Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2582-2845.8860

ISSN: 2582 – 2845

Ind. J. Pure App. Biosci. (2022) *10*(1), 1-7

Indian Journal of Pure & Applied Biosciences

Peer-Reviewed, Refereed, Open Access Journal

Research Article

Effect of Drought Condition on the Peduncle Mobilization and Yield of Wheat (*Triticum aestivum*)

Komal[1], Navneet Kumari[2], Savita[3] and Kirpa Ram[3*]

[1]Department of Botany, AIHM Jat College, Rohtak

[2]Department of Microbiology, Maharashi Dayanand University, Rohtak

*[3]Department of Botany, Baba Mastnath University, Rohtak

*Corresponding Author E-mail: dr.kirparamjangra@gmail.com

Received: 17.12.2021 | Revised: 8.02.2022 | Accepted: 15.02.2022

ABSTRACT

Drought is the major abiotic stress world widely thwart the crops growth and development year by year. Every growth stage of wheat from vegetative to reproductive stages effect by the water scarcity. Keeping in the view present investigation was planned with four wheat genotype viz., AKAW-3717, C-306, DHTW-60 and KUNDAN with three replicas at the pot house of IAHM Jat college, Rohtak with complete randomized design. Drought application showed statistical significant reduction in crop phenological attributes, relative water content, peduncle reserve mobilization, biomass plant^{-1} (g), grain weight spike^{-1} (g), grain yield plant^{-1} (g) and Test Weight (g). Genotype DHTW-60 was found minimum in yield forfeit under both irrigated and non-irrigated condition. Therefore, it can be utilised for further study and cultivation in water scarcity areas.

Keywords: *Drought, Peduncle reserve mobilization, Yield and relative water content.*

INTRODUCTION

Wheat (*Triticum aestivum* L.) of the family Gramineae is a popular grain crop of ancient origin. It constitutes one of the most important trade commodities as one-fifth of the world's wheat production is traded globally (Irshad et al., 2021). Wheat provides 21% of the food calories and 20% of the protein for more than 4.5 billion people in 94 countries, and as a global food crop, it contributes to food security for many countries. In 2020, it was planted on 1.9 million hectares, of which 0.97 million hectares were harvested for grain with a total production of 16 million Mt (Plains et al., 2020). The frequent occurrence of drought poses a threat to winter wheat production in this region and reduces the yield under both the dryland and irrigated conditions (Ray et al., 2018). The yield is a complex trait that is strongly influenced by environmental stresses. The increasing yield potential has indisputable importance in solving the wheat food deficit, especially in India.

Cite this article: Komal, Kumari, N., & Savita & Ram, K. (2022). Effect of Drought Condition on the Peduncle Mobilization and Yield of Wheat (*Triticum aestivum*), *Ind. J. Pure App. Biosci. 10*(1), 1-7. doi: http://dx.doi.org/10.18782/2582-2845.8860

Under a changing climate, environmental stresses have emerged as the main threats to staple crop production. Recently, wheat production has been adversely influenced by the progressive global climatic changes and increasing shortage of water resources, coupled by the worsening of the eco-environment, which has compromised the nutritional security of the increasing population (Sabagh et al., 2021).

Drought stress adversely affects plant establishment and consequently growth and development. Under extreme conditions, it may severely disturb several metabolic processes, resulting in diminished photosynthesis, impeded cell enlargement and division, and finally passed on the cells (Kramer et al., 2021). Drought at the reproductive stage is more harmful to plant metabolic processes compared to the vegetative growth stage. This is because DS at anthesis markedly reduces photosynthesis, reproductive development, and finally grain yield. Genotypes should be tested for their drought tolerance based on phenology, morphology, physiology, and biochemical behavior at different growth stages from germination to maturity (tillering, jointing, booting, anthesis, grain filling, and physiological maturity stages) due to their variable responses to DS. Plants can tolerate by changing their physiological functions under drought stress, such as less reduction in water content (Datta et al., 2011), chlorophyll content (Nowsherwan et al., 2018) membrane stability (Bayoumi et al., 2008), photosynthetic activity (Dawood et al., 2019), dry matter production (accumulation of soluble sugars (Bowne et al., 2012), proline content (Nowsherwan et al., 2018), amino acids (Guo et al., 2020), and enzymatic and non-enzymatic activities (Hussian et al., 2018) to protect against oxidative stress. Crop productivity in dry areas can be improved through appropriate exploitation of available genetic variability of crop plants to better adapt to climate change (Reynolds & Langridge, 2016). In this regard, wild emmer (*Triticum turgidum*) has been reported to harbor rich allelic diversity for numerous traits, including deep rooting for water stress resistance (Peng et al., 2017). Water stress resistance in plants involves intricate physiochemical pathways ranging from cellular to whole-plant signaling (Tardieu, 2016). Present study was planned to investigate the impact of water shortage on yield of wheat genotype.

