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LOW WATER STRESS INDUCED CHANGES ON PHENOLOGICAL CHARACTERISTICS OF BARLEY (*HORDEUM VULGARE* L.) GENOTYPES

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ABSTRACT

Water stress regularly leads to attenuations not only crop growth and ultimately yield. Barley is the only crop that is showed more tolerant behavior among all the cereal. Existing investigation work carried out under irrigated and low water environment with three replications in the pot-house Department of Botany, Baba Mastnath University using a complete randomized design. Incorporation of drought alters the reproductive stage through shifting the flowering in addition to the time of maturity. Mean genotype of days to heading (92.5) in BH-902, days to anthesis (99.5) in AMBER and days to physiological maturity 131.5 in (DWRB-828) whereas, RD-57 had minimum days to heading (73.3), anthesis (81.7) and physiological maturity (111.7). Average relative water content was varied in genotypes from 50.2% to 78.6% and treatments from 70.0% to 53.2%. The present study showed that all genotypes show significant reduction under stress condition with significant interaction effect between genotypes and treatment.
Keywords: *Barley, Drought and Phenology*

Introduction

Barley (*Hordeum vulgare* L.) ranked fourth in cereal crop after wheat, rice, and maize (FAO, 2016) due to its exceptional adaptations towards growing in a variety of different environmental conditions. It is mainly used as food, animal fodder and as a raw material for beer production (Pour-Aboughadareh *et al.,* 2013). Drought stress is one of the most significant abiotic stresses that affects plant growth and development (Osakabe *et al.,* 2002; Zobayed *et al.,* 2007; Khayatnezhad and Gholamin, 2012) and plant responses to drought stress are very intricate (Abarshahr *et al.,* 2011). Drought occurs around the world, every year, often with devastating effects on crop production (Guo *et al.,* 2009). The lack of adequate moisture leading to water stress is a common occurrence in rainfed areas, caused by infrequent rains and poor irrigation (Wang *et al.,* 2005). Drought tolerance is a complex trait, the expression of which depends on action and interaction of different morphological, physiological and biochemical characters (Sharma *et al.,* 2016).

Compared to other cereals, barley has good tolerance to drought, cold and salt stress and as a result is often grown in marginal environments (Ullrich, 2011). On average barley, genotypes have about 60% of their life cycle for vegetative growth and about 40% of their life cycle for grain filling. (Rasmusson *et al.,* 1979) obtained high heritability estimates for the duration of the vegetative period and comparatively low estimates for the grain filling period.

Dependent on phenology, crop processes are switched off, accelerated or slow down (Mirschel *et al.,* 2005). Drought stress at the growth period from double ridge to anthesis, and around anthesis, reduce potential grain per unit area (Fisher, 1985; Savin and Slafer, 1991; Cossani *et al.,* 2009; Paredes *et al.,*2017) due to lower fertilization caused by pollen sterility or ovule abortion (Hossain *et al.,* 2017) and the sink strength soon after anthesis, which might have been a major factor affecting post-anthesis growth, as reported by other authors (Calderini *et al.,* 1997; Acreche and Slafer,2009).

Materials and Method

In the current study fourteen barley genotypes (AMBER, BH-902, BH-946, BH-393, BH-855, BH-959, C-164, DWRB- 171, DWRB- 172, DWRB- 828, DWRB-92, RD-2907, RD-57 and SONU), which were adapted from CCS Haryana Agriculture University, Hisar and used to evaluate under drought conditions. Crop were raised under irrigated and drought condition with complete randomized design (CRD) in the pot house and laboratory of Botany department, Baba Mastnath University, NCR-Rohtak.

Days to heading was calculated as days taken from sowing to emergence of 75% spikes in a pot, *Days to anthesis* was calculated as days taken from sowing to appearance of 75% anthesis in pot and *Days to maturity* was calculated as days taken from sowing upto 75% of ear heads losses green colour. *Germination percentage* was recorded at 15 days after the sowing when radical length reached up to 1mm (Kabir et al, 2008) and the germination percentage was calculated by following formula:

Germination percentage = Number of germinated seeds/ Total number of seeds×100

Relative water content (RWC) was measured by the method of Barrs & Weatherley, (1962) following formula:

$$RWC(\%) = \frac{\text{Fresh weight} - \text{Dry weight}}{\text{Turgid weight} - \text{Dry weight}} \times 100$$

