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Review article

A comprehensive review of effects of water stress and tolerance in wheat (*Triticuma estivum* L.)

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Abstract: Wheat is regarded as one of the most important worldwide cereal crop and utilized as staple food commodity. Its productivity restricted by several biotic and abiotic stresses but among all of these,drought is most devastating stress which immediately affects the morphological and physiological attributes of wheat crop and lead to severe reduction in overall production.
Keywords: Wheat - Staple - Biotic - Abiotic - Drought.

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INTRODUCTION

Wheat (*Triticum aestivum* L.) is regarded as one of most vital cereal crop of world and mainly grow in rain fed regions in which drought occur which cause serious yield reduction (Rana *et al.* 2013). Drought stress is a globally widespread and ever growing environmental phenomenon encountered by wheat crop and long duration of water deficit lead to severe reduction in overall production (Nezhad ahmadi *et al.* 2013). Drought stress can be determined by three factors *viz.*, intensity, time of incidence and duration. Under drought stress conditions changeable nature of these factors make it complicated for plant breeder to decide which plant trait should be improved first to improve plant production (Mujtaba & Alam 2002).

Recent research advances associated with crop responses to numerous biotic and abiotic stresses especially water deficit stress is gaining significant emphasis, as global environment fluctuations situation prognosticates water deficit conditions (Ullah *et al.* 2010). Better critical knowledge about drought stress tolerance related to physiological and morphological characters helps in the screening of germplasm to evaluate genotypes against drought. One of the superior goals of plant breeders is to make wheat genotypes suitable to drought stress condition which ensures higher grain yield. Several efforts have been address to enhance the per acre productivity of wheat crop under water deficit situation by improving the attributes damaged by drought stress. Numerous previous reports exposed many morphological and physiological attributes correlated with drought in cultivated wheat varieties. Reviewed article on the drought subject has discussed separately the studies on morphological basis and studies on physiological basis. The comprehensive overview has been explained below.

1. Morphological Attributes

Wheat yield under drought stress suffer serious moisture deficit throughout its growth period from seedling to full maturity (Bilal *et al*. 2015). Under drought condition decreasing pattern was experienced in morphologically yield contributing characters like plant height (PH), grains per spike, spikes per plant, 1000-grain weight (TGW) in wheat (Kilic & Yağbasanlar 2010). Blum & Pnuel (1990) reported that yield and yield contributing traits of wheat crop were drastically decreased under least annual precipitation**.** Drought stress lead to reduction in number of fertile tillers per plant, grains per spike and 1000-grain weight (TGW) which ultimately cause noticeably low grain productivity. Relationship between plant height (PH), leaf area and wheat

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grain yield has been noticed at booting and anthesis phase which cause improvement in grain yield under water deficit condition (Gupta *et al.* 2001). The decreasing graph in grain number was linked with reduced leaf area and lower photosynthesis as outcome of drought stress (Fischer *et al.* 1980). Under drought stress condition screening of wheat genotypes to evaluate these yield contributing characters are suggested in hybridization programs for water deficit tolerance. Various research scientists have reported considerably positive relationship for effective tillers plant[1] in wheat which depicted negative relationship with 1000-grains weight (Ali *et al.* 2008). Considerable positive and worth mentioning association has been observed for grains per spike with total grain production in diverse bread and durum wheat genotypes, and grains per spike was observed 50–68 in irrigated condition while under stress 32–50 grains per spike were found (Jatoi *et al.* 2011). Thousand grains weight (TGW) is essential yield enhancingtrait and has been given due consideration during varietal evaluating procedure. Kilic & Yagbasanlar (2010) investigation depicted that under drought conditions grain filling period and spikelets per spike were associated with high grain production. Therefore it is suggested that these morphological attributes should be selected for screening diverse wheat genotypes under drought in successful breeding schemes. The adverse and unfavorable outcomes of water deficit stress on wheat sensitive stages of crop growth such as reproductive, booting and grain filling stagecan be minimized by preventing stress at these stages to develop genotypes showing drought tolerant (Saini & Westgate 1999).

2. Physiological Attributes

Different types of plant physiological responses have been reported by various Plant physiologists in their findings under drought stress situation. Zaharieva *et al.* (2001) reported that in globally drought affected areas physiological mechanism is very handy approach in evaluating and screening the extraordinary genotypes having drought resistant mechanism. Comprehensive information of physiological mechanisms permits plant researcher to develop promising genotypes that would be utilized efficiently, continue his growth and production under water deficit stage (Ashraf & Khan 1993).

Cell-membrane stability (CMS) is of vital important selection criteria of drought tolerant genotypes (Tripathy *et al*. 2000). It has been reported that under water stress cell membrane integrity and stability confers drought resistance (Bewley 1979). The water stress activates the reactive oxygen species which ultimately decreases membrane stability caused by lipid peroxidation (Menconi *et al*. 1995). Although many reports depicted lower lipid peroxidation and higher cell membrane stability (CMS) in drought tolerant wheat and maize genotypes (Pastori & Trippi 1992). It has been reported by Sairam & Saxena (2000) that higher level of accumulation of H_2O_2 under water stress leads to production of hydroxyl radicals, which cause lipid peroxidation and consequently cell membrane rupture. Damage caused by water deficit stress to cell membrane is negatively associated with increased activities of superoxide dismutase (SOD) and catalase (CAT) in drought susceptible and tolerant genotypes (Dhindsa & Matowe 1981). Under drought stress assembly of lower levels of H_2O_2 lead to lower damage of cell membrane in wheat drought tolerant genotypes.

