International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print) 2222-5234 (Online)
http://www.innspub.net
Vol. 5, No. 6, p. 113-118, 2014

RESEARCH PAPER OPEN ACCESS

Study of effects of end-season drought stress on the length of spikes, number of nodes per stalk, and diameter of stalks of irrigated barley lines in moderate regions of Kermanshah province

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Key words: Irrigated barely lines, Drought stress, length of spikes, number of nodes per stalk , diameter of stalks.

http://dx.doi.org/10.12692/ijb/5.6.113-118 Article published on September 20, 2014

Abstract

In 2009-10, a research was done in order to study the effects of late-season drought stress on yield and yield components of irrigated barely lines with 2 factors of genotype and drought stress in the form of split plot test in the format of complete random blocks with 3 repetition in Islamabad-e Gharb Station (Kermanshah province).For 9 levels of lines MBD-85-3 , MBD-85-6, MBD-85-8, MBD-85-14, MB-85-3, MB-85-5,MB-85-18 and 2 control cultivars Yosuf (D5) and Nosrat, drought stress and genotypes were considered as major and minor factors, respectively. Each plot was set at a 12-m^2 area (each ridge 60 cm). Plant density was set at 400 seeds/m^2 with 4-5 cm planting depth. Seeding was performed by winter Schneider test seeder with sprinkler irrigation. Soil test determined the amount and type of fertilizer to be used .Results of variance analysis showed that the difference between cultivars in terms of spike length as well as the difference between irrigation levels became significant at 1% level, but variety (cultivar) × irrigation interactions did not became significant . According to the variance analysis results, no significant differences were observed between cultivars in terms of the number of nodes per stalk, between irrigation levels and between cultivar × irrigation interactions. For diameter of stalks, results showed a significant difference at 5% level between cultivars, but not between irrigation levels. However, cultivar × irrigation interactions were significant at 1% level.

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Introduction

Barley *(Hordeumvulgare L.)* is an annual plant from cereal (Gramineae) family of genus Hordeum with 24 species including diploid , tetra ploid , and hexaploid and the basic chromosome number of which is x=7 . Farming barley is of species (H.Valgare L.) which includes both types of 2-rowed (H.V.disticum) and 6-rowed (H.V.hexasticum) barley although, in the past, they were classified into 2 separate species. During many centuries, barley has been paid attention to as a major cereal for following reasons (Rasmosen, 1970). Barley is an auto gamy plant with shallow fibrous roots. It has a cane knobby stalk, and narrow light green leaves with round ends. At connection place of leaf to talk, there are 2 large stipules and 1 long half-circle achromatic ligules. Barley is bisexual and has spike inflorescences (Bakero *et al.*, 1990). Like other plants, barley germination includes a series of events as a result of which germs undergo some metamorphosis changing from a dormant state into an actively generative metabolic one. This is reached after a period of dormancy caused by environmental (temperature, heat. Degree , oxeye , and light) , physiological (growth inhibitor substances , immature embryo) , and or morphological (seed coat) factors. Physiologically, termination is a process beginning with water uptake by dry seeds and terminating with emergence of primary root out of seed coat. Seeds of any species or variety have minimum, and maximum temperatures, which are 4°c, 22° c, and 36°c, temperatures, for barley germination. History of genesis and evolution of barley dates back to the beginning of agriculture so that its domestication time has been attributed to 5-7 thousand years B.C or more (Rasmosen , 1970).

