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Original article

Effect of seed priming and foliar application of growth regulators on morphophysiological changes and safflower grain and oil yield under drought stress

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Extended abstract

Introduction

Safflower (*Carthamus tinctorins* L.) is an annual oil plant from the chicory family (Asteraceae) which, due to its high oil (30-40%) high quality (having more than 90% of unsaturated acids, especially linoleic acid and oleic acid), has played an important role in expanding the cultivated area of oil plants and providing oil seeds. The global cultivated area of safflower in 2019 was about one million and 140 thousand hectares and the average global production of its seeds was about 590 thousand and 869 tons. Water shortage stress, as one of the most important non-living stresses, has a destructive effect on most stages of crop plant growth, such as germination, seedling establishment, the structure of organs and their activity, and makes it difficult to achieve the desired result. Priming is one of the methods that after placing the seeds in their bed and facing the ecological conditions of the environment, physiologically and biochemically, they get ready for germination, and it can be used to reduce the negative effect of dehydration stress in many from plants. There are several different methods for seed priming, including osmopriming, hydropriming, matrix priming, hormonal priming, and biopriming. Plant hormones (growth regulators) are useful agrochemical tools that help plants to consume nutrients more efficiently and demonstrate their genetic and physiological potentials.

Materials and methods

In order to investigate the effect of priming and foliar spraying of growth regulators on the morphophysiological changes and the yield of safflower oil seeds of the cultivar Pandeh under drought stress, An experiment was carried out in the research farm of the Faculty of Agriculture of Tarbiat Modares University as an autumn crop during the agricultural year of 2017-2018 in the form of one-time divided plots based on the design of randomized complete blocks with three replications. The experimental factors include three levels of irrigation (optimal irrigation (cessation of irrigation until the discharge of 25% of usable water), medium water stress (cessation of irrigation until the discharge of 45% of usable water), severe water stress (cessation of irrigation until the discharge of 65% of usable water)) in the flowering stage until The end of the growth period in the main plots and five levels of seed

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priming and foliar application of plants (pure water, gibberellic acid, salicylic acid, ascorbic acid, humic acid) along with a control treatment (without priming and foliar appication) as sub-plots were considered.

Results and discussion

The results showed that with the reduction of irrigation to the level of severe water stress, the yield and seed oil decreased by 41.31 and 43.46%, respectively, and significantly ($P<0.01$) compared to optimal irrigation. Also, with the reduction of irrigation water to the level of medium water stress, the amount of malondialdehyde increased by 15.92% and was significant compared to the optimal irrigation. With priming and foliar application of growth regulators, height, total chlorophyll, yield, and seed oil increased and malondialdehyde decreased significantly ($P<0.01$).

Conclusion

Based on the overall results, drought stress had a negative effect on the morphological characteristics and yield and oil percentage of safflower seeds. With priming by pure water, although the physiological traits and yield were improved, it was not significantly different from the control treatment. Foliar application of growth regulators by increasing the amount of total chlorophyll and improving growth had an important role in increasing yield. Due to the lack of water in the flowering and seeding stage of safflower in most regions of Iran, foliar application by growth regulators such as humic acid, salicylic acid and gibberellic acid can play an effective role in improving yield under medium water stress by increasing biochemical traits such as proline.

***Keywords*:** MDA, Oil yield, Plant height, Total chlorophyll

Table 1. Physicochemical characterisitcs of the soil at the test site

Depth of soil	Total Nitrogen (T.N)	P	K	pH	Ec	Organic Carbone (OC)	T.N.V
cm	%	-- mg.kg^{-1} --			ds.m^{-1}	----------%	
0-30	0.07	20	447	8.15	0.15	0.76	13
30-60	0.05	20	475	8.15	0.18	0.50	10

Table 2- Analysis of variance effect irrigation levels and foliar growth regulators on Morphophysiological traits, grain yield and oil safflower cultivar padideh

Source of variation	df	Plant height	Leaf area index	Total chlorophyll	Grain yield
Block	2	39.46^{ns}	0.04^{ns}	0.017^{ns}	318893.90^{ns}
Irrigation (I)	2	227.91^{ns}	15.63^{**}	3.78^{**}	34853104.17^{**}
Ea	4	60.96	0.17	0.021	93616.33
Growth Regulators (G)	5	468.77^{**}	3.08^{**}	7.96^{**}	4767062.18^{**}
I × G	10	93.64^{ns}	0.74^{**}	0.091^{**}	239271.21^{ns}
Eb	30	60.98	0.12	0.021	310558.71
CV%		*6.81*	*17.60*	*3.13*	*10.79*

