.69 Ton/fed.) than within plant treated with algae foliar (168.30 g/plant) and (17.10 Ton/fed.) as shown in Table **3**. Ruso and Berlyn, [42] suggested that natural bio-stimulants present in the seaweed extract could enhance nutrient uptake due to the improvement of the membrane permeability. The presence of phytohormones such as gibberellins, seaweed and cytokines on seaweed extracts would promote the endogenous hormonal activity in the plant [43, 44]. In addition, Perez-Sanz and

Table 2. Influences of Algal Foliar Application on antioxidant enzymes activities of potato leaves grown in drought stress conditions.

Enzyme (U/mg protein /min)	Treatment		L.S.D. 0.5%
	Without algal foliar	With algal foliar	
SOD	31.43[a]	34.65[b]	1.23
POD	37.76[a]	41.21[b]	1.36
APX	267.32[a]	285.32[b]	5.56
CAT	24.23[a]	28.34[b]	1.43

Means in the rows followed by the same letter are not significantly different according to Duncan's multiple-range t-test at $p < 0.05$.

Table 3. Effect of fresh green Algae Foliar Application on potato yield and its quality in demonstration field during summer 2013.

Treat.	Character / Rep.	No. Average of Tuber/Plant	Weight Average of Tuber/Plant (g/plant)	Weight Average of Tuber/Plant (g/plant)	Total Yield/fed. Ton/fed.
Cont.	Rep_1	3.94	89.96	354.44	12.142
	Rep_2	3.24	103.16	334.23	13.115
	Rep_3	4.15	111.65	463.34	12.800
	Ø	3.78	101.59	384.00	12.686
Treat.		5.36	165.31	766.01	17.167
		4.35	170.33	649.83	16.341
		4.88	169.25	715.84	17.101
	Ø	4.86	168.30	710.56	16.870
L.S.D.5%		0.86	22.07	199	2.25

Lucena [45] assumed that seaweed extracts promoted plant growth by increasing the efficiency of nutrients. All these facts are important on potato yield and could explain the improvement of the production.

Biochemical States of Potato Tuber

Micro and macro mineral concentrations in potatoes tubers have differed significantly in treated and untreated plant with algae foliar Table **4**. In general, the levels of Mn, Zn, Se, Cr, and Co did not show any significant differences between treated or untreated plants. The mineral concentration of Fe, K, Ca, Mg and P were significantly increased (P>0.05) in treated potato's plant when compared with that in untreated plants. High elemental composition in the treated plant may be due to a higher its selectivity or to higher rates of water uptake in plants treated with algae foliar so improve element imbalance in a certain degree. The changes in the total carbohydrates and proteins contents of the potatoes treated or untreated with algae foliar are presented in Table **3**. The total proteins and total carbohydrates contents were significantly (P>0.05) increased in treated plant (5.11% and 27.70 % respectively compared with that in untreated potatoes tubers (4.35% and 26.11% respectively) Table **5**, which could explain high tuber yield obtained in treated plants. However, many sugars with non-reducing and no energetic role, such as the oligosaccharides (raffinose and stachyose) and sugar alcohols like mannitol or sorbitol were found to accumulation at high amounts in different plant species in response to a broad range of abi-

Table 4. Effect of Algal Foliar Application on mineral composition of potato tuber.

Elements mg/kg, ppm	Treatment		L.S.D.5%
	Without Algal Foliar	With Algal Foliar	
K	10.45a	11.65b	0.76
Mg	1.03a	1.13b	0.08
Ca (ppm)	2.17a	4.63b	1.86
Cr (ppm)	0.18a	0.17a	**N.S**
Cu (ppm)	0.001	0.003	0.001
Fe (ppm)	2.48	5.35	1.54
Mn (ppm)	0.03	0.03	**N.S**
Se (ppm)	0.014	0.016	**N.S**
Zn (ppm)	0.02	0.02	**N.S**
Ni (ppm)	0.009	0.008	**N.S**
Pb (ppm)	0.001	0.001	**N.S**
Cd (ppm)	0.001	0.001	**N.S**
Co (ppm)	0.005	0.005	**N.S**
P (mg/100g)	401.66	508.33	85.4

Table 5. Effect of Algal Foliar Application on and protein contents of potato tuber.

