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Original Research Article

The Influence of Interaction between the Water Stress and Salicylic Acid on Elements Content of Fenugreek

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ABSTRACT

A pots experiment was carried out in the greenhouse of the Department of Biology in the College of Science-University of AL Mustansiriya, for the 2013-2014 growing season, to investigate the influence of foliar application of salicylic acid of two concentrations (50 and 100mg/L) and meanwhile the control transplants sprayed with distilled water on elements content (N,P,K and Ca) of fenugreek plants subjected to water stress in three irrigation periods (2,7 and 12days). The experiment was conducted as a factorial experiment. Completely randomized design was used with three replicates. Lest significant difference was used at probability of 0.05 to compare between means. Results indicated that effect of drought divergence from 2 to 12days reduced significantly the average of elements content (N, P, K and Ca). Foliar application of salicylic acid significantly increased the average of elements content (N,P,K and Ca), while the interaction between two factors studied was significant and exogenous application of salicylic acid had counteracted the adverse effect of water stress particularly 100mg/L salicylic acid concentration.
Keyword: Fenugreek; salicylic acid; water stress

INTRODUCTION

Fenugreek (*Trigonella foenum-graecum* L.) is an annual crop belonging to the legume family, and it is commonly used as a condiment in food preparation for its nutritive and restorative properties and has been used in folk medicine for centuries for a wide range of diseases including diabetes [1]. Like many other leguminous crops, the productions of this crop are affected by environmental stress such as: drought, salinity and heat [2].

Drought (water stress) is the main a biotic factor that affects the survival of soil microorganisms and plant growth and drought stress has an adverse influence on water relations, mineral nutrition, metabolism and photosynthesis [3]. Water is one of the most important resources for agricultural production. In many parts of the world, water availability is economically and/or technically limited; 28 and of the Earth's land surface is considered to be too dry for crop production [4]. The responses of plants to water deficit are observed in forms of phenological responses, morphological changes, physiological alterations, and biochemical adaptations, such as changes in plant structure, growth rate, tissue osmotic potential and antioxidant defenses [5]. Drought stress causes imbalance between the generation and quenching of reactive oxygen species (ROS). ROS, such as superoxide radicals (OH), which are highly reactive in the absence of effective protective mechanism .Drought can seriously damage plants by lipid peroxidation, protein degradation, breakage of DNA and cell death [6]. Plants protect cellular and sub cellular systems from the cytotoxic effects of these active oxygen radicals through both enzymatic and non-enzymatic antioxidant systems such as, peroxidase, IAA-Oxidase, Catalase, carotinoids, ascorbic acid and α-tocopherol [7, 8].

Salicylic acid (SA) is a signaling or messenger molecule in plants and induces plant tolerance against various biotic and a biotic stresses (9), also SA plays an important role in the regulation of some physiological processes in plants such as effects on growth and development, ion uptake and transport and membrane permeability [10]. Exogenous SA alters the activities of antioxidant enzymes and increases plant tolerance to a biotic stress by decreasing generation of ROS. It has been found that SA has different effects on stress adaptation and damage development of plants that depend on plant species, concentration, method and time of SA application [11]. Some earlier reports display that exogenous SA can ameliorate the impairing effects of drought stress in different species [12].The use of SA with concentrations of 1, 2 and 3mM on peanut under drought stress conditions, 50% of field capacity could significantly increase the performance of the plant [13].

The objectives of this work were to study the effect of water stress on elements content in fenugreek plants, and to examine whether the harmful effects of water stress can be offset by the exogenous application of SA.

MATERIALS AND METHODS

A pot experiment was conducted during the two growing season of 2013 and 2014 in the greenhouse of the Department of Biology in the College of Science-University of AL Mustansiriya, to study the effect of foliar application of SA on growth and water relationships of fenugreek cv. local under water stress. The treatments were as follows: SA concentrations: (50 and 100mg/L) and meanwhile the control. Water stress (Irrigation periods): (2,7and 12days). The experiment was conducted as a factorial experiment. Completely randomized design was used with three replicates. The above has been growing plant seeds studied on 7/11/2013 and by 15 seed per pot and watered pots up to 50% of field capacity distasteful first, then has the irrigation process under periods above on the basis of loss of weight, and after two weeks from the date of agriculture passage was eased plants to 10 plants in each pot. The spraying process conducted SA concentrations above when the early morning twice after 45 and 55 days from the date of agriculture sequentially using the sprinkler hand.

