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Effect of Banana Peel Extract or Tryptophan on Growth, Yield and Some Biochemical Aspects of Quinoa Plants under Water Deficit

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Abstract : Egypt presents a distinctive example of the drought problem faced in some arid and semi-arid regions. Water deficiency which often linked with other major abiotic stress such heat stress, salinity stress, etc. so, it is considered as one of the main factors responsible for crop productivity reduction. Thus, water conserving is becoming a crucial consideration for agriculture. In order to conserving water two field experiments were conducted during two successive seasons at the experimental Station of National Research Centre, Nubaria district, El-Behera Governorate-Egypt to compare the physiological role of tryptophan with 50 &75 mg/l, and banana peel extract at 500 and 1000 mg/l concentrations in improving growth, antioxidant defense system and productivity of quinoa plant under skipping irrigation. Meanwhile, Exogenous application of banana extract and tryptophan led to marked increases in growth characters (plant height, shoot, root fresh and dry weight) concomitantly with an increase in the levels of IAA, photosynthetic pigments, phenol, free amino acid contents and yield components, as compared with the control with skipping irrigation. Regarding to antioxidant activity different treatments increased antioxidant enzymes activities of quinoa plant. Moreover, treatments increased seed yield and its components, also a marked increase in nutritional values of the yielded seed (carbohydrate contents, protein%, flavonoids and antioxidant activity). It is noticed that banana extract especially at 500 mg/l was more pronounced than tryptophan in increasing most of the tested parameters of quinoa plant.
Keywords: Banana peel extract, Growth, Quinoa, Sandy soil, Tryptophan, Yield.

Introduction

Quinoa (*Chenopodium quinoa* Willd) is an original food crop can replenish part of foodstuff gap. It is a food crop recently introduce in Egyptian lands. Because of its high nutritive value seeds can be utilized for human food, in flour production and in animal feedstock[1]. Quinoa could be used in bread in combination or substitution of with wheat and other seed products[2]. Moreover, quinoa is considered as a multipurpose crop because of the high-quality protein seeds, especially rich in essential amino acids, minerals, carbohydrates, antioxidant compounds as carotenoids, flavonoids, vitamin C and dietary fiber compared to that of cereals such as corn, oat, rice and wheat[3]. Quinoa crop was chosen by FAO as one of the important crops which play major role in food security assuring in the 21th century due to its high nutritional value and its good tolerance to adverse climatic conditions[4].It is recommended as useful essential food industries for formulations of baby gluten-free foods[5]. Also, because this crop can grow in sandy soil of arid and semiarid regions so, it is used to replenish part of food gap.

Egypt presents a distinctive example of the drought problem faced in some arid and semi-arid regions. Water deficiency which often linked with other major abiotic stress such heat stress, salinity stress, etc. so, it is considered as one of the primary factors responsible for crop productivity reduction[6]. Thus, water conserving is becoming a crucial consideration for agriculture. Water deficiency caused adverse effect on plants via reduced growth, nutrient attainment reduction and alteration, in water status of plants[7]. During photosynthesis, water deficiency induced reduction of photosynthetic efficiency[8] because increased accumulation of reactive oxygen species [9].

Amino acids as organic nitrogenous compounds are the building blocks in the synthesis of proteins[10]. The use of amino acids as a precursor of plant growth promoters is one approach to minimize the effect of water stress on plant growth and productivity. A common precursor of plant hormone auxin is L-Tryptophan, which affects the physiological processes of plants after uptake directly or indirectly after transforming into auxins (IAA)[11]. L-tryptophan is an amazing amino acid. It may act as an osmolyte, ion transport regulator, modulates stomatal opening and detoxify harmful effects of heavy metals[12, 13]. Moreover, the tryptophan pathway plays a defensive role in plants [14].