MATERIALS AND METHODS

Four wheat genotypes (AKAW-3717, C-306, DHTW-60 and KUNDAN) procured from Chaudhary Charan Singh Haryana Agricultural University were evaluated for physiological, phenological and yield attributes under drought and control condition with three replications at the pot house of Jat college, Rohtak with complete randomized design. Relative water content (RWC) was measured by the method of Barrs & Weatherley, (1962) whereas stem reserve mobilization was calculated by the method suggested by Cox et al. (1986). For yield attributes crop phenology (Days to heading, Days to anthesis and Days to maturity), Biomass (g) per plant, Number of grains per spike, Grain weight (g) per spike, Grain yield (g) per plant and 1000 grain weight (g) were recorder at maturity. The data was analyzed by analysis of variance for the complete randomized block design (CRBD) using OPSTAT software available on www. http// hau.ernet.in home page (Sheoran et al., 1998) where each observation was replicated thrice and CD at 5 % was calculated.

RESULT AND DISCUSSION

Crop Phenology: The genotypes showed significant differences for Days to heading, anthesis and physiological maturity under drought environment compared to control condition (Table 1). Application of drought showed reduction in average days to heading from 83.0 to 76.5 days, days to anthesis from 91.5 to 84.5 days and physiological maturity from 123.5 to 116.5. the genotype DHTW-60 was found maximum for days to physiological maturity and minimum for the days to heading whereas genotype AKAW-3717 showed minimum days of physiological maturity over all genotypes. Results with respect to genotypes studies and stress were statistically significant but the interaction between genotypes and drought was also significant. The phenological phase of wheat are strongly depends on the date of sowing (Dodig et al., 2014; & Ram et al., 2017) and water availability (Venkateswarlu & Shanker, 2012) throughout the crop session. Hossain et al. (2013) observed that drought reduced the growth period for phenological development stages i.e. days to heading, days to anthesis, days to grain filling and days to physiological maturity of eight wheat genotype.

Table1. Effect of drought on days to heading, days to anthesis and days to physiological maturity of wheat genotypes

Genotypes	Days to Heading			Days to Anthesis			Days to Maturity		
	Control	Drought	Mean (G)	Control	Drought	Mean (G)	Control	Drought	Mean (G)
AKAW 3717	93.0	68.0	**80.5**	103.0	73.0	**88.0**	127.0	106.0	**116.5**
C-306	94.0	72.0	**83.0**	101.0	78.0	**89.5**	137.0	110.0	**123.5**
DHTW-60	85.0	68.0	**76.5**	94.0	75.0	**84.5**	140.0	111.0	**125.5**
KUNDAN	91.0	71.0	**81.0**	104.0	79.0	**91.5**	139.0	107.0	**123.0**
Mean (T)	**90.8**	**69.8**		**100.5**	**76.2**		**135.8**	**108.5**	
CD at 5%	**Treatment (T)= 1.94**			**Treatment (T)= 2.14**			**Treatment (T)= 2.53**		
	Genotypes (G)= 2.75			**Genotypes (G)= 3.03**			**Genotypes (G)= 3.58**		
	TxG= 3.84			**TxG= 4.28**			**TxG= 5.06**		

Differences are Statistically Significant and Data Analyzed by two-way ANOVA at LSD<0.05