Table 2. Continued

Source of variation	df	Proline	MDA	Percentage of seed oil	Oil yield
Block	2	0.13^{ns}	0.16^{ns}	2.97^{ns}	46280.71^{*}
Irrigation (I)	2	47.52^{**}	8.75^{**}	8.58^{ns}	513171031.21^{**}
Ea	4	1.50	0.09	4.32	2663.38ns
Growth Regulators (G)	5	2.52^{ns}	25.12^{**}	22.07^{**}	767748.93^{**}
I × G	10	20.17^{**}	0.15^{ns}	6.96^{*}	43664.12^{ns}
Eb	30	1.88	0.17	2.85	41940.80
CV%		*10.52*	*5.14*	*4.74*	*11.09*

$^{ns, *, **}$ Inexplicable and significant at the 5 and 1 percent probability levels, respectively

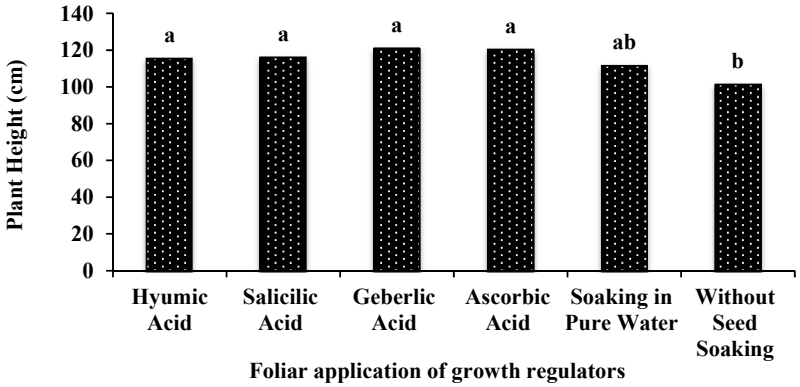

Fig. 1. Comparison of simple means of foliar application of growth regulators on plant height

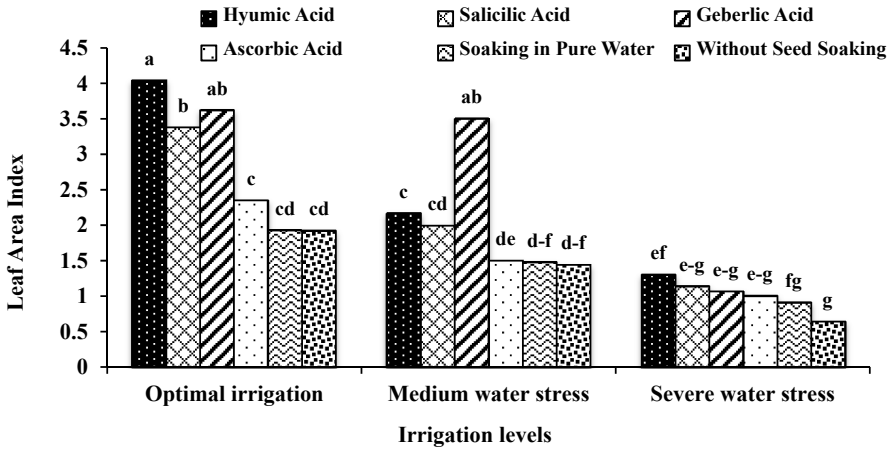

Fig. 2. Comparison of means of interaction of irrigation levels in foliar application of growth regulators on leaf area index

