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Original article

The effect of seed priming and foliar application of anti-stress materials on quantitative and qualitative yield of chickpea (*Cicer arietinum* L.) Adel cultivar under irrigation regimes

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Introduction

The chickpea is mainly cultivated in agricultural systems in arid and semi-arid regions and needs low input. Specifications such as the ability to fix nitrogen, deep rooting and the effective use of atmospheric depression have led the plant to play an important role in stabilizing crop production systems. On average chickpea seed contain 23% protein is highly digestible. Water deficit stress is the most important factor limiting the growth and agricultural products in arid and semi-arid regions of the world. Drought stress is one of the most important factors in grain yield reduction of chickpea during pod formation and grain filling. Amino acids facilitate the transfer of food in the vascular system by improving the permeability of the cell membrane. In plants under drought stress or salinity, proline is widely used as an osmotic regulator. In fact, amino acids are the main chain in the protein structure, and in turn, are effective in plant growth. Increased proline in chickpea leaves is a mechanism for osmotic adjustment under water stress conditions. Using the priming method is one of the methods for improving seed function and increasing the quality of seeds in adverse environmental conditions, In fact, priming shortens the time from planting to emergence and protects seed of harmful biotic and abiotic factors in the critical stage of seedling establishment. These treatments also result in the emergence of uniformity, resulting in a uniform establishment and improved yield in the crop.

Materials and methods

In order to study the effect of Anti-stress materials priming and foliar application on quantitative and qualitative yield of chickpea (*Cicer arietinum*) Adel cultivar under Irrigation regime an experiment was conducted at the Research Farm of Agriculture of Tarbiat Modares University as randomized complete block design arrangement in split plot with three replications. The main plots were included 1- optimal irrigation 2- Moderate Irrigation 3- severe Irrigation as withholding irrigation until depletion of 20, 45 and 70 percent of soil available water at root development zone respectively and then the plots were irrigated to field capacity from flowering to plant harvest. Priming and foliar application of anti-stress materials including proline, valine, alanine, commercial combination of amino acids and distilled water together with without anti-stress materials were randomized to the subplot units.

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Results and discussion

The results showed that priming and foliar application of anti-stress materials and optimal irrigation incresed the number of primary branches to the 58.31% and 36.38%, plant fresh weight to the 108.25% and 36.16%, chlorophyll a to the 40.90% and 68.35%, number of seeds/plant to the 74.48% and 34.66%, pod per plant to the 48.13% and 45.12%, duration of ripening to the 9.53% and 8.65, yield forage to the 30.56% and 39.44%, biological yield to the 65.16% and 44.82% in chekpea in compring with using severe irrigation and without priming and anti-stress materials foliar application treatments repectively. Also 1000 kernel weight and harvest index were increased %20.67 and 27.82% in optimal irrigation related to severe irrigation. Interaction effects between irrigation regimes and anti-stress materials on chlorophyll b showed that the highest rate chlorophyll b related to optimal irrigation with using commercial amino acids to to the 80% and the least it related to severe irrigation without anti-stress materials to the 24%. Application of amino acids was significant in most traits such as number of primary branches, plant fresh weight, chlorophyll a, chlorophyll b, Number of seeds/plant, pod per plant, duration of ripening, yield forage, biological yield.

Conclusion

Drought stress reduced photosynthesis and limited the amount of assimilate and thus reduced the yield and yield components in this experiment. In most cases, the application of priming and foliar application of amino acids had a positive effect on the traits, including number of primary branches, plant fresh weight, chlorophyll a, chlorophyll b, number of seeds/plant, pod per plant, duration of ripening, yield forage, biological yield at drought stress condition. Therefore, the use of amino acids, especially its commercial combination or proline, is recommended to reduce the effects of water deficit stress in the chickpea Adel cultivar.

***Keywords*:** Amino acid, Biological Yield, Water deficit stress, Yield components.

Table 1. Some physical and chemical properties of field soil

Depth	EC*10^3	PH of past	OC	Av.P	Av.K	Total N	Clay	Silt	Sand	Texture
	mmohs/cm		%	------p.p.m-------		----------%----------				
0-30	1.4	7.20	0.97	820	820	0.09	6	13	81	LS
30-60	0.85	7.56	1.1	829	829	0.11	7	11	82	LS

Table 2. Mean squares of traits under water deficit stress and priming and foliar application Anti-stress materials

S.O.V	df	Number of branches	plant Fresh weight	Chlorophyll a	Chlorophyll b	Number of seeds/plant	Pod per plant
Replication	2	53.130	22.17	12.57**	0.09	5.46	83.49
Irrigation regime (I)	2	540.02**	5301.3**	6.96**	0.06	1909.07**	141.71**
Error (a)	4	23.58	97.56	0.06	0.03	52.25	97.32
Anti-stress materials (R)	5	67.31*	371.07**	3.56**	0.14**	149.50**	348.18**
I * R	10	2.33	42.12	0.14	0.01*	6.29	18.00
Error (b)	30	21.30	89.84	0.01	0.006	34.31	68.32
CV%		*19.86*	*17.24*	*20.19*	*15.0*	*15.56*	*18.31*

