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Effect of application of elements and variety on biological and grain yield and harvest index of wheat in Zahak region

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Abstract

Wheat (*Triticum aestivum* L.) is one of the most important food resources. This plant is cultivated in a wide range in agricultural land of the world. To determine the effects of water deficiency in different final growth stages of two wheat cultivars (Chamran and Kavir) accompany with application of various elements such as potassium (K), zinc (Zn) and copper (Cu) on yield production, harvest index (HI), concentration of nitrogen (N) and other elements in grain were investigated under weather condition of Sistan. The experiment was carried out as Completely Randomized Block under spilt - spilt plot design with three replicates, on loomy fine sand soil during 2001-2002 and 2002- 2003 growth season at the Research Center Institute of Zabol, Zahak. The results of this study highlight that the respond of grain yields (GY), biological yield (BY), harvest index (HI were analyzed. Halted water at 10.5-1, fix scale decreased BY, GY and HI at statistically significant level ($p>0.01$). But the Chamran produced more BY, GY than Kavir wheat cultivar.

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Introduction

Wheat (*Triticum aestivum* L.) is one of the most important food resources. This plant is cultivated in a wide range in agricultural land of the world (Royo *et al.*, 2005). Wheat (*Triticum aestivum* L.) is the world's most important crop. Greater importance of bread wheat can be expected as a main source of food for solving the increasing population of the world. In arid and semiarid regions with Mediterranean climate, wheat crop usually encounter drought during the grain filling period. Wheat quality is controlled not only by genetic factors, but also by environmental conditions, especially the supply of water and fertility in soil that can change wheat quality under normal cropping condition (Triboi *et al.*, 2003). Wheat is the staple food for more than 35% of world population (Jing and chang, 2003). It is the leading source of vegetable protein in human food, having higher protein content than other major cereals. Wheat cultivated area in Egypt 2011 was 1.28 million hectare which producing 8.4 million tones (FAO, 2013). Different types of abiotic environmental stresses cause reduction in quantity and quality of wheat grain yield production (Jones, 2009). Among different types of abiotic environmental stresses, water stress is the most important factor in limiting wheat growth and grain yield formation (Ercoli *et al.*, 2007). In many regions of the world, drought stress is one of the most important factors that decrease agricultural crop production (Zahedi *et al.*, 2009). Due to the geographical situation, Iran's climate is Mediterranean and with respect to average participation (240 mm), is considered as arid and semi-dry regions of the world (Heidari- Sharifabad, 2008). Johari-pireuvatlou (2010) reported that wheat yield decreased from 25 to 85% under drought stress. Maralian *et al.*, (2010) reported that seed yield reduced with water stress as compared with the control. Water stress in such areas often occurs during these periods. Under such conditions, providing of carbohydrates that are needed for grain filling to form the economical yield is very important. The most important factor in reducing grain yield in such areas is grain weight reduction (Saeidi *et al.*, 2010). Grain yield is a complex trait and influenced by many factors. So, to enhance grain yield production in wheat, determining factors should be identified (Acreche and Slafer, 2006). Katerji *et al.*, (2009) reported that drought reduced the grain (37%) and straw (18%) yield. Exacerbate resource constraints of drought stress during the reduced grain filling period (Koocheki *et al.*, 2006), leaf senescence (Martinez *et al.*, 2003; Gregersen and Holm, 2007) and reduction in leaf photosynthesis (Yang and Zhang, 2006). The improvement of tolerance to drought has been a principal goal of the majority of breeding programmers for a long time, as a water deficit in certain stages of wheat growth is common for many wheat growing regions of the world (Farshadfar, 2012). Plant improvement for drought resistance is complicated by the lack of fast, reproducible screening techniques and the inability to routinely create defined and repeatable water stress conditions where a large amount of genotypes can be evaluated efficiently (Naroui Rad *et al.*, 2012). On the other hand, world demand for grain of wheat, as a stable food crop, is increasing. So, it is an urgent need to develop new genotypes with traits that could not only tolerate serious drought stress at various stages of growth but can also produce higher grain yield under drought stress conditions. Genetic variation among genotypes which is exist for various yield and yield related traits in wheat, is the most important issue in plant breeding programs (Talebi *et al.*, 2009). The ability of improving wheat cultivars that are able to maximum use of existing water and drought tolerant is the main objectives of increasing yield potential in semi-arid and dry areas (Ghasemali *et al.*, 2011). Phenotypic characters have been successfully used for genetic variation studies and cultivar development. Among these characters, morphological traits are commonly used to evaluate genetic variation because their measurements are simple (Najaphy *et al.*, 2012). Grain susceptibility to zinc deficiency, is less than other crops and deficiency of this factors in can reduce crop yield (Malekoti and Tehrani, 2000). Shahabifar and Mostashri (2002) have reported that by consumption of 40 kg zinc sulfate can be increased wheat yield by as much as 473 kilograms per hectare. Potassium fertilizers use in Iran in recent years has been less attention. As the result attracted potassium content of the soils decrease rapidly due to cropping and harvesting more potassium from the soil, and limited fallow in farms (Tabatabaei, 2010). Narimani *et al* (2010) reported that microelements foliar application improve the effectiveness of microelements. Zinc is main composition of ribosome and is essential for their development. Amino acids accumulated in plant tissues and protein synthesis decline by zinc deficit. The aim of this study is effect of application of elements and variety on biological and grain yield and harvest index of wheat in zahak region.