Stem reserve mobilization in peduncle showed significant fast remobilization in all the genotypes along with application of drought (Fig. 2). Faster remobilization was found in DHTW-60 followed by C-306 under drought situation whereas lowest stem reserve mobilization was observed in Kundan under both control (19.1%) and drought (22.4%) condition as compare to another genotypes. Graphical bar showed that genotypes and stress condition were statistically significant with significant interaction between genotypes and drought condition. The results of present investigation are supported by earlier finding Gupta et al. (2011); Sharifi et al. (2017) found similar result in wheat genotypes under water-deficit treatments had 50 to 80 % higher mobilization than the in well-watered treatments, which indicates that water deficits promoted remobilization. The long grain filling duration in tolerant cultivar is supported enhanced mobilization of stem reserves, thus limiting decrease in grain yield of tolerant cultivar under drought stress conditions as compared to the sensitive cultivar (Gupta et al., 2011; & Zhang et al., 2014).

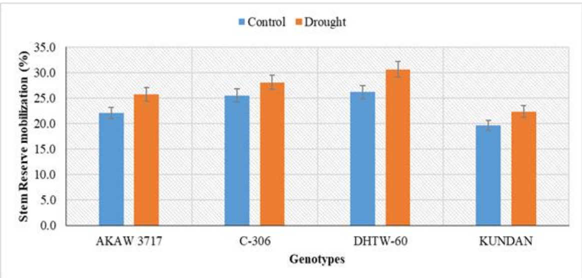

Figure 1. Effect of drought on stem reserve mobilization (%) of wheat genotypes

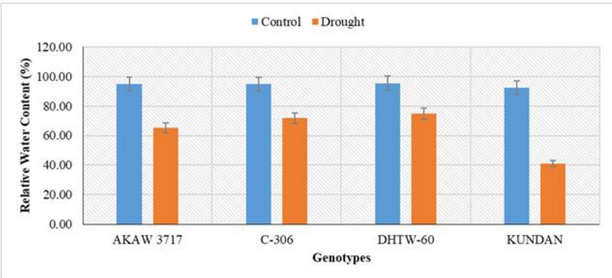

Figure 2. Effect of drought on relative water content (%) of wheat genotypes

Relative water content in graphical representation showed significant variation in all tested genotypes under drought condition. Maximum relative water content was observed in C-306 and minimum in AKAW-3717. Results with respect to genotypes studies and stress were statistically significant but the interaction between genotypes and drought condition was also significant. Our result is in accordance with observation of Almeselmani et al. (2012); Saxena et al. (2014), Ramani et al. (2017) and they found decrease in RWC in response to drought and high temperature at different growth stage of wheat. Sharma et al. (2016), find decrease in relative water content on the onset of drought stress in advance barley line.

Table2. Effect of drought on biomass plant^{-1} (g), grain weight spike^{-1} (g), grain yield plant^{-1} (g) and test weight (g) of wheat genotypes

Biomass (g) per plant					
Genotype	**AKAW-3717**	**C-306**	**DHTW-60**	**Kundan**	**Mean (T)**
Control	50.3	78.8	91.1	55.8	**69.0**
Drought	16.6	35.4	39.0	25.7	**29.2**
Mean (G)	**33.4**	**57.1**	**65.1**	**40.8**	
CD at 5%	Genotype = 2.22	Treatment= 3.14	Genotype x Treatment= 4.45		
Grain weight (g) per spike					
Control	2.65	3.16	3.52	2.73	**3.02**
Drought	1.60	1.75	1.78	1.62	**1.69**
Mean (G)	**2.12**	**2.46**	**2.65**	**2.18**	
CD at 5%	Genotype = 0.04	Treatment= 1.06	Genotype x Treatment= 0.08		
Grain yield (g) per plants					
Control	25.58	40.55	48.16	29.12	**35.85**
Drought	10.18	15.75	17.20	13.49	**14.16**
Mean (G)	**17.88**	**28.15**	**32.68**	**21.31**	
CD at 5%	Genotype = 0.80	Treatment= 1.14	Genotype x Treatment= 1.61		
Test Weight (g)					
Control	41.6	47.0	50.3	42.6	**45.4**
Drought	28.2	32.1	34.0	30.5	**31.2**
Mean (G)	**34.9**	**39.6**	**42.2**	**36.6**	
CD at 5%	Genotype = 0.97	Treatment= 1.38	Genotype x Treatment= 1.95		

