Available online at www.elixirpublishers.com (Elixir International Journal)

Agriculture

Elixir Agriculture 97 (2016) 42195-42197

ISSN: 2229-712X

Evaluation of Drought stress on vegetative and reproductive characteristics of Zinnia elegans

Mahdieh Aghamohammadi[1], Roohangiz Naderi[2*] and Ebrahim Hadavi[1]

[1]Department of Horticultural Sciences, Karaj Branch, Islamic Azad University, Karaj, Iran.

[2]Department of Horticultural Sciences, Faculty of Agricultural Sciences and Natural Resources, University of Tehran, Karaj, Iran.

ARTICLE INFO

Article history:
Received: 8 July 2016;
Received in revised form: 10 August 2016;
Accepted: 15 August 2016;

Keywords
Drought,
Reproductive Characteristics,
Vegetative Characteristics,
Zinnia.

ABSTRACT

Drought stress is one of the major abiotic stresses in arid and semi-arid land of agriculture worldwide. This study was performed to evaluation of Drought stress on vegetative and reproductive characteristics of *Zinnia elegans* . Experimental design was CRD with 3 replication, At elongation stage, the plants were provided different degrees of drought stress: (1) mild drought with 65–70 % of the soil water capacity; (2) moderate drought with 45–65 % of the soil water content; (3) severe drought with 20–30 % of soil water capacity and; (4) control with 70 % of soil water capacity. Studied traits included: height, number of branches, stem diameter, leaf number, shoot fresh weight, shoot dry weight, root fresh weight, root dry weight, proline, total chlorophyll. Totally, our results showed that drought stress reduced all studied traits except proline, and by increasing of stress, reduction was increased but this trend was different for proline. Severe stress showed 54, 40, 40, 46, 48, 64, 34, 66 and 53% reduction for height, number of branches, stem diameter, leaf number, shoot fresh weight, shoot dry weight, root fresh weight, root dry weight and total chlorophyll in compare to control, respectively.

Introduction

Drought stress is one of the major abiotic stresses in agriculture worldwide. Drought, a period of abnormally dry weather, results in soil-water deficit and subsequently plant-water deficit. The lack of water in the environment constitutes a stress when it induces an injury in the plant. Water deficit in the plant disrupts many cellular and whole plant functions, having a negative impact on plant growth and reproduction. Plant growth is controlled by several factors, of which water plays a vital role. A small decrease in the availability of water to a growing plant immediately reduces its metabolic and physiological functions. Water stress induced a significant decrease in metabolic factors such as the decrease in chlorophyll contents and an increase accumulation of proline in plants (Sakova et al. 1995; Gibon et al. 2000) Variations in the chlorophyll contents are often measured, because its loss is often assumed to be a symptom of stress injury (Majumdar et al. 1991).Tester and Bacic (2005) reported that one of the main effects of water deficit was the decrease in leaf expansion and leaf number. Although leaf plays an important role in photosynthesis, high leaf expansion rate can adversely affect plant usable water. At the commencement of water stress, cell growth inhibition decreases leaf expansion. Lower leaf area leads to absorption of less water from soil and the decrease in transpiration. Therefore, with the decrease in leaf area, the plant constructs its first defense system against drought.Response, mechanism and characteristics of plants to face drought stress have become a crucial environmental research topic in drought-prone regions.

Zinnia (Zinnia elegans) is the most prominent summer flower of the family Asteraceae, usually grown in beds, borders, containers, cottage garden landscapes or as background plants. However, its use as cut flowers cannot be denied as it is one of the most valued annual love flowers (Khan, 2004). Zinnia requires appropriate irrigation for its proper growth and development to be sufficiently green, vigorous and produce abundant flowers of adequate size and color intensity with good lasting qualities (Joiner and Gruis, 1961). The aim of this study was Evaluation of Drought stress on vegetative and reproductive characteristics of *Zinnia elegans.*

Material and methods

This study was performed to Evaluation of Drought stress on vegetative and reproductive characteristics of *Zinnia elegans*, The used seeds in this experiment were prepared by the gene bank Research Institute of Forests and Rangelands, and then the seeds were disinfected with fungicides Vitavax, experimental design was CRD with 3 replication, At elongation stage, the plants were provided different degrees of drought stress: (1) mild drought with 65–70 % of the soil water capacity; (2) moderate drought with 45–65 % of the soil water content; (3) severe drought with 20–30 % of soil water capacity and; (4) control with 70 % of soil water capacity. Soil composition included garden soil (two parts), fine sand (one part), completely rotted manure (one part), studied traits included: height, number of branches, stem diameter, leaf number, shoot fresh weight, shoot dry weight, root fresh weight, root dry weight, proline, total chlorophyll. Data analysis was performed with SAS software and Duncan test was used to compare the average of 5%.