Barley is a highly vast adaptive plant and one of the first plants dots domesticated by humans development and their basic food supply (Allarad *et al.*, 1964).For embryos absorbed water, oxygen requirement directly relates to increased temperature, but the amount of oxygen dissolved in water decreases as temperature increases. Germination is more dependent on moisture than on oxygen and dioxide carbon. For germination, barley and other cereal exhibit the least reaction to the light (Kouchaki *et al.*, 1988). Plant height increases as density increases. Under plant high-density conditions, shading results and stalks become etiolated. Probably, shade effect is caused by increased oxide and seems to be intensified at presence of gibberellins (Kouchaki & Sarmadnia , 1994) . The rate of barley production is estimated at 3.45 million tons in the country , 69.10% and 30.90% of which are harvested from irrigated lands and from dry farming, respectively (Agriculture Data sheet ,2009) Khorassan Razavi province holds the first place nationwide in terms of barley production at 16.68% , followed by Kermanshah , Hamadan, Isfahan, Golestan , and Tehran at the end to 6th places , respectably , producing 8.74% , 7.72% , 5.62% , 5.47% , 5.32% of total rate of barley production . Collectively, 6 mentioned provinces produce 49.55% of country barley while remaining 50.45% are produces by all other provinces of the country. The least rate of barley production is 0.07% by Hormozgan province (Agriculture Data sheet, 2009).

Materials and methods

In farming year of 2009-10, present research was done at research station of Islamabad-e Gharb, Kermanshah province. Research field is located 65 km of south Kermanshah at north 34°8′ latitude and east 47° 26′ longitude , elevated 1346 m from sea level having semiarid Mediterranean climate . Following results were obtained at agrology lab of soil & water research division from Kermanshah Agriculture Center by performing soil analysis operation on soil samples randomly taken from 0-125 cm depth of the soil of test field. Target region soil with 10.8% of sand, 56% of sill, and 33.2% of clay has a silly – clay –loam texture. During farming year of 2009-10 , at Islamabad-e Gharb station (Kermanshah province) this research was vane with 2 factors of cultivar and stress in the form of split plot design based on complete random blocks with 3 repetitions in order to study effects of late-season drought stress on morphological and physiological characteristics of different irrigated barley lines within temperate regions of Kermanshah province. Drought stress and normal conditions were regarded as major and irrigated barley cultivars as minor factors; the latter at 9 levels (MBD-85-3 , MBD-85-6 , MBD-85-8 , MBD -85-14 , MB-85-3 , MB-85-5 , MB-85-18 , and 2 control cvs. Nosrat and yosuf). Each plot was of 1.2×10= 12 m^2 area (with ridges 60 cm apart), and plant density was 400 seeds m^{-2} . The amount and type of fertilizers to be used were determined on the basis of soil test as follows: potash, phosphorus, and nitrogenous fertilizer were used, respectably, from potash sulfate source; and urea source , in the form of basal and top-dressing fertilizers. Based on the soil analysis results, 150 kg of ammonium phosphate fertilizer was used at the time of planting , and a third of urea fertilizer was used at the time of planting and remaining amount was used as top-dressing fertilizer during 2 stages of elongation and grain-set. Also, in grain-filling stage, Integration pesticide was used to control wheat bug. In order to control smut, used seeds were disinfected by using Maukazeb fungicide. Other stages of crop management were performed routinely.

Measurement

Spike lengths

The distance between the first terminal spikelet to spikelet cluster of ten randomly mm measurement barely and As the length of each plot was used to determine the mean spikes.

Number of nodes per stalk

Ten stems were randomly selected to count the number of nodes per shoot and shoot out as the number of nodes in each plot were used.

Diameter of stalks

Ten randomly selected shoots per stem diameter between the second and third node mm was measured with a caliper And as they shoot diameter of each plot was carried Average.

Statistical analysis

Variance analysis of data was performed on the basis of split plot design in the form of complete random blocks, and Duncken׳s method was employed to compare means. MSTAT-C software and 3-D graph drawing were used to analyze data, and statistical SAS and SPSS software was used to analyze principal components and coefficients of simple correlation between attributes.

Results and discussion

Spike lengths

For length of spikes, results of variance analysis indicated that the differences between cultivars as well as between irrigation levels became significant at 1% level, but the difference between cultivar × irrigation interactions did not became significant.