Natural antioxidants can be obtained from plant wastes which are transferred to compost rich by the nutritious organic matter to be returned to the soil for fertilization. Moreover, plant wastes can be extracted by simple methods to obtain natural antioxidants. The industrial by-products contain peels, equivalent to 40% of the total weight of fresh banana, generated as a waste product[15]. These are used as fertilizer or discarded in many countries as solid waste at large expense. Potential applications for banana peel depend on its chemical composition. Banana peel is rich source of natural phenolic compounds, antioxidants as vitamins, flavonoids and K element which is necessary for plants growth [16]. Banana peel is rich in nutritional ingredients such as in dietary fibre, proteins, essential amino acids, polyunsaturated fatty acids and potassium[17]. It contains common growth promoting substances, which may be involved (as foliar or soil applications) in the mechanism of induction of growth in various plant species[18, 19]. Moreover, [20]reported that, banana peel extract has high contents of vitamin A as beta carotene, vitamin C, amino acids especially tryptophan, protein, carbohydrates, macro and micronutrients, phenolic compounds, fat and fibers

Therefore, the present study investigates the ability of quinoa plant's grown sandy soil conditions in Egypt. To compare between the physiological roles of L-tryptophan and banana peel waste (as a natural source of antioxidants) in improving growth, some biochemical aspects , yield and nutritional values of the yielded of quinoa seeds.

Materials and Methods

Plant material and growth conditions:

A field experiment was conducted at the Experimental Station of National Research Centre, Nubaria district Beheira Governorate, Egypt, during two successive seasons of 2013/2014 and 2014/2015. The soils of both experimental sites were reclaimed sandy soil where mechanical and chemical analysis is reported in Table (1) according to [21].

Table 1: Mechanical and chemical analysis of the experimental soil sites.

A. Mechanical analysis:

Sand		Silt 20-0µ%	Clay < 2µ%	Soil texture
Course 2000-200µ%	Fine 200-20µ %			
47.46	36.19	12.86	4.28	Sandy

B. Chemical analysis:

pH	EC dSm^{-1}	$CaCO_3$	OM %	Soluble Cations meq/l				Soluble anions meq/l			
				Na^+	K^+	Mg^+	Ca^{++}	CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}
7.60	0.13	5.3	0.06	0.57	0.13	0.92	1.0	0.0	1.25	0.48	0.89

Available nutrients						
Macro element ppm			Micro element ppm			
+N	P	K	Zn	Fe	Mn	Cu
52	12.0	75	0.14	1.4	0.3	0.00

Seeds of quinoa (*Chenopodium quinoa* Willd.) were obtained from Agricultural Research Centre Giza, Egypt. The experimental design was in randomized complete block with four replications, quinoa seeds were sown on November in both seasons in rows 3.5 meters long, and the distance between rows was 20 cm apart. Plot area was 10.5 m^2 (3.0 m in width and 3.5 m in length). The recommended agricultural practices of growing quinoa were applied. Pre-sowing, 150 kg/feddan of calcium super-phosphate (15.5% P_2O_5) was applied to the soil. Nitrogen was applied after emergence in the form of ammonium nitrate 33.5% at a rate of 75 Kg/feddan in five equal doses before the 1^{st}, 2^{nd}, 3rd, 4^{th} and 5^{th}irrigation. Potassium sulfate (48.52 % K_2O) was added in two equal doses of 50 kg/feddan, before the 1^{st} and 3^{rd}irrigations. Irrigation was carried out using the new sprinkler irrigation system where water was added every 5 days. Skipping the irrigation at 50 and 65 days after sowing

Materials:

The applied substance tryptophan used in the present work was supplied from Sigma Chemical Company, St. Louis, MO, USA.

Extraction of banana peel:

Banana peel wastes collected from fruits. The collected banana peel was air-dried, powdered and kept for extraction. The resulting powder (500 g) was extracted with 2L of distilled water and left to stand for 48 hours at room temperature. The extract was centrifuged at 4500 rpm for 10 min. After centrifugation the residue was reextracted twice with water as described above. The crude aqueous extract was concentrated using rotary evaporator under reduced pressure at 45oC then the concentrated extracts were lyophilized and kept at -20°C.

The plants were sprayed twice with banana extract (500 & 1000 mg/l) and tryptophan (50 & 75 mg\l) while control plants were sprayed with distilled water during vegetative growth at 45 and 60 days after sowing. Data Recorded two weeks after the second spraying at 75 days from sowing plant samples were collected to determine plant height; fresh and dry weight of shoot and root as well as some biochemical parameters in leaves photosynthetic pigments, indole acetic acid contents total phenol contents, total free amino acid.

At harvest, the following items were estimated: plant height, fruiting branches number /plant, weight of seeds/ plant, weight of 1000 seeds and. Air dried seeds were ground into fine powder and kept in desiccators for analysis. Some chemical parameters are measured in the yielded grains as proteins %, carbohydrates %, flavonoids, and antioxidant activity.