Treatment	Total Carbohydrate %	Total Protein %
	F.W	F.W
Without Algal Foliar	26.44[a]	4.34[a]
With Algal Foliar	27.78[b]	5.10[b]
L.S.D. 0.5%	0.34	0.36

Means in the columns followed by the same letter are not significantly different according to Duncan 's multiple-range t-test at $p < 0.05$.

otic stress conditions such as drought or salinity. These sugars have been associated to a reduction in oxidative membrane damage and ROS scavenging due to its action as scavengers of hydroxyl radicals [46]. In general, many plants which show increased of protein and carbohydrates have been found to be good abiotic stress tolerant. Thus, the results revealed that algae foliar may contain some substances have the ability to enhances the treated potatoes to the biosynthesis of polyols compounds to in response to drought stress.

Effect of Drought Stress on Low-antioxidant Compounds

The quantity of total low antioxidant compounds includes: carotenoids, tocopherols, ascorbic acid flavonoids and total phenolic and total flavonoids contents of potato tuber of plants spray without algal foliar or without algae foliar, are shown in Table **6**. The concentration of these components showed a significant difference ($P < 0.05$) between treated and untreated samples. Spraying of potato tuber with algal foliar caused significant increase in accumulation of tocopherols, ascorbic acid, phenolic, flavonoids and Carotenoids (0.395 µmol /g F.W, 0.651 µmol/g F.W, 1.98 mg/g F.W, 0.88 mg/g F.W and 0.542 mg/g FW of defatted potato tuber, respectively) in yielded tuber compared with that in un-treated plants (0.256 µmol /g F.W, 0.421 µmol/g F.W, 1.45 mg/g F.W, 0.66 mg/g F.W and 0. 341 mg/g FW respectively). Thus, spraying plant with algal foliar increased the content antioxidant compounds in yield potato tuber crops. This discovering obviously proposes that cell reinforcement mixes in tuber of plants developed under dry spell anxiety were fundamentally affected by algal foliar treatment. In wheat plant grow under salinity stress (seawater up to 20%), low antioxidant GSH, carotenoids, tocopherols and phenols were increased significantly in wheat leaves of plants treated with microalgae foliar [47]. However, the levels of non-enzymatic (glutathione, ascorbate, carotenoids, phenolic and tocopherols) content in potato tuber grown under stress condition were comparable to previous findings in several plants grows under drought and salt stress [15, 48]. Thus, under stress conditions, the increasing of concentration of non-enzymatic antioxidants in grow plants were cooperated to maintain the integrity of the photosynthetic membranes and other physiological processes. Several types of phenyl–propanoid compound including coumarins and flavonoids are induced in plants grown under various biotic and abiotic stress factors [49].

The DPPH Radical Scavenging of Potatoes Tubers

DPPH method to evaluate the ability of plant extracts to scavenge free radicals generated from DPPH reagent as shown in Table **7** [50]. Ethanolic extracts of potatoes tubers treated or untreated with algae extracts showed good DPPH radical scavenging activity as expressed with values of 50% inhibition of DPPH radicals were 100 µg/ml and 75 µg/ml, respectively. Thus, tubers of plant treated with algae extracts showed good antiradical activity and their free radical-scavenging activity may be greatly associated with their antioxidants non-enzymes contents in plants. Although the tuber potatoes extract contained a high amount of total phenolic contents, it showed a less DPPH radical-scavenging than that standard antioxidant, ascorbic acid (35g/ml).

CONCLUSIONS

Drought stress influences the development, dry matter and yield of potatoes tubers were expansion as a reaction to

Table 6. Effect of Algal Foliar Application on antioxidant compounds content in potato tuber grown in drought stress conditions.

Compounds	Treatment		L.S.D. 0.5%
	Without algal foliar	With algal foliar	
Carotenoids (mg/g F.W)	0.341	0.542	0.03
Tecopherols (µmol/g F.W)	0.256	0.395	0.04
Ascorbic acid (µmol/g F.W)	0.421	0.651	0.02
Phenolic (mg/g F.W)	1.45	1.98	0.12
Flavonoids (mg/g F.W)	0.66	0.88	

Table 7. Antioxidant activity (IC_{50}) of potato tuber grown under drought conditions as effected with Algal Foliar Application.

Treatment	IC_{50} (µg/ml)
Ascorbic	35
Without Algal Foliar	100
With Algal Foliar	75

treated with green growth foliar in plant developed under dry stress. This impact may be because of the rummaging of receptive oxygen species by enzymatic and non-enzymatic frameworks, to keep up the cell film stability, lipids and proteins substance are viewed as fundamental systems of drought resistance.

CURRENT & FUTURE DEVELOPMENTS

More specific on using of algal foliar in application on different crops to enhancement stress tolerances of plant.

CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

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