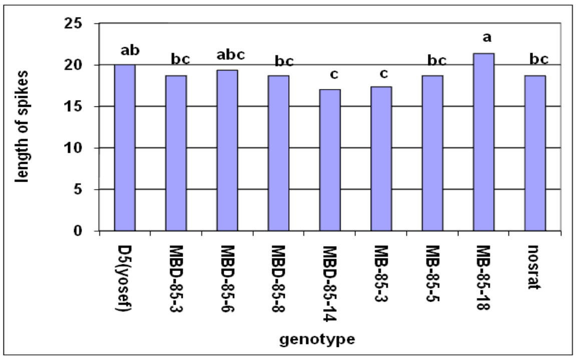

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Fig. 1A. Mean spike lengths of different irrigated barley genotypes under normal conditions.

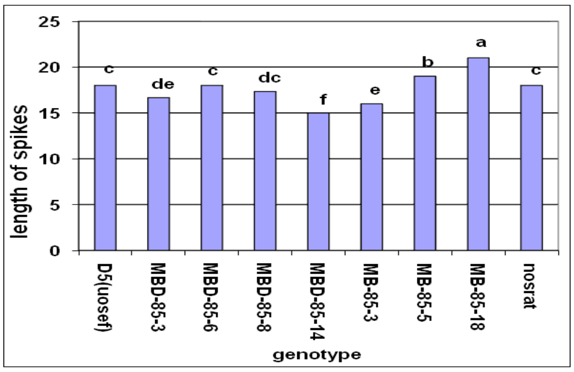

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Fig. 2A. Mean spike lengths of different irrigated barley genotypes under stress conditions.

Lines MB-85-18 and MBD-85-14 exhibited the highest (21.2 cm) and lowest (16 cm) spike lengths, respectively. For irrigation treatments, the highest (18.8 cm) and lowest (17.7 cm) spike lengths were observed with line MBD-85-3 and cv. Yousef (D5) ,respectively. As mentioned earlier, limited water supply results in limitations on all nutritional sources, therefore, plants are forced to decrease their vegetative growth. Also, for irrigation treatments, a significant difference was observed at 1% level of which(in order,21.3 cm and 17.0 cm) belonged to liens MB-85-18 and MBD-85-14, RESPECTIVELY. In addition, spike lengths had a significant difference(level of 1%) between and –season drought stress treatments, maximum(21.0 cm) and minimum (15.0 cm) values of which related to lines MB-85-18 and MBD-85-14, respectedly. As with the height of plants, it can be said that stress results in early maturity of plants and prevents further vegetative growth. Length of spikes is also a trait which decreases below values under normal condition due to stopped vegetative growth under stress conditions. This indicates that length of spikes depends on plant genotypes. Stress effects on length of spikes can be interpreted as affecting vegetative growth of rachises. Put it differently, when more irrigation is applied to barley held, maturity of plants, namely completion of germinative period, faces a slight delay, parallel to which plants grow more vegetatively. Obtained results are in agreement with those of works done by(Bakhshi Kanayeki 2004) and by . (Osterhughes *et al.*1983).

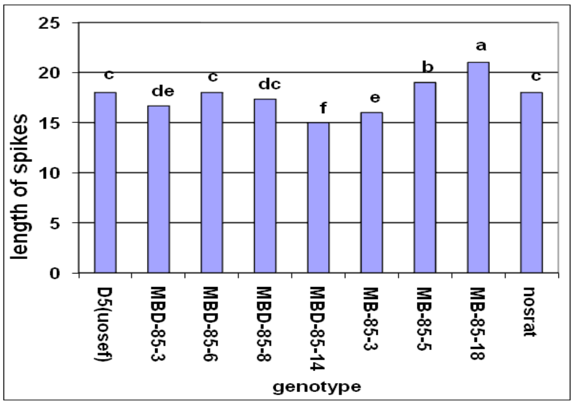

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Fig. 3A. Drought stress x normal conditions interactions for length of spikes.

(Osterhughes etal. 1983) argued that limited irrigation results in reduced number of spikelets, which is attributed to negative effect of decreased number of flowers fertilized per spikelet and to reduction of fertilized flowers due to less production of spikelet primordial.