Cell membrane stability (CMS) under drought stress depicts the ability of plant tissues to prevent electrolytes leakage by keeping the cell membrane in safe mood (Sullivan 1971). Estimation of Cell membrane stability (CMS) via *in vitro* includes dehydration of leaf tissues by means of polyethylene glycol (PEG) and then assessment of electrolyte leakage from leaves. Leakage of various solutes, such as organic acids, amino acids, saccharides, phenolic compounds and hormones from revealed cell membrane stability (CMS) after subject to dehydration through polyethylene glycol has been reported (Leopold *et al.* 1981). CMS Values have immense significance in hybridization programs because these Values predict the drought tolerant varieties (Dhanda *et al.* 2004). Genotypes having lower CMS value are vulnerable to water deficit condition while the genotypes showing higher CMS values depicts drought tolerant behaviour. The genotypes having less than 50% values are tremendously susceptible to drought while genotypes with 71–80% values are considered to grow with full potential under water deficit. Farshadfar *et al*. (2011) noticed in investigation that under water deficit conditions cell membrane stability (CMS) depicted positively considerable relationship with tillers per plant, grain yield, but negative association 100 kernel weights (TGW).

Higher leaves chlorophyll contents is significantly correlated with photosynthesis and regarded as encouraging selection trait in crop productivity (Teng *et al.* 2004). It has been reported in many studies that under drought stress Photosynthesis exhibit direct relationship with wheat grain production because less stomata opening frequency and low amount of CO_2 fixation lead to reduction in photosynthetic amount (Mafakheri *et al.*

2010). Severe water deficit stress restricts the photosynthesis by damaging the chlorophyll components (CC) and changing the photosynthetic machinery (Iturbe-Ormaetxe *et al.* 1998). Decreased photosynthetic amount under water deficit condition is an outcome of Inhibition of RuBisCO (ribulose-1, 5-bisphosphate carboxylase/oxygenase) enzyme activity and development of ATP (Dulai *et al.* 2006). Many researchers revealed in their investigations that photosynthesis of higher plants is extremely susceptible to drought stress and Lower amount of chlorophyll cause chlorosis and reduction in crop growth (Khosh & Ando1995). Higher concentration of chlorophyll is essential for plants because it depicts the low quantity of photo-inhibition of the photosynthetic which prevents the carbohydrates losses and eventually enhances growth (Farquhar *et al.* 1989).

Relative water content (RWC) of leaves has been reported as direct indicator of plant water contents under water deficit conditions (Lugojan & Ciulca 2011). Drought stress lead to reduction of water status during crop growth, soil water potential and plant osmotic potential for water and nutrient uptake which ultimately reduce leaf turgor pressure which results in upset of plant metabolic activities. Momentous pattern of divergence can be observed in Relative water content (RWC) among diverse genotypes during various plant growth stages. The highest Relative water content (RWC) might be calculated at crop vegetative stage (Almeselmani *et al.* 2011). Under water stress condition decrease in water status and osmotic potential in plants is the ultimate outcome of lower relative water content. Osmoregulation mechanism plays a phenomenal role in preserving turgor pressure which helps in soil water absorption and continue plant metabolic activities for its survival.

Proline is well known to occur extensively in higher crop plants and accumulates in higher concentration in response to different abiotic environmental stresses specially drought stress (Kavi-Kishore *et al*. 2005). Accumulation of higher proline concentration in crop plant under water deficit condition is highly associated with and drought tolerance genotypes depicts its concentration is much higher than drought sensitive genotypes. It has been found by many scientists that in saline stress soil proline are mainly accumulated in leaves of many higher halophytic plant (Briens & Larher 1982) but plants grown under drought stress showed much higher concentration of proline in leaves, shoots, in desiccating pollen and in root apical regions Lansac *et al.* 1996). Accumulation of higher concentration of proline permits plants to keep less amount of water potential which cause accumulation of osmolytes in osmoregulation process which enables the plant to take up water to perform growth and metabolic activities (Kumar *et al.* 2003).

Under water deficit condition proline perform many functions like act as osmolyte contribute s in the maintenance of membrane and protein, scavenging free radicals. Moreover after the severe damage of stresses proline contents provide adequate reducing agents that assist in mitochondrial oxidative phosphorylation and production of adenosine triphosphate (ATP) for revival from damages of various stresses (Hare *et al*. 1998).The primary site of proline contents accumulation in response to drought stress in crop plant is cytosol (Ketchum *et al*. 1991).

CONCLUSION

Wheat (*Triticum aestivum* L.) being a most vital cereal crop has always been of area of interest to plant breeders. Since several years numerous efforts have been made to boost up its productivity under various conditions especially under drought stress condition. This review depicted that drought stress caused extensive decline in all the studied attributes performance. So there is need to explore several helpful attributes and to minimize the harmful effect of water stress on wheat crop productivity through development of genotype having drought tolerant and better performance.

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