Differences are Statistically Significant and Data Analyzed by two-way ANOVA at LSD<0.05

Yield attributes: Drought had significantly reduced biomass plant^{-1} (g), grain weight spike^{-1} (g), grain yield plant^{-1} (g) and test weight (g) in all the genotypes under drought as compared to controlled condition (Table 2). The highest mean Biomass per plant was observed under control (69.0) than the drought (29.2) sown condition. The mean grains weight per spike was significantly reduced under drought as compared to control sown conditions *i.e.* 1.69 g and 3.02 g, respectively. The mean seed yield per plant reduced under drought (14.16) was half of the mean seed yield of normal (35.85) condition. The highest value for 1000 grain weight (test weight) was observed under control (45.4) whereas minimum value was under drought (31.2) sown condition. The maximum biomass plant^{-1} (g), Grain weight spike^{-1} (g), Grain yield plant^{-1} (g) and Test Weight (g) was found in DHTW-60 compared to AKAW-3717, C-306 and Kundan under drought sown condition. The overall interaction effect between genotypes and treatment was significant. Similar findings have also been reported by various workers (Farooq et al., 2014; Cimini et al., 2015; Munjal & Dhanda, 2016; & Ram et al., 2017). Dwivedi et al. (2017) also reported high reduction in biomass (51.2%), spike length (39.9 %) & grain yield (60.3%). Laghari et al. (2012); Saxena et al. (2016); Dwivedi et al. (2017) find that stress during reproductive stage of wheat has destructive effects on test weight, biomass, grain weight and grain yield.

CONCLUSION

Grain quality is depending on mobilization of photosynthate; drought enhance the rate of mobilization of peduncle internode to grain but decline in photosynthesis showed yield reduction. Present investigation showed water shortage at grain filling stage reduced relative water content test weight, biomass, grain weight and grain yield. Genotype DHTW-60 compared to AKAW-3717, C-306 and Kundan showed minimum yield penalty under drought sown condition. Therefore, it can be utilised for further study and cultivation in water scarcity areas.

Acknowledgement

We thank the all staff members of Department of Botany, FOS-BMU, Rohtak for their valuable recommendation and comments.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Conflict of Interest

The author(s) declares no conflict of interest.

Author Contribution

All authors contributed equally to establishing the topic of the research and design experiment.

REFERENCES

Almeselmani, M., & Deshmukh, P. S. (2012). Effect of high temperature stress on physiological and yield parameters of some wheat genotypes recommended for irrigated and rainfed condition. *Jordan Journal of Agricultural Science*, *8*, 66-78.

Asseng, S., Foster, I., & Turner, N.C. (2011). The impact of temperature variability on wheat yields. *Glob. Chang. Biol*, *17*, 997–1012.

Bayoumi, T. Y., Eid, M. H., & Metwali, E. M. (2008). Application of physiological and biochemical indices as a screening technique for drought tolerance in wheat genotypes. *Afr. J. Biotechnol*, *7*, 2341–2352.

Bowne, J. B., Erwin, T. A., Juttner, J., Schnurbusch, T., Langridge, P., Bacic, A., & Roessner, U. (2015). Drought responses of leaf tissues from wheat cultivars of differing drought tolerance at the metabolite level. *Mol. Plant*, *5*, 418–429.

Barrs, H. D., & Weatherley, P. E. (1962). A re-examination of the relative turgidity technique for estimating water deficits in leaves. *Aust. J. Biol. Sci.*, *15*, 413-428.

Cox, M. C., Qualset, C. O., & Rains, D. W. (1986). Genetic variation for nitrogen assimilation and translocation in wheat; Nitrogen translocation in relation to grain yield and protein. *Crop Sciences*, *26*, 737-740.

