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Study of effects of end-season drought stress on biological yield and harvest index of irrigated barely lines in moderate regions of Kermanshah province

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Key words: Irrigated barely lines, drought stress, biological yield, harvest index (HI).

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Abstract

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 indicated that the difference among cultivars in terms of biological yield became significant at 5% probability level, that no significant difference was observed among irrigation levels, but cultivar × irrigation interaction was significant at 5% probability level. Also, the results showed that the difference among cultivar in terms of harvest index became significant at 5% probability level while it became significant at 1% probability level for irrigation levels, and cultivar × irrigation interaction was significant at 5% probability level.

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Introduction

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 , 1985).

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).

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, 1985). 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.

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). 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.

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 Maunkozeb fungicide. Other stages of crop management were performed routinely.

Measurement

The amount of seeds to be used was determined based on 1000-grain weight, 400-grains m^{-2} density, and 1000-grain weight per plot. On a predetermined date after planting, sprinkler irrigation was carried out and dates of sprouting of test plots were noted. During fall and winter, experiments were visited and received necessary care while taking respective notes. Late March and early April, reactions of cultivars to cold were determine. At harvest time, 1 m was excluded from the beginning and the end of each plot. Number of ears per m^2 was counted. In order to count ears, one 1m × 60 c impanel was thrown into each plot and obtained numbers were recorded for each plot. Ten ears were selected randomly, then, the number of grains of each ear was counted, and 10-ear weight mean was calculated. One thousand grains were counted randomly through each test treatment and weighed by a digital scale.

Biological yield

After full maturation, an area of 4.8 m^2 of each plot was harvested for each treatment and weighed in order to determine yield ha^{-1} .

Harvest index (HI)

$$HI = \frac{\text{SeedYield}}{\text{Biological Yield}} \times 100$$

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

Biological yield

Results of variance analysis indicated that biological yield difference among cultivars became significant at 5% probability level, but no significant difference was observed with irrigation levels while cultivar × irrigation interaction was significant at 5% probability level. The highest (17.8 ton) and lowest (12.7 ton) values of biological yield belonged to treatment MB-85-18 and line MBD-85-14, respectively.(Fig 1A) Also for irrigation treatments, the highest (15.8 ton) and lowest (14.8 ton) biological yields related to line MBD-85-3 and cultivar Yousef (D_5), respectedly. Water deficiency results in protoplasm strain and turgescence drop. Solutions diffusion and cell division are reduced and, as a result, growth of stalks, leaves and fruits decreases. Final effect on growth depends on frequency and duration of water stress periods. There fore, it is necessary to determine stages of tolerance to soil water deficiency for any crops so that, under water deficient conditions, irrigation can be planned in such a manner that maximum economic yields can be obtained for each water or area unit. Water stress does not affect all plant organs equally.

In addition irrigation treatments are not significantly different in terms of biological yield, the highest (20.7 ton) and lowest (13.7 ton) amounts of which belonged to line MB-85-18 and line MBD-85-14, respectively. (Fig 2A) For end-season drought stress treatments, biological yield had a significant difference at 1% probability level, the highest (17.7 ton) and lowest (11.7) amounts of which belonged to cv. Yousef (D5) and line MBD-85-14, respectively. It can be concluded that biomass weight of one variety is primarily dependent on its genotype and secondly on the water stress. Since grain yield is a component of biological yield, there is a positive correlation between them. (Fig 3A)

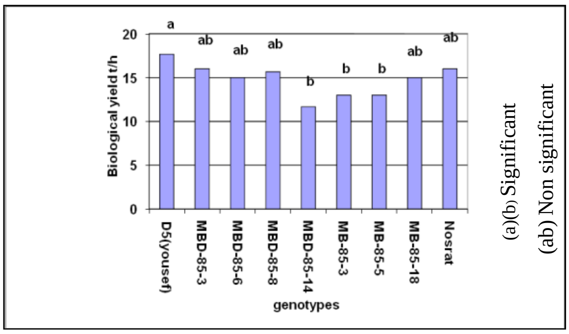

Fig 1A. Biological yield means for different genotypes of irrigated barely under end-season drought stress conditions

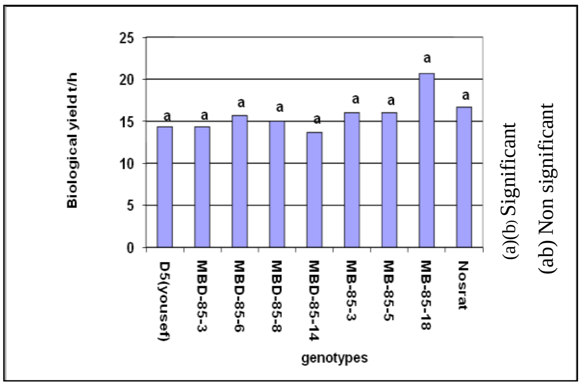

Fig 2A. Biological yield means for different genotypes of irrigated barely under normal conditions

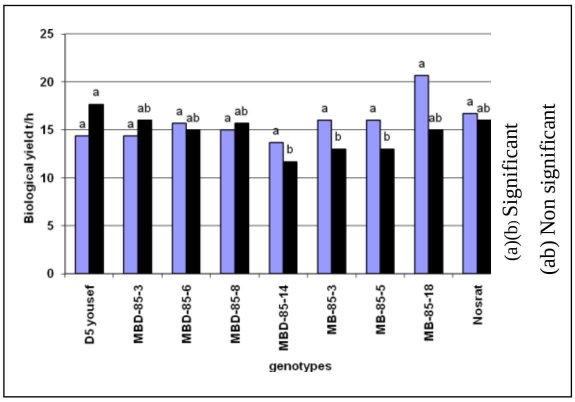

Fig 3A. Drought stress × normal conditions interaction for biological yield.