Chemical analysis:

Photosynthetic pigments: Total chlorophyll a and b and carotenoids contents in fresh leaves were estimated using the method of Lichtenthaler H.K. et al [22]. Indole acetic acid content were extracted and analyzed by the method of Larsen et al[23]. Total phenol content, the extract was extracted as IAA extraction, and then measured as described by Danil, et al [24]. Free amino acid was determined with the ninhydrin reagent method Yemm & Cocking 25. The antioxidant enzyme (Superoxide dismutase. (SOD, EC 1.12.1.1) activity was spectrophotometrically assayed at 560 nmby nitro-blue-tetrazolium(NBT) reduction method Chen & Wang [26]. Catalase. (CAT, EC 1.11.1.6) activity was determined spectrophotometrically by following the decrease in absorbance at 240 nm Chen and Wang [26]. Peroxidase. (POX, EC 1.11.1.7) activity was spectrophotometrically assayed by the method of Kumar & Khan [27]. Determination of total carbohydrates was carried out according to Herbert D et al [28].Total protein concentration of the supernatant was determined according to the method described by Badford M.M. [29]. Total flavonoids were determined using the method reported by Changet al [30]. The antioxidant activity (DPPH radical scavenging) was determined using the method of Liyana-Pathiranan et al [31].

Statistical analysis:

The data were statistically analyzed on complete randomized design system according to [32]. Combined analysis of the two growing seasons was carried out. Means were compared by using least significant difference (LSD) at 5% levels of probability.

Results

Growth parameters:

The growth parameters of quinoa plants in response to treatment with different concentrations of banana peel (500 & 1000) and tryptophan (50 & 75mg/l) and grown under water deficit (by skipping irrigation) are presented in Table (2). Results are reveal that, using banana peel extract and tryptophan as foliar treatment at different concentrations increased shoot length, shoot fresh and dry weight as well as root fresh and dry weight of quinoa plant as compared with control plant. While, the highest plant fresh and dry weight (shoot, root) were recorded at 500 mg/l banana peel. As the percentage of increases in response to 500 mg/l banana peel extract reached to 47%, 74%, 76%, 52% and 60% in shoot length, fresh and dry weights of shoots and roots as compared to untreated control.

Table 2: Effect of Banana peel extract or Tryptophan on growth parameters of quinoa plant at 75 days after sowing grown in water deficit.

Material mg/l		Shoot length (cm)	Shoot FW (gm)	Shoot DW (gm)	Root FW (gm)	Root DW (gm)
Control		24.29±0.433	29.30±0.712	2.45±0.061	1.87±0.055	0.70± 0.020
Banana peel extract	**500**	35.67±0.448	50.85±0.095	4.35±0.258	2.85±0.128	1.12±0.241
	1000	31.00±0.207	46.7±0.593	4.04±0.265	2.45±0.176	0.95±0.0321
Tryptophan	**50**	33.80±0.267	40.30±0.176	3.68±0.215	2.37±0.142	0.91±0.026
	75	32.40±0.243	35.77±0.485	3.03±0.255	2.13±0.231	0.90±0.020
LSD at 5%		1.20	1.48	0.63	0.45	0.33

Photosynthetic Pigments:

The effect of different concentrations of banana peel (500 & 1000 mg/l) and tryptophan (50 &75 mg/l) and grown under water deficit (by skipping irrigation) on photosynthetic pigments (chlorophyll a, chlorophyll b, carotenoids and total pigments) of quinoa plant are shown in Table 3. Banana peel and tryptophan significantly increased chlorophyll a chlorophyll b, total carotenoids and consequently total pigments. The maximum increases of the photosynthetic pigments were obtained by foliar application with banana peel extract (500 mg/l) followed by tryptophan (75 mg/l). As the percentage of increases in response to 500mg /l banana peel extract reached to 61 % chlorophyll a, 44% chlorophyll b, 47% carotenoid by 163% and 55% total pigments.

Table 3: Effect of banana peel extract or tryptophan on photosynthetic pigments (µg/g fresh weight) of quinoa plant at 75 days after sowing grown in water deficit.