Result and discussion

Height

According to analysis of variance, drought stress had significant effect on height at 1% statistical significant level,

Tele:
E-mail address: zbreeder@gmail.com

height was reduced by drought stress and application of mild, moderate and severe stress levels led to 11, 33 and 54 % reduction in compare to control, respectively. Highest means (44.2 cm) was observed by control. Carter and Sheaffer (1983) reported 48% decrease in internode length under drought stress. Sengul (2002) reported the decrease in internode length with the increase in moisture stress.

Number of branches

According to analysis of variance, drought stress had significant effect on number of branches at 1% statistical significant level, number of branches was reduced by drought stress and application of mild, moderate and severe stress levels led to 9, 25 and 40 % reduction in compare to control, respectively. Highest means (3.2) was observed by control.

Stem diameter: According to analysis of variance, drought stress had significant effect on stem diameter at 1% statistical significant level, stem diameter was reduced by drought stress and application of mild, moderate and severe stress levels led to 4, 24 and 40 % reduction in compare to control, respectively. Highest means (2.5 cm) was observed by control.

Leaf number

According to analysis of variance, drought stress had significant effect on leaf number at 5% statistical significant level, leaf number was reduced by drought stress and application of mild, moderate and severe stress levels led to 13, 26 and 46 % reduction in compare to control, respectively. Highest means (41) was observed by control. Deblonde et al ., (2001) reported that drought reduced the number of green leaves, drought also induced significant length reductions in potato.

Shoot fresh weight

According to analysis of variance, drought stress had significant effect on shoot fresh weight at 5% statistical significant level, shoot fresh weight was reduced by drought stress and application of mild, moderate and severe stress levels led to 13, 38 and 48 % reduction in compare to control, respectively. Highest means (39.2 g) was observed by control. Similar to these results was mentioned by Okçu et al., (2005).

Shoot dry weight

According to analysis of variance, drought stress had significant effect on shoot dry weight at 1% statistical significant level, shoot dry weight was reduced by drought stress and application of mild, moderate and severe stress levels led to 29, 55 and 64 % reduction in compare to control, respectively. Highest means (23.1 g) was observed by control.

Root fresh weight

According to analysis of variance, drought stress had significant effect on root fresh weight at 1% statistical significant level, root fresh weight was reduced by drought stress and application of mild, moderate and severe stress levels led to 17, 20 and 34 % reduction in compare to control, respectively. Highest means (2.9 g) was observed by control. Lee and Mudge reported that water deficit decreased root growth, but unaffected shoot growth of American ginseng. Also, foliar chlorophyll content was also decreased in the water deficit treatments.

Root dry weight

According to analysis of variance, drought stress had significant effect on root dry weight at 1% statistical significant level, root dry weight was reduced by drought stress and application of mild, moderate and severe stress levels led to 27, 50 and 66 % reduction in compare to control, respectively. Highest means (1.8 g) was observed by control.