Number of nodes per stalk

Results of variance analysis showed that no significant differences in the number of nodes per stalk were observed between cultivars × irrigation interactions, Maximum (4.2) and minimum (4.0) number of nodes per stalk belonged to line MBD-85-14 and to cv.Nosrat, respectedly.

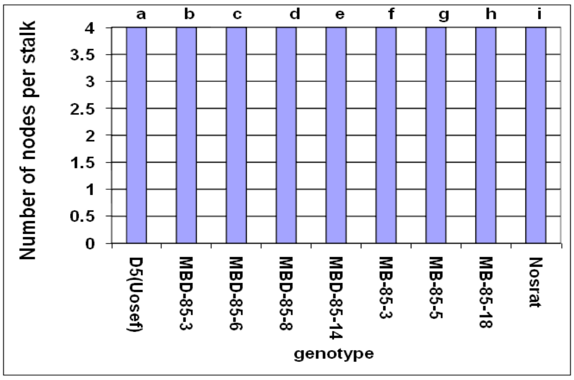

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Fig. 1B. Umber of nodes per stalk for different irrigated barley genotypes under normal conditions.

For number of nodes per stalk, there was no significant difference between irrigation treatments as well. For end-season drought stress treatments, number of nodes per stalk showed no significant difference, the highest (4.3) and lowest (4.0) values of which were seen with line MBD-85-14 and with cv. Nosrat, respectively.

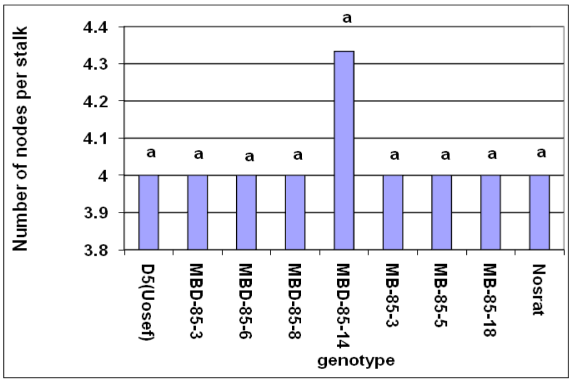

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Fig. 2B. Number of nodes per stalk for different genotypes under end-season drought stress conditions.

Diameter of stalks

Variance analysis results indicated that, for trait of stalk diameter, difference between cultivars was significant at 5% level, but no significant difference was observed between irrigation levels. However, it was significant at 1% level between cultivar × irrigation interactions. The highest (4.8 mm) and lowest (4.0 mm) values of stalk diameter related to lines MB-85-5 and MBD-85-14, respectively. For irrigation treatments, Maximum (4.5 mm) and minimum (4.3 mm) values of stalk diameter were observed with cv.Yousef (D5) and with line MBD-85-3, respectedly. reported that as drought intensity increased, the amount of grain carbon and rate of assimilation decreased by 24% and 57%, respectively, after flowering while the rate of stalk stores transmission increased by 36%. It can be concluded that stores found in propagula, especially stalks, became the main sources of grains growth during grain-filling stage after stress occurs. There fore, it can be said that 2 carbohydrate sources contribute to providing photosynthetic matters during grain-filling stage: flowing photosynthetic products, which are transferred to grains directly, and tissue-stored photosynthetic matters, which are redistributed while providing abovementioned matters during circadian darkness time as well as at the end of grain-filling stage. For irrigation treatments, stalk diameters exhibited some significant differences at 1% level, the highest (5.0 mm) and lowest (4.0) values of which belonged to line MB-85-5 and to cv.Nosrat, respectedly.