Results and Discussion

Maximum number of days to heading and anthesis was found in BH-902 followed by AMBER among all genotypes under both control and drought condition (Table-1). Mean number of days to heading were 92.5 in controlled condition while 73.3 in drought condition and mean number of days to anthesis were 93.4 in controlled condition and 90.0 in drought condition. Minimum number of days to heading was taken by RD-2907 and RD-57 in both environments. Reduction in days to anthesis from 99.8 to 81.7. A sharp reduction was observed in days to maturity under drought conditions in all genotype. The mean reduction was 119.8 days under drought and 121.3 days under control condition. The genotype AMBER and DWRB- 828 found maximum in days to physiological maturity under both conditions whereas the genotype BH-855 found minimum in days to physiological maturity in all genotype testing. Reduction in days to physiological maturity from 129.6 to 110.5. All genotypes show significant reduction under stress condition whereas interaction effect between genotypes and treatment was not significant compare to controlled environment. Fisher, 1985; Savin and Slafer, 1991; Cossani *et al.,* 2009; Paredes *et al.,* 2017 and Hossain *et al.,* 2017 were found reduction in phenological parameters under drought condition.

Table 1 : Effect of drought on days to heading, days to anthesis, days to maturity, germination and relative water content of barley genotype.

Genotypes		Mean (Genotypes)				
		Heading	Anthesis	Maturity	Germination %	Relative Water Content (%)
AMBER		92.0	99.5	129.0	90.0	65.5
BH-902		92.5	98.0	124.5	97.7	58.9
BH-946		91.5	98.5	124.5	95.0	59.2
BH-393		78.5	91.5	117.0	97.3	72.8
BH-855		74.5	82.0	110.5	95.3	78.6
BH-959		86.5	95.5	121.0	86.7	67.1
C-164		88.0	94.5	120.5	93.5	71.4
DWRB- 171		84.5	95.5	121.5	91.5	63.1
DWRB- 172		82.8	90.0	116.5	87.5	64.4
DWRB- 828		89.5	97.0	131.5	92.2	77.3
DWRB-92		76.2	83.8	115.0	93.0	62.2
RD-2907		73.3	85.7	125.5	84.7	52.1
RD-57		73.3	81.7	111.7	86.8	50.2
SONU		85.5	91.0	118.5	90.7	76.0
Mean (Treatments)	**IR**	**85.1**	**93.4**	**121.3**	**96.3**	**70.0**
	DR	**81.9**	**90.0**	**119.8**	**86.8**	**53.2**
CD at 5%						
Treatment (T)=		0.842	0.959	1.128	1.038	0.701
Genotypes (G)=		2.228	2.538	9.384	2.746	1.856
T XG=		3.150	3.589	13.271	3.883	2.624

IR- Irrigated and **DR**- Drought

Water scarcity showed reduction in germination of all tested genotype under drought condition (Table-1). Under irrigated condition genotype showed maximum germination percentage and percentage was varied between 100.0% to 94.7% under irrigated condition whereas, 95.3% to 74.7% under drought condition. Mean value of germination was 96.3% (IR) and 86.8% (DR). Reduction in RWC was observed under drought condition in all genotype as compared to control condition. Maximum RWC was recorded in BH-885 and minimum in RD-57. Mean reduction in RWC ranged from 78.0% to 53.2%. All genotypes show significant reduction under stress condition whereas interaction effect between genotypes and treatment was not significant compare to controlled environment. Pour-Aboughadareh *et al*., 2013; Khayatnezhad and Gholamin, 2012 and Sharma *et al*., 2016 found similar kind of results under the drought condition.

Table 2 : Mean sum of square of barley genotypes for days to heading, days to anthesis, days to maturity, germination and relative water content under drought and irrigated condition.

Source of Variation	DF	Heading	Anthesis	Maturity	Germination %	RWC (%)
Treatment (T)=	1	220.918**	248.142**	45.145**	1,914.30**	12,953.03**
Genotypes (G)=	13	302.547**	234.547**	227.526**	99.887**	474.129**
T XG=	13	31.229**	30.726**	146.999**	34.298**	48.539**

** Significant at 1% of significance

The mean sum square for days to heading, days to anthesis, days to maturity, germination and relative water content shown in Table 2 indicated significant difference due to genotypes (G) and drought treatments (T). Interaction effects between genotypes and drought was also found significance at 1% of significance on phenology and physiological parameters tested. This indicated that genotypes differed in their response to drought condition.

Conclusion

Significances from the current study revealed that phenology of barley genotype is the best method of genotype selection for drought condition. Genotype BH-885 and BH-902 were found promising between the tested barley genotype can be used for grown under conditions of water scarcity.

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