Material mg/l		Chlorophyll a	Chlorophyll b	Carotenoids	Total pigments
Control		11.2±0.015	4.01±0. 510	3.52±0.314	18.73±0.829
Banana peel extract	500	18.05±0.459	5.77±0.324	5.16±0.627	28.98±0.821
	1000	13.3±0.364	4.76±0.445	4.17±0.391	22.23±0.482
Tryptophan	50	16.84±0.314	5.11±0.291	5.12±0.227	26.54±0.488
	75	14.56±0.282	4.38±0.410	4.59±0.123	24.06±0.555
LSD at 5%		0.98	0.42	0.32	1.81

Change in IAA, Phenol and free amino acid contents:

Data in (Table 4) showed that, foliar application at different concentrations of banana peel extract (500 & 1000 mg/l) and tryptophan (50 and 75 mg/l) and grown under water deficit (by skipping irrigation) caused significant increases in IAA, total phenol and free amino acid contents .Table 3 clearly shows that the effect of banana peel extract at 500 mg/l and 75 mg/l tryptophan were the most effective treatments respectively, since it increased IAA by 81 % & 59%, phenol by 51% & 34% and free amino acid by 57% & 54% .

Table 4: Effect of banana peel extract or tryptopham on IAA (µg/g fresh weight), total phenol (mg/100g fresh weight) and free amino acid (mg/100 g dry weight) of quinoa plant at 75 days after sowing grown in water deficit.

Material mg/l		IAA	Phenol	Total free amino acid
Control		35.98±0.155	109.32±2.466	233.26±1.123
Banana peel extract	500	65.30±0.606	164.88±0.595	365.15±0.802
	1000	54.42±0.324	135.40±0.328	352.91±0.711
Tryptophan	50	49.28±0.686	120.00±2.509	348.67±4.615
	75	57.34±0.615	146.57±0.416	359.58±2.623
LSD at 5%		1.52	5.03	8.73

Antioxidant enzyme activities:

Superoxide dismutase, catalase and peroxidase activities were increased in response to application of different concentrations of banana peel extract or tryptophan on quinoa plants as compared to those of untreated control plants and grown under water deficit (by skipping irrigation) (Table 5). The most effective treatment was detected with banana peel extracts at 500mg/l followed by treatment with tryptophan 75 mg/l since; it increased the activities of SOD by 61% & 50%, CAT by 21 % & 16% and POX by 71% and 50 % as compared to control plants.

Table 5: Effect of banana peel extract or tryptophan on enzyme activities (µg/g fresh weight/hour) of quinoa plant at 75 days after sowing grown in water deficit.

Material mg/l		SOD	CAT	POX
Control		26.81±0.484	59.01±0.518	25.29±0.516
Banana peel extract	500	43.12±0.796	71.28±0.598	43.36±0.910
	1000	37.19±0.441	64.30±0.802	35.23±1.108
Tryptophan	50	33.72±0.250	58.75±0.770	32.85±0.897
	75	40.22±0.277	68.32±0.336	38.03±0.618
LSD at 5%		1.64	2.18	2.53

Yield and yield components:

Data presented in (Table 6) show the effect of foliar application of banana peel extract (500 and 1000 mg/l) and tryptophan (50 & 75 mg/l) on yield parameters of quinoa plants grown under newly reclaimed sandy soil and skipping irrigation. Data clearly show that, application of different treatments increased significantly yield and yield components such as shoot length, fruiting branches number /plant, shoot weight, seed weight/ plant and 1000 seed weight. The maximum increases of the yield parameters were obtained by foliar application with banana peel extract 500 mg/l. As the percentage of increases in response to 500 mg /l banana peel extract reached to 70%, 63%, 102%, 115% and 45% as shoot length, fruiting branches number /plant, shoot weight, seed weight/ plant and 1000 seed weig.ht as compared to the untreated plants, respectively.

Table 6: Effect of banana peel extract or tryptophan on yield and yield components of quinoa plant grown in water deficit.