After 80days contents of N, P, K and Ca in vegetative part was determined as follows as: percentage of nitrogen was determined by the microkjeldahl methods [14], percentage of phosphorus was determined by using spectrophotometer [15], percentage of potassium was determined by using flame photometer[16] and percentage of calcium was determined according [17], than calculated the elements content according to the equation:- Element content (mg/g)= Element concentration(%) × Total dry weight × 10

Statistical Analysis

An analysis by the results statistically followed in the design and implementation of the experiment compared to the averages using the least significant difference (LSD) test at a level of 5% probability [18].

RESULTS AND DISSECTION

The results of the statistical analysis of the data in Tables 1, 2, 3 and 4 show that water stress, SA and interaction was significant at 5% level.

The results indicate in the table 1 that the presence of significant effect of water stress (irrigation periods) in reduced N content, when spacing irrigation periods from 2days to 12days N content decreased 30.16%. As the table that explained sprays the plant with SA cause a significant increase in plant height, when raising the concentration100mg/L the increase 60.61% comparing the treatment of non spray (control). As for the interaction it has been significantly and reached the highest value in the irrigation 7day period and the concentration of 100mg/L SA, and the lowest value was in the irrigation period 12day and without spraying SA.

Indicated the results shown in the table 2 the presence of a significant decrease in P content when irrigation period of 12 days by 40.85 % in comparison with control. Either when sprayed SA concentrate 100mg/L got a significant increase in P content and by 195.97% comparing the treatment of non spray (control). As for the interaction it has been significantly and reached the highest value in the irrigation 2day period and the concentration of 100 mg/L SA, and the lowest value was in the irrigation 12day period and without spraying SA.

The results show a table 3 that an increase in water stress caused by the divergence irrigations a significant decrease in K content for the periods irrigation 7 and 12 day rate compared to the period irrigation 2days, the K content rate in the irrigation was 2days 43.22mg/g, down significantly when two irrigation 7 and 12 days to 37.43 mg/g and 32.04mg/g sequentially. SA spraying reduced the harmful effects of water stress by increasing the K content (Table 3). Treatment of spraying a concentration of 50mg/L given K content rate of 35.27mg/g, while the treatment of spraying achieved a concentration of 100mg/L SA, highest rate of K content was 49.18mg/g compared with control was gave 28.25mg/g. As for the effect of interaction between irrigation periods and the concentrations of SA sprayed in K content was significantly, and that the results of the statistical analysis recorded the highest value of K content in irrigated plants a period of two days and sprayed a concentration of 100mg/L SA gave 57.43mg/g compared to the rest of the other treatments interaction, and the lowest the value of the character was in irrigated plants a period of 12days and without spraying SA gave 23.25mg/g.

Indicated the results shown in the table 4 the presence of a significant decrease in Ca content when irrigation period of 12days by 30.72% in comparison with control. Either when sprayed SA concentrate 100mg/L got a significant increase in Ca content and by 63.26% comparing the treatment of non spray (control). As for the interaction it has been significantly and reached the highest value in the irrigation 2 day period and the concentration of 100mg/L and the lowest value was in the irrigation 12day period and without spraying SA.

Table 1: Effect of SA, irrigation periods and interaction in the Nitrogen content (mg/g)

Irrigation periods(day)	SA(mg/L)			Mean
	0	50	100	
2	32.34	48.39	57.84	46.19
7	29.04	40.16	43.37	37.52
12	23.15	34.29	39.63	32.36
Mean	28.18	40.95	46.95	
L.S.D. 5%	Irrigation periods	SA	Interaction	
	0.15	0.15	0.26	

Table 2: Effect of SA, irrigation periods and interaction in the Phosphorus content (mg/g)

Irrigation periods(day)	SA(mg/L)			Mean
	0	50	100	
2	7.73	14.44	20.27	14.15
7	5.14	11.45	16.59	11.06
12	3.51	9.98	11.62	8.37
Mean	5.46	11.96	16.16	
L.S.D.	Irrigation periods	SA	Interaction	
5%	0.12	0.12	0.20	