Proline

According to analysis of variance, drought stress had significant effect on proline at 5% statistical significant level, proline was increased by drought stress and application of mild, moderate and severe stress levels led to 1.44, 2 and 2.14 fold in compare to control, respectively. Highest means (7.3 mg/g fresh weight) was observed by severe stress. Proline accumulates in a variety of plant species in response to stresses such as drought, salinity and extreme temperatures. Although its role in plant osmotolerance remains controversial, proline is thought to contribute to osmotic adjustment, detoxification of reactive oxygen species and protection of membrane integrity (Molinari et al., 2007). Manivannan et al., 2007 reported that the root length, shoot length, total leaf area, fresh and dry weight, chlorophyll a, b, total chlorophyll and carotenoid in *Helianthus annuus* were significantly reduced under water stress treatments. Water stress increased the proline, free amino acid and glycinebetaine contents along with increased activity of γ-glutamyl kinase but the activity of proline oxidase reduced as a consequence of water stress. Mathur, et al. (1995) found that metabolic factors such as free proline contents in leaves increased significantly under severe drought stress. Kundu and Paul (1997) also observed higher proline accumulation in the Brassica leaves at reproductive growth stages by water stress. Vartanian, et al. (1992) observed high proline accumulation through water shortage, reaching up to 4.6% of total dry matter. Proline accumulation during drought stress is an adaptive response that enhances survival and tissue water status (Chu et al. 1974).

Total chlorophyll

According to analysis of variance, drought stress had significant effect on total chlorophyll at 5% statistical significant level, total chlorophyll was reduced by drought stress and application of mild, moderate and severe stress levels led to 12, 34 and 53 % reduction in compare to control, respectively. Highest means (9.59 mg/g fresh weight) was observed by control. Mafakheri et al (2010) reported that all physiological parameters were affected by drought stress. Drought stress imposed during vegetative growth or anthesis significantly decreased chlorophyll a, chlorophyll b and total chlorophyll content in chickpea. Kundu and Paul, (1997) observed decreased in chlorophyll a and b contents in rape under water stress at flowering but not at pod filling growth stage. Din, et al. (2011) observed that water stress reduced chlorophyll a and b contents by 38% compared with the adequately watered plants. Totally, our results showed that drought stress reduced all studied traits except proline, and by increasing of stress, reduction was increased but this trend was different for proline. Also, Severe stress showed 54, 40, 40, 46, 48, 64, 34, 66 and 53% reduction for height, number of branches, stem diameter, leaf number, shoot fresh weight, shoot dry weight, root fresh weight, root dry weight and total chlorophyll in compare to control, respectively.

Table 1. Analysis of variances for studied characteristics.

	Height	Branch number	Stem diameter	Leaf number	Shoot fresh weight	Shoot dry weight	Root fresh weight	Root dry weight	Poiline	Total chlorophyll
drought	216.5**	3.12**	2.68**	425.901*	195.88*	157.57**	0.58**	0.89**	6.93*	11.12*
error	14.3	0.34	0.33	59.65	33.2	12.98	0.0521	0.0981	1.13	2.165
C.V	9	23	26	24	19	25	9	27	21	21

Table 2. comparison of characteristic means in response to drought stress.

	Height (cm)		Number of branches		Stem diameter		Leaf number/plant		Shoot fresh weight (g)		Shoot dry weight (g)	
Control	44.2	a	3.2	a	2.5	a	41	a	39.2	a	23.1	a
Mild drought	39.2	b	2.9	b	2.4	a	35.6	b	34	b	16.2	b
Moderate drought	29.3	c	2.4	c	1.9	b	30.2	c	24	c	10.2	c
Severe drought	20.3	d	1.9	d	1.5	c	21.9	d	20.1	d	8.3	c

	Root fresh weight (g)		Root dry weight		Proline (mg/g fresh weight)		Total chlorophyll (mg/g fresh weight)	
Control	2.9	a	1.8	a	3.4	c	9.59	a
Mild drought	2.4	b	1.3	b	4.9	b	8.43	b
Moderate drought	2.3	b	0.9	c	7.1	a	6.3	c
Severe drought	1.9	c	0.6	d	7.3	a	4.5	d

References

1. Carter, P.R. and Sheaffer, C.C., 1983. Alfalfa response to soil water deficits. I. Growth, forage quality, yield, water use, and water-use efficiency. *Crop Science*, *23*(4), pp.669-675.

2. Chu, T., Aspinall, D. and Paleg, L.G., 1974. Stress Metabolism. VI.* Temperature stress and the accumulation of proline in barley and radish. *Functional Plant Biology*, *1*(1), pp.87-97.

3. Deblonde, P.M.K. and Ledent, J.F., 2001. Effects of moderate drought conditions on green leaf number, stem height, leaf length and tuber yield of potato cultivars. *European Journal of Agronomy*, *14*(1), pp.31-41.