Material mg/l		Shoot length (cm)	Fruiting branches number /plant	Shoot Weight (gm)	Seed weight/ Plant (g))	1000 seed weight (g)
Control		44.90±0.548	14.48±0.667	29.00±0.481	8.21±0.388	1.02±0.009
Banana peel extract	500	76.33±0.715	23.67±0.333	58.66±0.368	17.65±0.298	1.48±0.030
	1000	64.34±0.467	20.33±0.333	44.90±0.124	12.67±0.194	1.43±0.007
Tryptophan	50	68.78±0.619	18.33±0.333	50.91±0.461	15.56±0.578	1.22±0.040
	75	67.00±0.380	22. 76±0.333	54.53±0.266	13.47±0.209	1.28±0.026
LSD at 5%		1.70	1.46	1.08	1.27	0.09

Nutritive value of the yielded seeds:

Data in (Table 7) show that foliar application of banana peel extract and tryptophan and grown under water deficit (by skipping irrigation) led to significant increases in the nutritional value of the yielded quinoa seeds as compared with control plant. Moreover, the percentage of carbohydrate, protein, flavonoid, and antioxidant activity (as DPPH- radical scavenging capacity) were gradually increased with increasing concentrations of tryptophan. Meanwhile, the increases in carbohydrate, protein flavonoids, and antioxidant activity % of the yielded quinoa seeds were obtained by 500 mg/l more than 1000 mg/l in banana peel extract. The most effective treatment was detected with banana peel extracts at 500mg/l followed by treatment with tryptophan 75 mg/l as it reached to 28% & 22 for carbohydrate 50% & 28% for protein, 23% & 19% for flavonoid, and 37% & 28% antioxidant activity relative to control plant.

Table 7: Effect of banana peel extract tryptophan on nutritive value and antioxidant substances of the yielded seeds of quinoa plant grown in water deficit.

Material mg/l		Carbohydrates %	Protein %	Flavonoids %	DPPH%
Control		52.10±0.378	11.72±0.819	61.36±0.364	42.29±0.268
Banana peel extract	500	66.84±0.817	17.53±0.552	75.24±0.066	58.12±0.384
	1000	60.95±0.234	13.81±0.879	70.115±0.136	50.62±0.424
Tryptophan	50	56.88±0.069	12.32±0.364	69.615±0.367	46.41±0.715
	75	63.42±0.323	15.05±0.473	72.78±0.023	54.05±0.462
LSD 5%		1.60	1.76	0.53	1.73

Discussion

The growth parameters:

The growth parameters of quinoa plants in response to treatment with different concentrations of banana peel (500 & 1000) and tryptophan (50 & 75 mg/l) and grown under water deficit (by skipping irrigation) increased shoot fresh and dry weight as well as root fresh and dry weight of quinoa plant as compared with control plant. Banana peel or tryptophan has been reported to induce significant effects on various biological aspects in plants. Chemical analysis of banana peel extract shows that, it has high contents of natural phenolic compounds antioxidants as vitamins, flavonoids and K element which are necessary for plants growth [16]. Banana peel is rich in nutritional components such as proteins, essential amino acids, polyunsaturated fatty acids and potassium[17]. It contains common growth promoting substances which increased plant growth. Exogenous application of tryptophan mitigated the adverse effects of water stress on growth parameters [33]. Application of tryptophan mitigated partially or completely the adverse effects of water deficit on growth of the quinoa plant through increasing photosynthetic pigments (Table 3) and endogenous promoters especially IAA (Table 4) which in turn alleviate the harmful effect of water deficit. The same results were obtained by [33, 34] on wheat and periwinkle plants respectively; who found that, the increase in growth of plant in response to tryptophan treatment relative to untreated plants might be a result from increased levels of endogenous hormones consequently stimulation of cell division and/or cell enlargement and subsequently growth [35]. In addition, they reported that, tryptophan improved many physiological processes such as regulated the plant growth, differentiation and metabolism of plants under water stress and increasing physiological availability of water and nutrients.

Photosynthetic pigments

Applications of banana peel extract or tryptophan as foliar treatment at different concentrations and grown under water deficit (by skipping irrigation) in quinoa plants significantly increased photosynthetic pigments (Table3).The increases in photosynthetic pigments of quinoa plant in response to tryptophan treatment, these results were confirmed by the findings of [33]. In this connection, [36]concluded that tryptophan induced effect on chloroplast biosynthesis through its role in IAA biosynthesis, which was found to lessen the water stress induced decrease in chlorophyll content. Also, the promotive effect of banana peel extract may be due to the presence of natural antioxidants such as flavonoids and vitamin C[16]. These increases could be attributed to the banana peel application depends on the scavenging of reactive oxygen species by this antioxidant molecule and/or by increasing the antioxidant enzyme activity (Table 5) and promoting photosynthesis, maintaining enzyme activity[37]. Moreover, it is noticed that, carotenoids content was significantly higher in quinoa plants under treatment with banana peel extract or tryptophan. Carotenoids play a role as a free radical scavenger which, enhance their capacity to reduce the damage caused by ROS, which in turn increased chlorophyll content of such plants[38].

