

Drought Stress in Rice (*Oryza Sativa* L.)

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Rice (*Oryza sativa* L.) is a semi-aquatic plant cultivated in land available of sufficient water. About 50% of rice cultivated area in the world are devoid of water supply and problem like prolonged drought have been reducing yield of rice crop. Lack of timely and sufficient rainfall as well as scarce condition of water availability in field can be defined as the drought condition that badly affects the growth and yield of field crops (Hanson et al., 1995). Higher air temperature, scorching sunlight and lesser relative humidity due to lack of timely rainfall are major factors responsible for cause of drought condition. Plants become unable to withdraw nutrients and water from soil due to lack of soil moisture and soil compaction caused by increased bulk density. Stomata of leaves gets closed reducing gaseous exchange due to drought. Plant cells get killed due to ex-osmosis caused by higher ionic concentration in drought affected soil. As compared to other crops, rice is probably more susceptible to drought. Higher water requiring characteristics of rice makes it more susceptible drought condition.

Drought stress affects expansion and elongation of growth (Anjum et al., 2003; Kusaka et al., 2005; Shao et al., 2008). Different morphological and agronomic traits like plant height, tillering capacity, leaf area index, test weight of grain, number of grains per panicle are responsible for final reduction in grain yield (Bocco et al., 2012). Root length, root thickness, root depth, spikelet fertility, panicle exertion, leaf greenness (SPAD), leaf temperature, days to flowering, days to maturity, leaf tip drying and leaf rolling are some important traits affecting final grain yield (Ndjondjop et al., 2010). Physiological characters namely diffusive resistance of stomata, closing and opening of stomata, position of stomata osmotic adjustment, leaf rolling, leaf water retention and leaf senescence are associated with drought tolerance (Singh, 1993). Reproductive stage is more affected by drought as compared to vegetative stage in rice crop. Drought affects spikelet fertility and the production of viable pollen, panicle exertion, pollen shed and germination and embryo development, which are involved in fertilization and initiation of grain filling. Loss of grain yield occurs due to reduction in spikelet fertility and dry weight of fertile spikelets (Liu et al., 2006; Rang et al., 2011). Permanent loss of vegetative part is caused by drought and during flowering stage of development, flower anthesis and seed setting get badly affected that leads to higher spikelet sterility reducing final yield. Effective leaf area and photosynthesis process both get reduced by drought stress if occurred during anthesis period. So if plant is given sufficient water supply during its flowering period to develop some tolerance capacity against water stress condition. Permanent reduction of the panicle exertion, occurrence of spikelet sterility decreasing grain yield are occurred if drought occurs during anthesis time. When drought occurs on maturing stages of plant growth then accumulation of assimilates occurred before anthesis is very important for final yield. In case of both drought and sufficient water supply condition, higher yield are observed in rice cultivars having higher amount of CHO. Weed infestation increases plant susceptibility to insects and diseases as well as increases the detrimental effect caused by drought.

It is necessary to measure and analyze the parameters of soil that influences the growth and yield of rice crops that are grown under rainfed lowland areas which are mainly drought prone type. Soil matric potential, hydraulic conductivity, bulk density, field capacity, wilting point are some of them to be measured. As soil matric potential drops below zero i.e. the matric potential of saturated soil, water availability and water uptake decreases by plant. Avoidance or tolerance can reduce detrimental effect of drought in plants. Avoiding drought is the ability of plants to provide a high water potential with reduced water availability in the soil and in fact avoid dehydration. Tolerance to dehydration is the ability of plants to withstand minimum water injury and internal water deficits. Another way to face the drought is to escape. This is where the plant completes its life cycle long before the onset of drought. Crop duration is adjusted so that critical stages like panicle emergence do not coincide with probable drought periods. Early or late maturation, varieties sensitive to photoperiods can quickly escape drought and regain strength.

The proper and appropriate phenotyping plays an increasingly important role in the selection of drought-resistant genotype. Singh et al. (2012) found that development of early maturing rice varieties to escape the drought, development of drought tolerance varieties that perform better under drought stress condition. The improvement and incorporation of characteristics like deep root system, leaf rolling, cuticle wax, position of stomata and rapid recovering ability are the major drought stress mitigation strategies for rice crop. Increased moisture availability to crops through water conservation and harvesting, and watershed development is an important component. Drought forecasting and timely provision of such advice to farmers is an important drought mitigation strategy that can help reduce the overall economic cost of drought.

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