Materials and methods

Location of experiment

To determine the effects of water deficiency in different final growth stages of two wheat cultivars (Chamran and Kavir) accompany with application of various elements such as potassium (K), zinc (Zn) and copper (Cu) on yield production, harvest index (HI), concentration of nitrogen (N) and other elements in grain were investigated under weather condition of Sistan.

Field experiment

The experiment was carried out as Completely Randomized Block under spilt - spilt plot design with three replicates, on loomy fine sand soil during 2001-2002 and 2002- 2003 growth season at the Research Center Institute of Zabol, Zahak. In this experiment, there were 3 type of irrigation, complete irrigation (w1), cut irrigetion after pollination (10.5-1, Fix scale) (w2), and cut irrigetion after milky stage of grain (10.5-5, Fix scale) (w3) as sub–plots , and fertilizer treatments included; non-fertilizer (e1), copper sulphate (CuSo4) (e2), zinc sulphate (ZnSo4) (e3) and potassium sulphate (K2So4) (e4) 0, 30, 40, 150kg/ha, respectively which is applied at sowing time as sub-sub plot.

Characters of plot

Each plot consisted of 6 rows planting a length of 6 meters and the distance between rows was 20 cm. Wheat planting density of 450 plants per square meter was intended.

Amount of phosphorus fertilizer

The amount of phosphorus fertilizer 150 kg/ha the source of triple superphosphate and the amount of 350 kg urea per hectare to supply nitrogen to the plant before planting was added to the soil.

Methods of measurement concentration of elements

Grain nitrogen concentration in the first experiment, the method Kejeldal obtained. Also seed samples obtained in the first experiment, the concentration of potassium, zinc, and copper film devices atomic absorption, respectively.

Data collect

Data collected were subjected to statistical analysis by using a computer program MSTATC. Least Significant Difference test (LSD) at 5 % probability level was applied to compare the differences among treatments` means.

Result and discussion

Biological yield

Analysis of variance showed that the effect of year on biological yield was not significant (Table 1). Analysis of variance showed that the effect of cut irrigation on biological yield was significant (Table 1). The maximum biological yield of treatments complete irrigation (15.574 t/ha) was obtained (Table 2). The minimum biological yield of treatments cut irrigation after pollination (13.449 t/ha) was obtained (Table 2). Analysis of variance showed that the effect of variety on biological yield was significant (Table 1). The maximum biological yield of treatments Chamran (4.47) was obtained (Table 3).