Change in indole acetic acid and total phenol contents:

Applications of banana peel extract or tryptophan as foliar treatment at different concentrations and grown under water deficit (by skipping irrigation) in quinoa plants increased total indole acetic acid contents (Table 4). It is notice that the increase in auxin contents concurrent with the increase in growth rate as shown in Table (2). Similar results were obtained by [39, 40] who suggested that tryptophan increase contents of IAA. It could be concluded that this increase may be due to the role of endogenous hormone in stimulating cell division and/or the cell enlargement and this in turn improve plant growth (Table 2). Abdallah et al[41, 42]confirmed these results in wheat and quino. Foliar applications of banana peel extract or tryptophan increased significantly in total phenol contents (Table 4). Increase in phenol contents in different treatments under osmotic stress have been reported in sunflower cultivars plants[43]. This increase may be due to total phenols role to play a significant mechanism in regulation of plant metabolic processes [41, 44]confirmed this result in quinoa and cotton plants respectively. Moreover, phenols act as a substrate for many antioxidants enzymes, so, it mitigates the water stress injuries[45]. In addition, the phenolic compounds has antioxidant role of as free radical scavenger through their reactivity as electron or hydrogen donor, to stabilize and delocalize the unpaired electron, and from their role as transition metal ions chelator[46]**.** Also, [47]recorded an accumulation of phenolic compounds in response to abiotic stress. El-Bassiouny and Abdel-Monem [48] found that, application of tryptophan in both sunflower cultivars under the salinity stress involved in adaptation to environmental changes in plants which caused significant increases in phenol contents.

The increase in total phenolic contents led was agree with increasing IAA contents because of phenolic compounds (diphenols and polyphenols) which may inhibit IAA oxidase activity and leading to auxin accumulation and reflected in stimulating the growth (Table 2) and yield (Table 6) of plant [49].

Sadak et al[50] found that, application of tryptophan or banana peel increased significantly IAA and phenolic contents of roselle leaves.

Change in free amino acid contents:

Banana peel extract or tryptophan application caused significant increases of free amino acids as compared with control plant at water deficient stress (by skipping irrigation) (Table 4). The osmotic adjustment in plants subjected to drought stress occurs by the accumulation of high concentrations of osmotically active compounds known as compatible solutes such as proline, soluble sugars and free amino acids[38]. They revealed also that such substance play an important role in the adaptation of cells to various adverse environmental conditions through raising osmotic pressure in the cytoplasm, stabilizing proteins and membranes, and increasing plant growth (Table 2) and cellular functions[51] .

Moreover, [20] reported that, banana peel extract has high contents of vitamin A, vitamin C, amino acids especially tryptophan. L-Tryptophan is an amazing amino acid because it may act as an osmolyte, modulates stomatal opening and ion transport regulator[13]. Moreover, a higher amino acid accumulation contributing to osmotic adjustment was observed in shoots of water stress in sunflower cultivars[48].

Antioxidant enzymes

Superoxide dismutase, catalase and peroxidase are enzymes that responsible for ROS-scavenging. Banana peel extract or tryptophan application caused significant increases activities in quinoa leaves as compared to control plants (Table 5). These results are in agreement with [48]found that the exogenous application of tryptophan marked increases in CAT, PPO, POX and PAL activities under the different levels of salinity stress in sunflower plants. Nguyen et al.,[20] and Sathya[52] reported that, banana peel extract has high contents of vitamin A as beta carotene, vitamin C and amino acid especially tryptophan. El Bassiouny & Sadak [53] observed that, ascorbic acid induced significant increased of many enzyme activities. In addition, ascorbic acid decreases the damage of many enzyme activities which induced by oxidative process [54].

At stress conditions higher content of hydrogen peroxide is detoxified by catalase and glutathione peroxidase [55]. Superoxide dismutase (SOD) is the first defense enzyme that converts superoxide to H_2O_2, which can be scavenged by catalase (CAT) and different classes of peroxidases (POX) and ascorbate peroxidase. These results are in agreement with the results observed by[53].