Harvest index (HI)

Harvest of variance analysis showed that the difference among cultivars in terms of harvest index (HI) became significant at 5% probability level and that among irrigation levels became significant at 1% level, But cultivar × irrigation interaction was significant at 5% probability level. Maximum (38.7) and minimum (27.7) values of harvest index were obtained from lines MB-85-3 and MBD-85-3, respectively. For irrigation treatments, maximum (36.6) and minimum (29.1) values of harvest index belonged to line MBD-85-3 and cv. Yousef (D5), respectively. Among irrigation treatments, in addition, harvest index was not significantly different, the highest (43.7) and lowest (29.3) values of which related to lines MBD-85-8 and MB-85-18, respectively.(fig 1B) Among end-season frought stress treatments, harvest index was significantly different at 5% probability level, maximum (37.0) and minimum (21.7) amounts of which belonged to lines MB-85-5 and MBD-85-3, respectively. (fig 2B) In fact, harvest index is grain yield to total weight of dry matter/biomass ratio which is so extremely affected by environmental changes that its value is high under normal conditions and low under drought stress conditions at final plant growth period . The reason why harvest index decreases is the effect the water stress has on reduction of grain weight, affecting this index. This index reflex transmission of dry matter to the part of plant being harvested. In general, a plant yield can be enhanced by increasing total dry matter produced on the fields and, particularly, by increasing harvest index,. It can be concluded, therefore, that to increase yield is possible in 2 ways : genotypes with (a) high biological yield and with (b) high harvest coefficient produce maximum grains. Harvest index (HI) can be used as a measure of selection in wheat breeding programs. When harvest index (HI) is used by breeding programs, knowledge of the degree of this traits heritability can be effective.(Fig 3B) During study of 22 barely genotypes under non-stress and drought stress conditions using multivariate statistics, Karami concluded that number of grains per spike, 1000-grain weight, biological yield, and harvest index accounted for about 95% of variance in grain yield under both conditions.

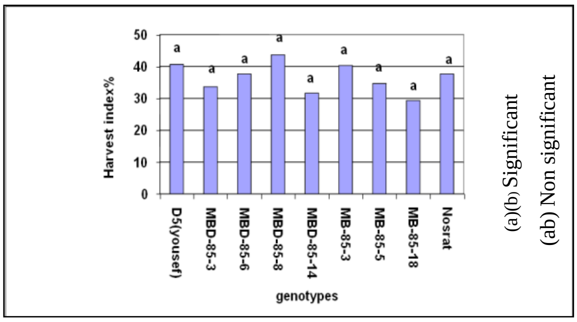

Fig 1B. Harvest index means for different irrigated barely genotypes under normal conditions

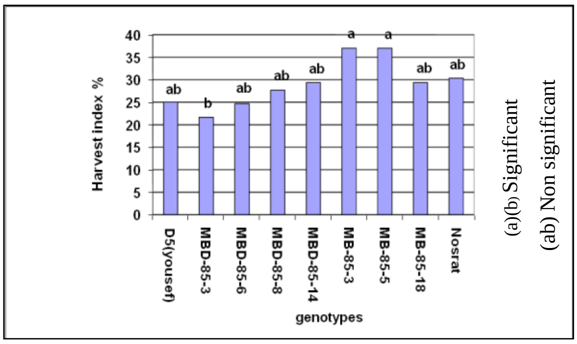

Fig 2B. Harvest index means for different irrigated barely genotypes under end-season drought stress conditions.

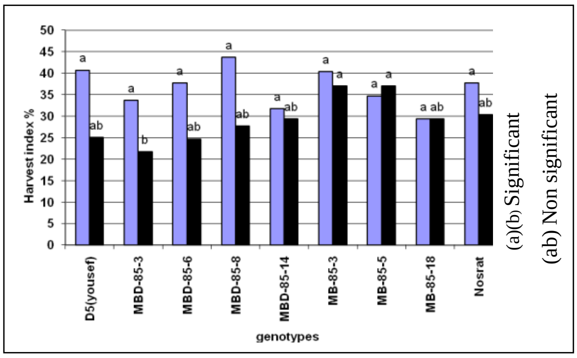

Fig 3B. Drought stress × normal conditions interaction for harvest index.

Conclusion

Results of variance analysis indicated that biological yield difference among cultivars became significant at 5% probability level, but no significant difference was observed with irrigation levels while cultivar × irrigation interaction was significant at 5% probability level. Harvest of variance analysis showed that the difference among cultivars in terms of harvest index (HI) became significant at 5% probability level and that among irrigation levels became significant at 1% level, But cultivar × irrigation interaction was significant at 5% probability level.

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