Grain yield

Analysis of variance showed that the effect of year on grain yield was not significant (Table 1). Analysis of variance showed that the effect of cut irrigation on grain yield was significant (Table 1). The maximum grain yield of treatments complete irrigation (5.060 t/ha) was obtained (Table 2). The minimum grain yield of treatments cut irrigation after pollination (3.45t/ha) was obtained (Table 2). Analysis of variance showed that the effect of variety on grain yield was significant (Table 1). The maximum biological yield of treatments chamran (14.75) was obtained (Table 3).

Table 1. Anova analysis of the wheat affected by cut irrigation and variety.

S.O.V	df	Biological yield	Grain yield	Harvest index
R	2	1.252^{ns}	0.288^{ns}	0.0128^{ns}
Year	1	36.997^{ns}	7.793^{ns}	101.758^{ns}
Error a	2	2.298	1.257	23.202
Cut Irrigation	2	54.414^{**}	33.019^{**}	553.169^{**}
Year * Cut Irrigation	2	1.887^{ns}	1.796^{ns}	96.469^{ns}
Error b	8	2.887	0.577	30.167
Variety	1	7.613^{*}	1.420^{**}	4.463^{ns}
Year * Variety	1	0.009^{ns}	0.414^{ns}	14.739^{ns}
Cut Irrigation* Variety	2	0.668^{ns}	0.657^{**}	9.230^{ns}
Cut Irrigation* Variety* Year	2	0.747^{ns}	0.373^{ns}	14.993^{ns}
Application of elements	3	2.182^{ns}	0.663^{**}	15.000^{ns}
Application of elements* Year	3	0.521^{ns}	0.097^{ns}	13.928^{ns}
Application of elements* Cut Irrigation	6	0.590^{ns}	0.259^{ns}	13.019^{ns}
Application of elements* Cut Irrigation* Year	6	2.118^{ns}	0.278^{ns}	15.340^{ns}
Application of elements* Variety	3	1.107^{ns}	0.098^{ns}	15.546^{ns}
Application of elements* Variety* Year	3	0.493^{ns}	0.090^{ns}	5.640^{ns}
Application of elements* Variety* Cut Irrigation	6	0.457^{ns}	0.157^{ns}	9.761^{ns}
Application of elements* Variety* Cut Irrigation* Year	6	1.720^{ns}	0.171^{ns}	8.744^{ns}
Error c	84	1.231	0.127	8.231
CV	-	7.62	8.16	9.51

*, **, ns: significant at $p<0.05$ and $p<0.01$ and non-significant, respectively.R: Repeat, Ms: Means of square, CV: Coefficient variation.

Table 2. Comparison of different traits affected by cut irrigation.

Cut Irrigation	Biological yield (t/ha)	Grain yield (t/ha)	Harvest index (%)
W1 (complete irrigation)	15.574a	5.060a	32.651a
W2 (cut irrigetion after pollination)	13.449b	3.450b	26.298b
W3 (cut irrigetion after milky stage)	14.633a	4.600a	31.547a

Any two means not sharing a common letter differ significantly from each other at 5% probability.

Table 3. Comparison of different traits affected by Variety.

Variety	Biological yield (t/ha)	Grain yield (t/ha)
V1 (Chamran)	4.47a	14.75a
V2 (Kavir)	4.24b	14.29b

Any two means not sharing a common letter differ significantly from each other at 5% probability.

Harvest index

Analysis of variance showed that the effect of year on harvest index was not significant (Table 1). Analysis of variance showed that the effect of cut irrigation on harvest index was significant (Table 1). The maximum harvest index of treatments complete irrigation (32.651) was obtained (Table 2). The minimum harvest index of treatments cut irrigation after pollination (26.298) was obtained (Table 2). Analysis of variance showed that the effect of variety on harvest index was not significant (Table 1).

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