4. Din, J., Khan, S.U., Ali, I. and Gurmani, A.R., 2011. Physiological and agronomic response of canola varieties to drought stress. *J Anim Plant Sci*, *21*(1), pp.78-82.

5. Gibon, Y., Sulpice, R. and Larher, F., 2000. Proline accumulation in canola leaf discs subjected to osmotic stress is related to the loss of chlorophylls and to the decrease of mitochondrial activity. *Physiologia Plantarum*, *110*(4), pp.469-476.

6. Joiner, J.N. and Gruis, J.T., 1961. Effects of nitrogen and potassium levels on growth, flowering and chemical composition of Zinnia and marigold. *J Am Soc Hortic Sci*, *74*, pp.445-447.

7. Khan, M.A., Ziaf, K. and Ahmad, I., 2004. Influence of nitrogen on growth and flowering of Zinnia elegans cv. Meteor. *Asian Journal of Plant Sciences*, *3*(5), pp.571-573.

8. Kundu, P.B. and Paul, N.K., 1997. Effects of water stress on chlorophyll, proline and sugar accumulation in rape (Brassica campestris L). *Bangladesh Journal of Botany*, *26*(1), pp.83-85.

9. Lee, J. and Mudge, K.W., 2013. Water deficit affects plant and soil water status, plant growth, and ginsenoside contents in American ginseng. *Horticulture, Environment, and Biotechnology*, *54*(6), pp.475-483.

10. Mafakheri, A., Siosemardeh, A., Bahramnejad, B., Struik, P.C. and Sohrabi, Y., 2010. Effect of drought stress on yield, proline and chlorophyll contents in three chickpea cultivars. *Australian journal of crop science*, *4*(8), p.580.

11. Majumdar, S., Ghosh, S., Glick, B.R. and Dumbroff, E.B., 1991. Activities of chlorophyllase, phosphoenolpyruvate carboxylase and ribulose-1, 5-bisphosphate carboxylase in the primary leaves of soybean during senescence and drought. *Physiologia Plantarum*, *81*(4), pp.473-480.

12. Manivannan, P., Jaleel, C.A., Sankar, B., Kishorekumar, A., Somasundaram, R., Lakshmanan, G.A. and Panneerselvam, R., 2007. Growth, biochemical modifications and proline metabolism in Helianthus annuus L. as induced by drought stress. *Colloids and Surfaces B: Biointerfaces*, *59*(2), pp.141-149.

13. Mathur, D. and Wattal, P.N., 1995. Influence of water stress on seed yield of Canadian rape at flowering and role of metabolic factors. *PLANT PHYSIOLOGY AND BIOCHEMISTRY-NEW DELHI-*, *22*, pp.115-118.

14. Molinari, H.B.C., Marur, C.J., Daros, E., De Campos, M.K.F., De Carvalho, J.F.R.P., Pereira, L.F.P. and Vieira, L.G.E., 2007. Evaluation of the stress-inducible production of proline in transgenic sugarcane (Saccharum spp.): osmotic adjustment, chlorophyll fluorescence and oxidative stress. Physiologia Planta

15. Okçu, G., Kaya, M.D. and Atak, M., 2005. Effects of salt and drought stresses on germination and seedling growth of pea (Pisum sativum L.). *Turkish journal of agriculture and forestry*, *29*(4), pp.237-242.

16. Sakova, L.R., Paclik, and V. Curn.(1995). The drought tolerance of four Brassica species. Sbornik-Jihoceska-Univerzita-Zemedelska-Fakulta,-Ceske-Budejovice. *Fytotechnicka-Rada*, *1*, pp.77-86.

17. Sengul, S., 2002. Yield components, morphology and forage quality of native alfalfa ecotypes. *Online Journal of Biological Science*, *2*(7), pp.494-498.

18. Tester, M. and Bacic, A., 2005. Abiotic stress tolerance in grasses. From model plants to crop plants. Plant Physiology, 137(3), pp.791-793.

19. Vartanian, N., Hervochon, P., Marcotte, L. and Larher, F., 1992. Proline accumulation during drought rhizogenesis in Brassica napus var. Oleifera. *Journal of plant physiology*, *140*(5), pp.623-628.