Cimini, S., Locato, V., Vergauwen, R., Paradiso, A., Cecchini, C., & Vandenpoel, L. (2015) Fructan biosynthesis and degradation as part of plant metabolism controlling sugar fluxes during durum wheat kernel maturation. *Frontiers in Plant Science*, *6*, 89-92.

Datta, J., Mondal, T., Banerjee, A., & Mondal, N. (2011). Assessment of drought tolerance of selected wheat cultivars under laboratory condition. *J. Agric. Technol*, *7*, 383–393.

Dawood, M. F. A., Abeed, A. H. A., & Aldaby, E. E. S. (2019). Titanium dioxide nanoparticles model growth kinetic traitsof some wheat cultivars under different water regimes. *Indian J. Plant Physiol*, *24*, 129–140.

Dodig, D., Zoric, M., Jovic, M., Kandic, V., Stanisavljevic, R. & Šurlan-Momirovic, G. (2014). Wheat seedlings growth response to water deficiency and how it correlates with adult plant tolerance to drought. *Journal of Agriculture Science*, *53*, 466-480.

Dwivedi, R., Prasad, S., Jaiswal, B., Kumar, A., & Tiwari, A. (2017). Evaluation of wheat genotypes (*Triticum aestivum* L.) at Grain Filling Stage for heat tolerance. *International Journal of Pure and Applied Bioscience*, *5*, 971–975.

EL Sabagh, A., Islam, M. S., Skalicky, M., Raza, M. A., Singh, K., Anwar Hossain, M., Hossain, A., Mahboob, W., Iqbal, M. A., & Ratnasekaera, D. (2021). Salinity Stress in Wheat (Triticum aestivum L.) in the Changing Climate: Adaptation and Management Strategies. *Fron. Agron. 3*, 43.

Farooq, M., Hussain, M., & Siddique, K. H. M. (2014). Drought stress in wheat during flowering and grain- filling periods. *Critical Review in Plant Sciences*, *33*, 331–349.

Guo, X., Xin, Z., Yang, T., Ma, X., Zhang, Y., Wang, Z., Ren, Y., & Lin, T. (2020). Metabolomics Response for Drought Stress Tolerance in Chinese Wheat Genotypes (Triticum aestivum). *Plants*, *9*, 520.

Gupta, A., Kaur, K., & Kaur, N. (2011). Stem Reserve Mobilization and Sink Activity in Wheat under Drought Conditions. *American Journal of Plant Sciences*, *2*, 70-77.

Hossain, A., Teixeira da Silva, J. A., Lozovskaya, M. V., & Zvolinsky, V. P. (2013). The effect of high temperature stress on the phenology, growth and yield of five wheats (*Triticum aestivum* L.) genotypes. *Asian Australasian Journal Plant Science Biotechechnology*, *6*(1), 14–23.

Hussain, H. A., Hussain, S., Khaliq, A., Ashraf, U., Anjum, S. A., Men, S., & Wang, L. (2018). Chilling and Drought Stresses in Crop Plants: Implications, Cross Talk, and Potential Management Opportunities. *Front. Plant Sci. 9*, 393.

Irshad, M., Ullah, F., Fahad, S., Mehmood, S., Khan, A. U., Brtnicky, M., Kintl, A., Holatko, J., Irshad, I., & El-Sharnouby, M. (2021). Evaluation of Jatropha curcas L. leaves mulching on wheat growth and biochemical attributes under water stress. *BMC Plant Biol*., *21*, 303.

Kramer, P. J. (1983). Water Relation of Plants; Academic Press: Orlando, FL, USA, pp. 342–389. Available online: http://www. sciencedirect.com/science/book/9780124250406 (accessed on 6 September 2021).

Kooyers, N. J. (2015). The evolution of drought escape and avoidance in natural herbaceous populations. *Plant Sci. 234*, 155–162.

Laghari, K. A., Sial, M. A. M., & Arain, M. A. (2012). Effect of high temperature stress on grain yield and yield components of Wheat. *Science, Technology and Development*, *31*(2), 83-90.

