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Original article

Study the effect of iron, zinc and manganese foliar application on morphological and agronomic traits of bread wheat (Chamran cultivar) under irrigation regime

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Extended abstract

Introduction

Wheat (*Triticum aestivum* L.) is considered as the major cereal crop in the world in respect of the cultivated area and total production. Drought is a polygenic stress and is considered as one of the most important factors limiting crop yields around the world. Most of the Iranian soils, have a high pH and calcareous nature, and micronutrients solubility in these soils is low. Micronutrient deficiency is widespread in many Asian countries due to the calcareous nature of soils, high pH, low organic matter, salt stress, continuous drought, high bicarbonate content in irrigation water, and imbalanced application of NPK fertilizers. Micronutrients plays a critical role in increasing plant resistance to environmental stresses. Foliar nutrition is an option when nutrient deficiencies cannot be corrected by applications of nutrients to the soil. Foliar spraying of microelements is very helpful when the roots can not provide necessary nutrients. Iron as a micronutrient, is critical for chlorophyll formation and photosynthesis and is important in the enzyme systems and respiration of plants. Zinc is a ubiquitous micronutrient. It is required as a structural and functional component of many enzymes and proteins, and increases the yield and yield components of wheat. Manganese as a micronutrient, is necessary in photosynthesis, nitrogen metabolism and to form other compounds required for plant metabolism.

Materials and methods

To study the effect of iron, zinc and manganese foliar application on morphological and agronomic traits of bread wheat (Chamran cultivar) under irrigation regime, an experiment was conducted as split-plot with four replications in Ramhormoz city in the crop year 2016-2017. The experimental factors were included irrigation regime in two levels of complete irrigation (non-water stress) and irrigation cut from the beginning of tillering stage to the physiological ripening (water stress) as the main factor, and micronutrients foliar application in six levels of non-foliar application (control), foliar application by water, iron, zinc, manganese and iron + zinc + manganese (each 3 $lit.h^{-1}$) in three times and at tillering, stemming and pollination stages as the sub factor. Solutions for foliar application were prepared by using Iron chelate (6%), Zinc chelate (7.5%) and Manganese chelate (7%). The measured traits included Peduncle length, spike length, plant height, number of tillers per m^{-2}, number of spikes per m^{-2}, number of grain per spike, 1000-seed weight and grain yield. At maturity, the inner two row of each plot unit were harvested to estimate grain yield, and sup sample of 1 m^{-2} was obtained for determining Peduncle

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length, spike length, plant height, number of tillers per m^{-2}, number of spikes per m^{-2}, number of grain per spike, 1000-seed weight. Analysis of variance was performed using general linear model (GLM) procedure of statistical analysis system (SAS version: 9.3). The means were analyzed using the least significant difference (LSD) method at P=0.05 (LSD 0.05).

Results and discussion

Results showed that the water stress decreased significantly (P<0.01) traits of peduncle length (26.62%), spike length (12.87%), plant height (22.91%), number of tillers per m^{-2} (29.21%), number of spikes per m-2 (26.85%), number of grain per spike (13.43%), 1000-seed weight (17.37%) and grain yield (46.10%). However, the separate and combined application of iron, zinc and manganese increased the measured traits on average 15.20, 7.72, 7.32, 25.18, 23.24, 8.84, 8.76 and 32.63 percent under water stress, respectively. Meanwhile, zinc application showed the greatest effect in reducing the damage caused by water stress on measured traits.

Conclusions

In general, the use of micronutrients, especially zinc, as foliar application, can reduce the harmful effects caused by water stress and improve the morphological and agronomic traits of bread wheat in Ramhormoz region.

***Keywords*:** Cereals, Drought stress, Micronutrient elements.

Table 1. Soil physical and chemical properties of experimental location

E.C	pH	Soil texture	Clay	Silt	Sand	O.C	P	K	Fe	Zn	Mn
$dS.m^{-1}$			----------%----------				----------$mg.kg^{-1}$----------				
5.71	7.51	Silty clay	49	35	16	0.83	16.56	180	2.21	0.72	0.80

Table 2. Weather statistics of Ramhormoz during the experimental period

Month	Mean of air temperature (℃)		RH (%)	Precipitation (mm)
	Maximum	Minimum		
November	30.0	18.1	41	18.3
December	27.1	10.9	56	55.7
January	16.9	9.7	65	58.4
February	20.6	8.4	49	15.1
March	22.2	13.7	43	10.5
April	30.4	17.4	42	6.8