Table 2.Continued

S.O.V	df	Duration of ripening	Yield forage	1000 Kernal weight	Biological yield	Harvest index
Replication	2	23.29	383679.17	1161.35	293554.35	31.23
Irrigation regime (I)	2	594.39**	18080769.7**	11139.57*	26033265.9**	734.58*
Error (a)	4	2.61	88760.41	641.35	523575.41	53.49
Anti-stress materials (R)	5	106.84**	825421.51**	1215.84	4054566.98**	9.18
I * R	10	4.57	32452.43	78.04	74126.93	13.08
Error (b)	30	15.11	54481.11	545.33	287129.16	13.58
CV%		*3.26*	*9.99*	*8.84*	*11.00*	*4.25*

ns, * and **: Not–significant and significant at 5% and 1% probability levels, respectively

Table 3. Mean comparison of traits under water deficit stress and priming and foliar application anti-stress materials

Treatments	Number of branches Primary in plant	plant Fresh weight (g)	Chlorophyll a (mg gFW^{-1})	Number of seed/plant	Pod per plant
Irrigation regime					
Optimal irrigation	26.55^{a}	66.93^{a}	4.03^{a}	45.21^{a}	51.58^{a}
Moderate water deficit	25.94^{a}	62.65^{a}	3.09^{a}	41.81^{a}	48.68^{a}
Severe water deficit	16.77^{b}	35.29^{b}	2.86^{b}	25.91^{b}	34.82^{b}
Anti-stress materials					
Commercial combination	25.00^{a}	60.21^{a}	3.99^{a}	41.14^{a}	50.62^{a}
proline	25.00^{a}	60.18^{a}	3.83^{a}	40.13^{ab}	50.27^{a}
Valine	24.55^{a}	57.88^{ab}	3.52^{a}	39.60^{ab}	47.46^{ab}
Alanine	24.44^{a}	57.08^{ab}	3.48^{a}	39.47^{ab}	47.14^{ab}
Distilled water	21.22^{ab}	50.16^{bc}	2.78^{b}	34.97^{bc}	40.40^{bc}
Control	18.33^{b}	44.22^{c}	2.37^{b}	30.55^{c}	34.88^{c}

Table 3. Continued

Treatments	Duration of ripening (day)	Yield forage (kg ha^{-1})	1000 Kernal weight (g)	Biological yield (kg ha^{-1})	Harvest index (%)
Irrigation regimes					
Optimal irrigation	123.28^{a}	2566.7^{a}	286.33^{a}	5800.6^{a}	55.68^{a}
Moderate water deficit	121.5^{b}	2472.9^{a}	269.00^{a}	5297.5^{a}	53.11^{a}
Severe water deficit	112.55^{c}	1965.8^{b}	237.27^{b}	3512.1^{b}	43.56^{b}
Anti-stress materials					
Commercial combination	124.11^{a}	2533.73^{a}	274.56^{a}	5299.2^{a}	51.14^{a}
Proline	121.66^{ab}	2596.7^{a}	273.89^{a}	5457.7^{a}	51.57^{a}
Valine	118.88^{bc}	2506.4^{a}	271.89^{a}	5257.9^{a}	51.40^{a}
Alanine	118.55^{bc}	2462.8^{a}	262.22^{ab}	5114.3^{a}	51.12^{a}
Distilled water	117.22^{cd}	2049.4^{b}	257.67^{ab}	4322.8^{b}	50.64^{a}
Control	114.22^{d}	1862.2^{b}	245.0^{b}	3768.4^{c}	48.82^{a}

Means with similar letters in each column, show non- significant difference according to LSD tests at 5% level.

Table 4. Mean comparison for the interaction effect water deficit stress and priming and foliar application Anti-stress materials on content Chlorophyll b

Irrigation regime	Anti-stress materials	محتوی کلروفیل b Chlorophyll b (mg gFW^{-1})
Optimal irrigation	Commercial combination	0.80^{a}
	Proline	0.64^{b}
	Valine	0.63^{bc}
	Alanine	0.62^{bc}
	Distilled water	0.62^{bc}
	Control	0.57^{bcd}
Moderate water deficit	Commercial combination	0.58^{bcd}
	Proline	0.57^{bcd}
	Valine	0.56^{bcd}
	Alanine	0.55^{bcd}
	Distilled water	0.54^{bcd}
	Control	0.51^{cde}
Severe water deficit	commercial combination	0.51^{cde}
	Proline	0.46^{def}
	Valine	0.38^{efg}
	Alanine	0.34^{fgh}
	Distilled water	0.27^{gh}
	Control	0.24^{h}

The means with similar letters in column, show non- significant difference according to LSD tests at 5% level