Table 3: Effect of SA, irrigation periods and interaction in the Potassium content (mg/g)

Irrigation periods(day)	SA(mg/L)			Mean
	0	50	100	
2	33.58	38.66	57.43	43.22
7	27.60	35.86	48.84	37.43
12	23.56	31.28	41.27	32.04
Mean	28.25	35.27	49.18	
L.S.D.	Irrigation periods	SA	Interaction	
5%	0.18	0.18	0.30	

Table 4: Effect of SA, irrigation periods and interaction in the Calcium content (mg/g)

Irrigation periods(day)	SA (mg/L)			Mean
	0	50	100	
2	31.71	37.27	44.69	37.89
7	22.32	30.23	39.25	30.60
12	17.66	27.96	33.12	26.25
Mean	23.90	31.82	39.02	
L.S.D.	Irrigation periods	SA	Interaction	
5%	0.20	0.20	0.35	

Water deficit is considered as a major environmental factor affecting many aspects of plant physiology and biochemistry [19]. The reduction in these parameters is coincided with the general trends of the effect of drought on plants. Several investigators indicated that drought inhibited growth by reducing rate of cell division and expansion, leaf size, stem elongation and root proliferation, and disturbing stomatal oscillations, metabolic activities, ion uptake and nutrient metabolism [20, 21]. The reduction in the contents of these elements were attributed primarily to soil water deficiency which markedly reduces the transpiration rate that lessen the flow rates of elements in soil, their absorption by stressed root cells and also its ability to translocation through the xylem and different organs and tissues. This situation resulted in an interruption in the various metabolic pathways carried out by plants namely; respiration, biosynthesis of phospholipids, nucleic acids, plastids, enzymes, etc, disorders in both plasma membrane permeability and stomata osmotic regulations, thus plants seized growth and eventually died [22]. The decrease of K concentrations can be related to reduction of in-flow water in plant. Potassium had important roles on osmoregulation, enzyme activation, neutralization, transport process [23]. Also limited movement of Ca through the roots due to deficit mass flow may result Ca deficiency under water deficit conditions [24].

It is clear from the above results, that SA could be a very promising compound for the reduction of the a biotic stress sensitivity of crops, since under certain conditions it has been found to mitigate the damaging effects of various stress factors in numerous plant species [25]. Miura and Tada [26] stated that the effects of SA on the physiological processes of plants depend on its concentration, type of plant, the stage of plant growth and environmental conditions. In general, low concentrations of SA may enhance the antioxidant capacity and tolerance to abiotic stresses but high concentrations of SA may cause cell death or susceptibility to abiotic stresses [27].

CONCLUSION

From the results of this study it may be concluded that drought stress significantly reduced elements content, the reduction increased with the increased drought stress. Foliar application Salicylic acid proved to be effective in mitigating the drought effect on fenugreek.

CONFLICT OF INTEREST STATEMENT

The authors declare that they have no competing interests.

REFERENCES

1. Eidi A, Eidi M, Sokhteh, M. Effect of fenugreek (*Trigonella foenum -graecum* L.) seeds on serum parameters in normal and streptozotocin-induced diabetic rats. Nutri Res 2007; 27:728-733.
2. Almansouri M, Kinet JM, Lutts S. Effect of salt and osmotic stresses on germination in durum wheat (*Triticum durum* Desf.). Plant Soil 2001; 231, 243-254.
3. Fall D, Ourarhi M, Missbah M, Bakhoum EN, Zoubeirou AM, Abelmoumem H. The efficiency and competitiveness of three Mesorhizobium sp. strain nodulating *Acacia senegal* (L.) wild under water deficiency conditions in greenhouse. Symbiosis 2011; 54: 87-94.
4. Bray EA. Genes commonly regulated by water-deficit stress in *Arabidopsis thaliana*. J Experi Bot 2004; 55: 2331-2341.
5. Duan B, Yang Y, Lu Y, Korpelainen H, Berninger F, Li C. Interactions between water deficit, ABA, and provenances in *Picea asperata*. J Experi Bot 2007; 58 (11):3025-3036.