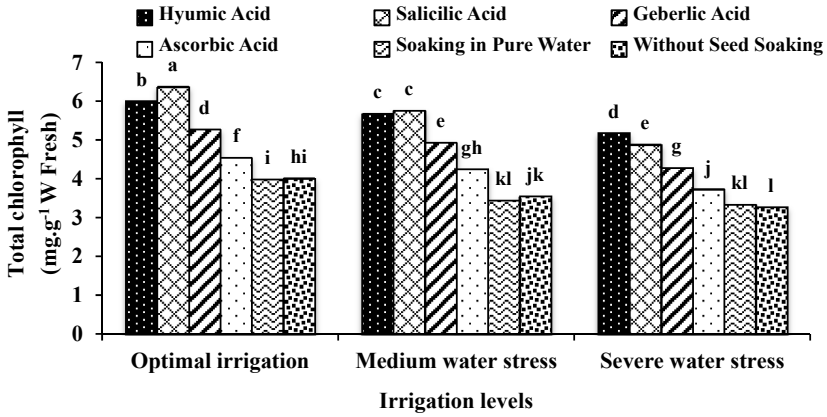

Fig. 3. Comparison of means of interaction of irrigation levels in foliar application of growth regulators on Total chlorophyll.

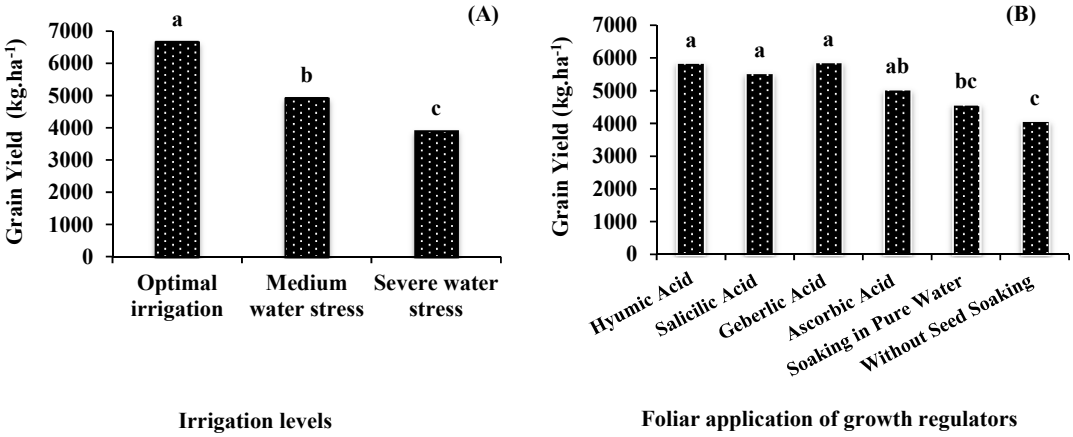

Fig. 4. Comparison of simple means of irrigation levels (A) and foliar application of growth regulators (B) on Grain yield

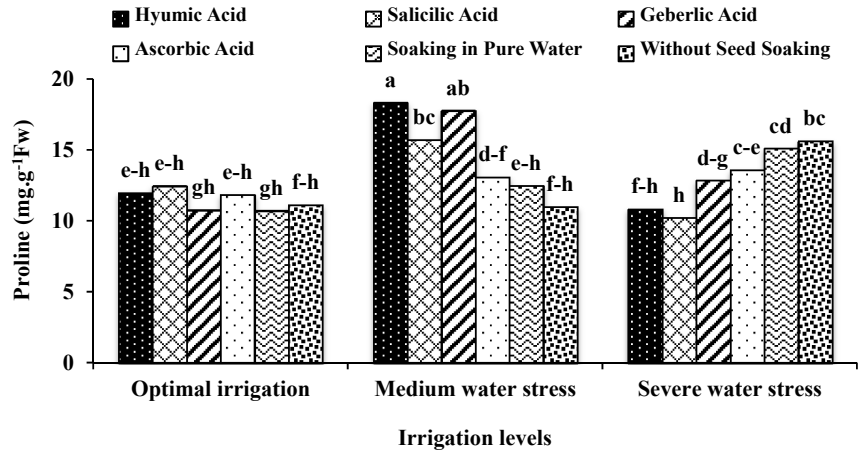

Fig. 5. Comparison of means of interaction of irrigation levels in foliar application of growth regulators on Leaf proline