Yield and yield components:

Foliar application of banana peel extract (500 and 1000 mg/l) or tryptophan (50 &75 mg/l) increased significantly yield and yield components of quinoa plants grown under sandy soil and skipping tow irrigation as compared to control (Table 6). These results were confirmed by[50] on rosella plants. Banana peel extract at 500 mg/l was the most effective treatment which, returned to the antioxidant ability caused by vitamin A, vitamin C, amino acids especially tryptophan, protein, carbohydrates, macro and micronutrients, phenolic compounds, fat and fibers but does not seem to be a property of a single phytochemical compound[20, 52]. Moreover, the exogenous application of banana peel extract (containing large amount of antioxidants)[16] which mitigated partially the adverse effects of water stress on yield components of flax cultivars [56]. With regard to the increases in yield components of quinoa plant in response to tryptophan application [40] found that, exogenous application of tryptophan increased yield and yield components on sunflower cultivars under water stress. Hassan and Bano [57] stated that tryptophan treatment increased yield components and some biochemical constituents of wheat plant. Amino acids such as tryptophan which have a high integrity with different metabolic rate in plants were used to promote plant growth and yield of plants[58]. In addition, these changes may be attributed to the increase in nutrients uptake and assimilation. The stimulatory effect were found to be correlated with the increase in content and activity levels of endogenous promoters particularly IAA (table 4). Thus, it can be concluded that the increment of seed yield/plant, in response to the applied treatments is mainly due to the increases in the number of branches/ plant which increases the fruits number /plant. Moreover, the increase in yield and its components might be due to the effect of antioxidants role on enhancing protein synthesis (Table 7) and delaying senescence[59]. Moreover, [33]concluded that, increased levels of endogenous phytohormones in wheat plants treated with tryptophan enhanced growth and yield. Plant growth regulators appear either to form sink mobilizing the different nutrients, which are involved in building new tissues in wheat plants and/or enhance photosynthesis.

Nutritive value of the yielded seeds:

The different treatments of banana peel extract or tryptophan effectively increased the total carbohydrate and protein percentage of yielded quinoa seeds (Table 7). Similar finding were obtained in different plant species in response to tryptophan application[33, 40], who found that, total carbohydrate, and protein concentrations were increased in wheat and sunflower plants respectively. Moreover, [60]revealed that application of L-tryptophan significantly affected the maize crop growth, yield and total nitrogen uptake compared with an untreated control.

Total flavonoids content in yielded seeds:

Data represented in (Table7) indicated that foliar application of banana peel extract and tryptophan for significant increase in total flavonoids content. These results were confirmed by [50] on rosella plants. Flavonoids are secondary metabolites of phenolic nature which play important roles in the protection of plants against environment stress[61]. Padayatty et al [62]reported that, flavonoids in human diet reduce the danger of various cancers and prevent menopausal symptoms thus the high contents of flavonoids has a very important effect on human health.

Antioxidant activity in yielded grains:

Data in (Table 7) show that foliar application of banana peel extract and tryptophan led to significant increases in the antioxidant activity (as DPPH- radical scavenging capacity) of the yielded quinoa seeds as compared with control plant. These results were confirmed by[50] on rosella plants. The increase in the antioxidant activity can be considered an advantage of treatment used[63, 64]. The increases in total phenols and total flavonoids lead to antioxidant activity increase[65,66]. Moreover, [41]suggesting that high contents of antioxidant activities and phenolic components have been detected in wheat demonstrating that wheat may serve as an premium feeding source of natural antioxidants and improve human health promotion and disease prevention

Conclusion

The growth enhanced by foliar application of banana peel extract or tryptophan under water deficit (skipping irrigation), which stimulating growth regulators level (IAA) and involved in protecting the photosynthetic apparatus and consequently increasing the photosynthetic. Moreover, quinoa plant gave higher nutritional value of carbohydrate%, protein%, total flavonoids, and antioxidant activity in yielded seeds. Banana peel extract was the most effective in enhancing the above parameters which, may be returned to the antioxidant capacity caused by vitamin A& C and flavonoids constituents, amino acid especially tryptophan macro and micronutrients, but does not seem to be a property of a single phytochemical compound. Banana peel extract reduced consumption of water because of decreasing the high costs of irrigation is the main problem of agriculture development in the world.

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