6. Tambussi EA, Bartoli CG, Beltrano J, Guiamet JJ, Arans JL. Oxidative damage to thylakoid proteins in water stressed leaves of wheat (*Triticum aestivum*). Physiol Plantarum 2000; 108:398–404.
7. Munné-Bosch S, Alegre L. Changes in carotenoides, tochopherols and diterpenes during drought and recovery and the biological significance of chlorophyll loss in Rosmarinus officianalis planta. Plants 2000; 210: 925-931.
8. Awate PD, Patil MS, Gaikwad DK. Alleviation of oxidative damage by exogenous application of plant growth regulators on medicinally important oil yielding plant SimaroubaGlauca Dc. under water stress conditions. Ind J App Res 2014; 4(6): 36-37.
9. Horvath E, Szalai G, Janda T. Induction of a biotic stress tolerance by salicylic acid signaling. J Plant Growth Reg 2007; 26(3): 290- 300.
10. Simaei M, Khavari-Nejad RA, Bernard F. Exogenous application of salicylic acid and nitric oxide on the ionic contents and enzymatic activities in NaCl-stressed soybean plants. American J Plant Sci 2012; 3: 1495-1503.
11. Metwally A, Finkemeier I, Georgi M, Dietz KJ. Salicylic acid alleviates the cadmium toxicity in barley seedlings. Plant Physiol 2003; 132(1):272-281.
12. Arfan M, Athar HR, Ashraf M. Does Exogenous Application of salicylic acid through the rooting medium modulate growth and photosynthetic capacity in two differently adapted spring wheat cultivars under salt stress? J Plant Physiol 2007; 164 (6): 685-694.
13. Karimian MA, Dahmardeh M, Bidarnamani F, Forouzandeh M. Assessment quantitative and qualitative factors of peanut (*Arachis hypogaea* L.) under drought stress and salicylic acid treatments. Biol Forum Int J 2015; 7(1): 871-878.
14. Chapman HD, Pratt FP. Method of analysis for soils, plants and waters. Univ of California, Division of Agric Science, 1961.
15. Matt KJ. Colorimetric determination of phosphorus in soil and plant materials with ascorbic acid. Soil Sci 1970 109:214-220.
16. Page AL, Miller RH, Kenney DR. Methods of Soil Analysis. USA: Madison Wisconsin; 1982, p 111-120.
17. Wimberley NW. The analysis of agriculture material. MAFF Tech Bull London 1968; 95-103.
18. Little TM, Hills FJ. Agricultural Experimentation Design and Analysis. New York: John Wiley and Sons; 1978.
19. Charles O, Joly R, Simon J E. Effect of osmotic stress on the essential oil content and composition of peppermint. Phytochem 1994; 29:2837-2840.
20. Li WQ, Liu XJ, Khan MA, Gul BQ. Relationship between soil characteristics and halophytic vegetation in coastal region of North China. Pak J Bot 2008; 40: 1081-1090.
21. Farooq M, Wahid A, Kobayashi N, Fujita D, Basra SMA. Plant drought stress: effects, mechanisms and management. Agron Sustain Dev 2009; 29:185-212.
22. Lindhauer MG. Influence of K nutrition and drought on water relations on water relations and growth of sunflower (*Helianthus annuus* L.). Z Pflanzenernähr Bodenk 2007; 148: 654-669.
23. Reddy AR, Chaitanya KV, Vivekanandan M. Drought-induced responses of photosynthesis and antioxidant metabolism in higher plants. J Plant Physiol 2004; 161: 1189–1202.
24. Kacar B, Katkat V. Plant Nutrition. Nobel, Ankara, Turkey: Nobel Press; 1998.p 831.
25. Janda T, Horvath E, Szalai G, Paldi E. Role of salicylic acid in the induction of a biotic stress tolerance. Plant Hormone 2007; 1: 91-150.

26. Miura K, Tada YY. Regulation of water, salinity and cold stress responses by salicylic acid. Frontiers in Plant Sci 2014; 5:1-12.
27. Hara M, Furukawa J, Sato A, Mizoguchi T, Miura K. Abiotic stress and role of salicylic acid in plants in a biotic stress responses in Plants, eds A. Parvaiza and M.N.V. Prasad New York, NY: Springer; 2012, p 235.

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