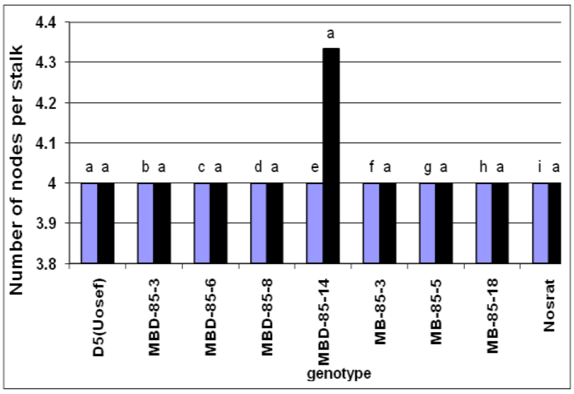

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Fig. 3b. Drought stress x normal conditions interactions for number of nodes per stalk

Trait of stalk diameter showed no significant difference between and- season drought stress treatments. Maximum(5.0 mm) and minimum (4.0 mm) values of which pertained to cv. Nosrat and to line MBD-85-14, respectively.

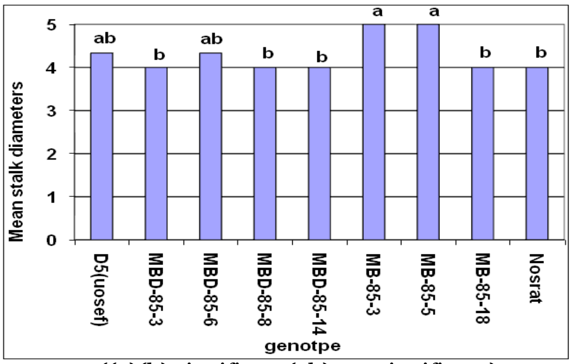

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Fig. 1c. Mean stalk diameters for different irrigated barley genotypes under normal conditions.

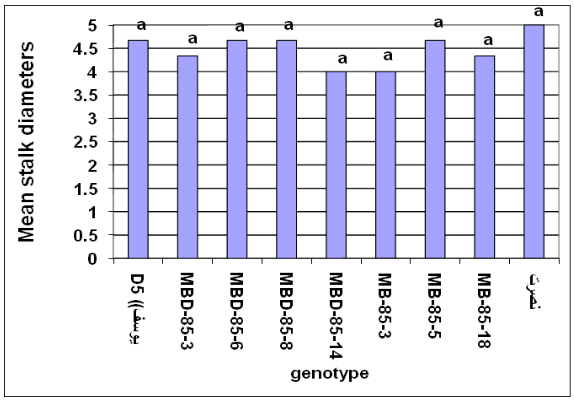

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Fig. 2c. Mean stalk diameters for different irrigated barley genotypes under end-season drought stress conditions.

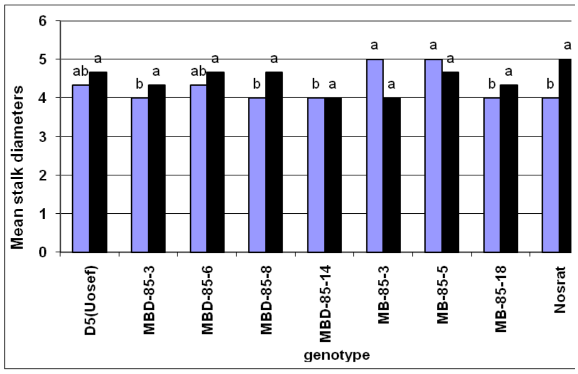

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Fig. 3c. Drought stress x normal conditions interactions for mean stalk diamete

Conclusion

For length of spikes, results of variance analysis indicated that the differences between cultivars as well as between irrigation levels became significant at

1% level, but the difference between cultivar × irrigation interactions did not became significant. Results of variance analysis showed that no significant differences in the number of nodes per stalk were observed between cultivars × irrigation interactions, Maximum (4.2) and minimum (4.0) number of nodes per stalk belonged to line MBD-85-14 and to cv.Nosrat, respectedly. Variance analysis results indicated that, for trait of stalk diameter, difference between cultivars was significant at 5% level, but no significant difference was observed between irrigation levels.

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