Table 3. Analysis of variance measured traits affected by experimental factors

S.O.V	df	Peduncle length	Spike length	Plant length	Number of tillers per m^{-2}
Block	3	3.33^{ns}	1.43^{ns}	4.19^{ns}	8176.64^{ns}
Irrigation regime (A)	1	3465.07^{**}	102.46^{**}	18725.24^{**}	174231.63^{**}
Error a	3	1.68	0.31	0.53	376.45
Foliar application (B)	5	54.76^{**}	16.91^{**}	143.38^{**}	26593.85^{**}
A × B	5	26.46^{*}	6.69^{*}	54.56^{**}	2965.33^{**}
Error b	30	0.734	0.16	0.36	247.11
CV%		*4.04*	*4.23*	*6.64*	*5.15*

Table 3.Continued

S.O.V	df	Number of Spikes per m^{-2}	Number of grain per spike	1000- grain weight	Grain yield
Block	3	2270.21^{ns}	1.66^{ns}	0.88^{ns}	79236.14^{ns}
Irrigation regime (A)	1	243276.63**	183.32**	1663.02**	504760.58**
Error a	3	105.10	0.62	0.56	49362.18
Foliar application (B)	5	55638.47**	126.68**	40.68**	243219.62**
A × B	5	3789.40**	57.73**	43.12**	215045.47**
Error b	30	63.32	0.58	0.37	27645.36
CV%		3.15	2.44	3.00	10.26

ns, * and **: Non significant and significant at P<0.05 and P<0.01, respectively

Table 4. Comparison of mean the effect of micronutrients foliar application on measured traits under irrigation regime

Irrigation regime	Foliar application	Peduncle length	Spike length	Plant length	Number of tillers
		----------(cm)----------			per m^{-2}
Complete irrigation	**Control**	30.09^{f}	17.56^{d}	77.91^{d}	312.66^{d}
	Water	31.28^{e}	18.10^{c}	79.60^{c}	336.00^{c}
	Fe	33.72^{b}	18.95^{ab}	82.81^{ab}	340.66^{c}
	Zn	35.21^{a}	19.39^{a}	83.37^{a}	394.66^{a}
	Mn	32.46^{c}	18.80^{b}	81.90^{b}	362.33^{b}
	Fe+Zn+Mn	33.18^{bc}	18.83^{b}	82.83^{ab}	366.33^{b}
Water stress	**Control**	22.08^{k}	15.30^{h}	60.06^{h}	221.33^{h}
	Water	23.25^{j}	15.83^{g}	61.50^{g}	244.00^{g}
	Fe	26.07^{h}	16.45^{f}	66.05^{e}	266.33^{f}
	Zn	28.49^{g}	16.98^{e}	66.20^{e}	338.33^{c}
	Mn	24.77^{i}	16.43^{f}	63.46^{f}	288.00^{e}
	Fe+Zn+Mn	24.85^{i}	16.46^{f}	63.53^{f}	290.66^{e}
LSD 5%		*1.15*	*0.51*	*1.39*	*20.10*

Table 4.Continued

Irrigation regime	Foliar application	Number of Spikes	Number of grain per spike	1000- grain weight	Grain Yield
		per m^{-2}		(g)	(kg.h^{-1})
Complete irrigation	**Control**	435.66^{e}	39.66^{d}	39.30^{d}	4565.57^{e}
	Water	480.00^{d}	41.00^{c}	40.52^{c}	5140.26^{d}
	Fe	520.00^{c}	43.00^{b}	41.23^{bc}	5676.49^{c}
	Zn	590.33^{a}	44.33^{a}	42.66^{a}	6723.31^{a}
	Mn	517.33^{c}	43.00^{b}	41.21^{bc}	5628.73^{c}
	Fe+Zn+Mn	555.33^{b}	44.33^{a}	42.00^{ab}	6153.40^{b}
Water stress	**Control**	318.66^{h}	34.33^{h}	32.47^{h}	2460.53^{i}
	Water	351.33^{g}	35.66^{g}	33.72^{g}	2831.58^{h}
	Fe	395.66^{f}	37.00^{f}	35.00^{f}	3384.39^{g}
	Zn	472.00^{d}	38.33^{e}	36.22^{e}	3927.39^{f}
	Mn	392.33^{f}	37.00^{f}	34.97^{f}	3396.47^{g}
	Fe+Zn+Mn	400.66^{f}	38.33^{e}	36.18^{e}	3902.73^{f}
LSD 5%		32.24	1.12	1.16	332.83

Means in each column followed by similar letters are not significantly different at 0.05 probability level using of LSD