Munjal, R., & Dhanda, S. S. (2016). Assessment of Drought Resistance in Indian Wheat Cultivars for Morpho-Physiological Traits. *Ekin Journal of Crop Breeding and Genetics*, *2*, 74–81.

Nowsherwan, I., Shabbir, G., Malik, S. I., Ilyas, M., Iqbal, M. S., & Musa, M. (2018). Effect of drought stress on different physiological traits in bread wheat. *SAARC J. Agric*., *16*, 1–6.

Pang, J., Turner, N. C., Khan, T., Du, Y. L., Xiong, J. L., Colmer, T. D., Devilla, R., Stefanova, K., & Siddique, K. M. (2017). Response of chickpea (*Cicer arietinum* L.) to terminal drought: leaf stomatal conductance, pod abscisic acid concentration, and seed set. *Journal of Experimental Botany*, *68*(8), 1973-198.

Plains, S., Field, R., Post, O., & Box, O. (2020). May Crop Production Texas Wheat Production and Yield. 9992, 2019–2020. Available online:https://www.nass.usda.gov/Statistics_by_State/Texas/Publications/Current_News_Release/2020_Rls/spr-crop-production05-2020.pdf (accessed on 1 January 2021).

Ramani, H. R., Mandavia, M. K., Dave, R. A., Bambharolia, R. P., & Silungwe, H. (2017). Biochemical and physiological constituents and their correlation in wheat (*Triticum aestivum* L.) genotypes under high temperature at different development stages, *9*(4), 1–8.

Ram, K., Munjal, R., & Sunita & Kumar, N. (2017). Combine Effects of Drought and High Temperature on Water Relation Traits in Wheat Genotypes under Late and Very Late Sown Condition. *International Journal of Current Microbiology and Applied science, 6*(8), 567–576.

Ray, R. L., Fares, A., & Risch, E. (2018). Effects of Drought on Crop Production and Cropping Areas in Texas. *Agric. Environ. Lett. 3*, 170037.

Reynolds, M. P., Quilligan, E., Aggarwal, P. K., Bansal, K. C., Cavalieri, A. J., & Chapman, S. C. (2016). An integrated approach to maintaining cereal productivity under climate change. *Global Food Security, 8*, 9–18.

Saxenal, D. C., Sai Prasad, S. V., Parashar, R., & Rathi, R. (2016). Phenotypic characterization of specific adaptive physiological traits for heat tolerance in wheat. *Indian Journal of Plant Physiology, 21*(3), 318–322.

Sharma, K. D., Kumar, A., & Verma, S. R. (2016). Variations in physiological traits as screening tool for drought tolerance in barley (*Hordeum vulgare* L.). *Indian Journal of Plant Physiology, 21*(1), 93-100.

Sharifi, R. S., Khalilzadeh, R., & Vatandoost, M. (2017). Study of Nitrogen Fertilizer and Cycocel on Fv/Fm and Dry Matter Mobilization to Grain Yield of Wheat (*Triticum Aestivum* L.). *Cercetari Agronomice in Moldova*, *50*, 123-129.

Saxena, J., & Minaxi, & Jha, A. (2014). Impact of a phosphate solubilizing bacterium and an arbuscular mycorrhizal fungus (Glomus etunicatum) on growth, yield and P concentration in wheat plants. *CLEAN – Soil, Air, Water, 42*, 1248–1252.

Venkateswarlu, B., & Shanker, A. K. (2012). Dryland agriculture: bringing resilience to crop production under changing climate, *in Crop Stress and its Management: Perspectives and Strategies*, eds B. Venkateswarlu, A. K., Shanker, C., Shanker, & Maheswari, M. (Dordrecht: Springer), 19–44.

Zhang, B., Li, W., Chang, X., Li, R., & Jing, R. (2014). Effects of favorable alleles for water-soluble carbohydrates at grain filling on grain weight under drought and heat stresses in wheat. *Plos one*, *9*, 54-61.

Zampieri1, M., Ceglar, A., Dentener, F., & Toreti, A. (2017). Wheat yield loss attributable to heat waves, drought and water excess at the global, national and subnational scales. *Environmental Research Letter, 12*, 8-19.