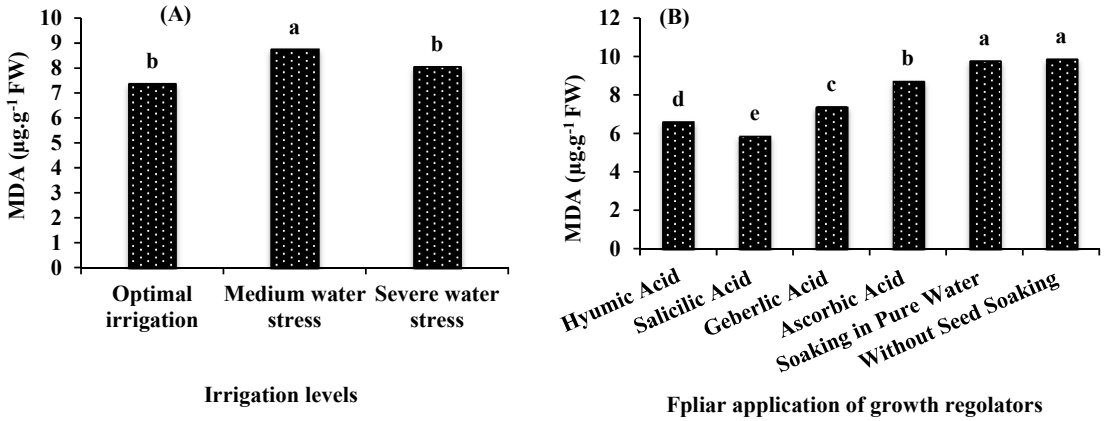

Fig. 6. Comparison of simple means of irrigation levels (A) and foliar application of growth regulators (B) on MDA

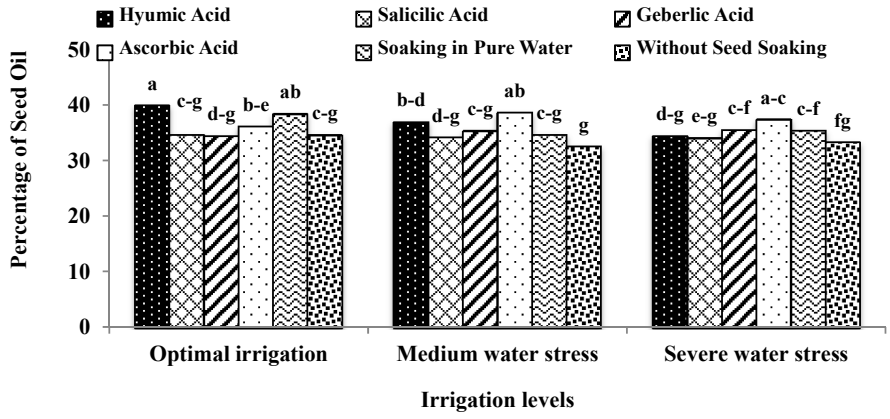

Fig. 7. Comparison of means of interaction of irrigation levels in foliar application of growth regulators on Percentage of seed oil

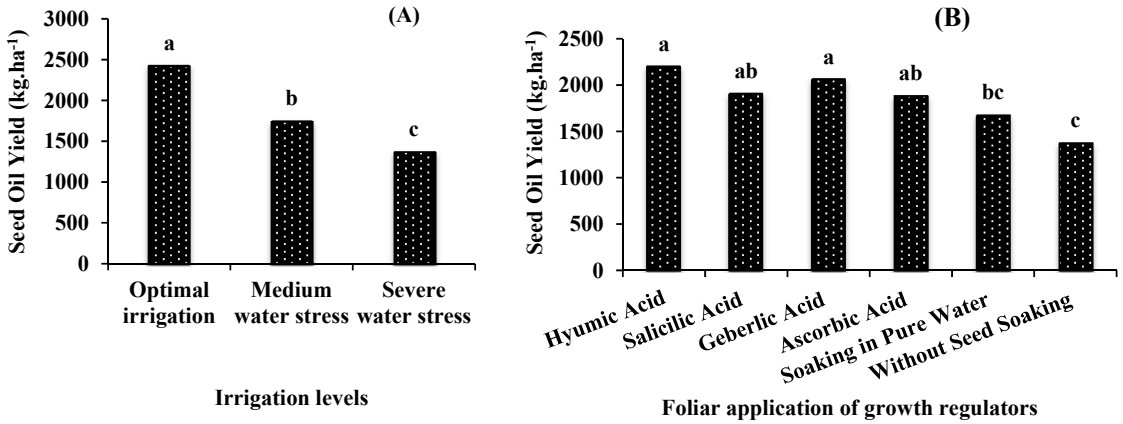

Fig. 8. Comparison of simple means of irrigation levels (A) and foliar application of growth regulators (B) on seed oil yield