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Short Communication

Influence of Drought Stress on Plant Growth and Productivity

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Abstract

Drought stress affects crop productivity worldwide, it represents one of the major challenges to world food security. Drought stress effects on a different physiological process in the plant tissue, it inhibits the absorption of K^+ ion, increases absorption of Na^+ ion, and reduced cell soluble protein contents. There are negative effects on plant growth at various morphological, physiological, and Molecular bases, it reduces photosynthesis, affects plant water relations, disturbs plant nutrient relations, and consequently decreases crop productivity. Under drought conditions plant using various strategies includes drought escape, drought avoidance, and drought tolerance reduces, however, tolerant plants initiate various defense mechanisms at morphological, physiological and molecular basis to tolerate drought conditions.

Keywords: Drought Stress; Drought Escape; Ions Absorption; Photosynthesis; Plant Nutrient Relations

Background

Drought stress defined as a situation in which plant water potential and turgor are reduced enough to interface with normal functions. Plant subjected to water stress by the reduction of water around the root system and combined with increased atmospheric vapor pressure deficit [1]. The world faces major challenges in increasing its food production to more than 50 percent by 2050 [2]. Drought stress considered to be a restrictive factor for crop productivity, there are various negative effects for water defect on plant growth and productivity, therefore, drought considered the limiting factor for sustainable agriculture, it will make challenging to provide the food demands of the growing global population. Under drought stress conditions plant subjected to different morphological or physiological effects depending on growth stages, timing, longevity, and severity.

Effects of Drought Stress on Plant Growth

Drought stress suppresses cell expansion and cell growth due to the low turgor pressure, therefore, plant growth is seriously affected by drought stress, consequently, at a morphological base plant decrease leaf numbers and leaves area to adapted with drought conditions, however, tolerant plants bearing small and needle leaves, these plants survive under drought very well, however their growth rate and biomass are rather low [3].

Drought Affects Ion Balanced in the Cell as Follow

Drought stress disturbed the ionic balance of the cell and thus impacting the physiological processes of the plant as follow:

a. Inhibit the absorption of K^+ ion.

b. Increase absorption of Na^+ ion in various plants.

c. Reduced cell soluble protein contents due to the breakdown of protein into amino acids under water stress condition.

Effect of Drought Stress on Crop Yield

Drought-induced yield reduction has been reported in several species, which depends upon growth stage and the severity duration of the stress period, so, plant production inhibited under drought stress conditions from 50 to 73% [4].

Effect of Drought on Plant Water Relations

Drought conditions affected plant water relation by decreased availability of water, relative water content, reduce leaf water potential, transpiration rate and increase leaf temperature due to the negative effect of drought on stomatal opening and closing processing. However, water availability is not the limiting factor for

stomatal conductance, but there are complicated interactions of intrinsic and extrinsic factors [5].

Effect of Drought on Plant Nutrient Relations

Drought stress inhibited uptake of various nutrients by decreasing available energy for assimilation mineral nutrient to organic form can be used in metabolic processing, also, drought conditions cause a depletion of some nutrients content in the plant, due to low moisture availability which decreases the mobility of nutrients [6].

Influence of Drought on Photosynthesis

Drought stress affects stomatal opening and closure processing which considered the major key for reduced photosynthesis, also, drought affects pigments components, decreased activities of Calvin cycle enzymes, which are major factors of reduced crop productivity. Furthermore, drought stress decrease ribulose 1,5-bisphosphate carboxylase/oxygenase (Rubisco) activity by increasing the activity of Rubisco binding inhibitors, also, under drought conditions activities of the various enzymes such as phosphoenol pyruvate carboxylase, fructose-1, 6-bisphosphatase, and pyruvate orthophosphate dikinase reduced linearly with decreased leaf water potential [7].

Effects of Drought Stress on Photosynthesis

a. Decreasing in leaf turgor.

b. Reduce water potential.

c. Decreased CO2 uptake.

d. Closure of their stomata to prevent transpirational water loss.

e. Increased leaf temperature as the rate of transpiration decreases.

As a general, there is a correlation between drought severities and reducing photosynthesis, which consequently decrease other processes like CO_2 uptake and nutrients absorption and increase electrons which forming reactive oxygen species.

Plant adaptation Techniques during Drought Stress

Plants using different techniques to adapt and survive under drought conditions like:

A. Improved Water Use Efficiency:

Under drought conditions, plants increase water use efficiency by decreased water loss, reduced leaf area and transpiration rate [8].

B. Reduce Relative Water Content:

Plants under water stress decreased their relative water content, and reduced leaf water potential [9].

Plant strategies under water stress:

a. Avoidance drought

b. Escape drought

c. Tolerance drought

d. Adaptation of CO_2 uptake

e. Changes in plant metabolism in response to drought stress.

Drought Resistance Mechanisms

Tolerant species have different changes in plant tissue, and at physiological and molecular basis to tolerant drought conditions, to cope with the drought, tolerant plants initiate defense mechanisms against water deficit [3]. Under drought stress conditions plants adapted to survive by using a different morphological, physiological and biochemical responses.

Morphological Mechanisms

Under limited moisture supply plants use various morphological mechanisms to sustain itself and survive under stress, the morphological mechanisms involve:

Escape

Escape from drought allowing plants to reproduce before the environment becomes harshly dry, also, plants use earlier flowering as one of drought escape technique to adaptive with drought conditions. There are different factors determined plant ability to escape from drought stress like genotype, growth stage and other abiotic conditions.

Avoidance

Under drought stress conditions plant reducing water loss as an efficient mechanism to adapt to stress conditions through closing stomatal to control water transpiration. The root system is the key organ in drought tolerates, the deep and thick root system is helpful for uptake water from substantial depths, therefore, roots characters like density, depth, length, and biomass considered the key for drought avoidance traits which determine plant ability to produce yield under drought conditions [10].

Physiological Mechanisms

There are different physiological mechanisms to clarify drought tolerance on physiological bases like Osmotic adjustment, osmoprotection, antioxidation, and a scavenging defense system have been the most important bases responsible for drought tolerance.

Molecular Mechanisms

Under drought stress conditions plants decreased plant cellular water, and some change in gene expression (up- and down-regulation) take place under these conditions which are induced in response to drought at the transcriptional level. Drought stress could be the direct reason for gene expression, or this change may result from other abiotic stress or injury responses.

Conclusion

Drought stress considered one of the main serious threats to global food security, it reduces crop yield particularly grain crops. Drought stress disturbed the ionic balance of the cell

which influencing the physiological processes of the plant, also, inhibits the absorption of K^+ ion, increase absorption of Na^+ ion, and reduced cell soluble protein contents. Plants use different strategies to survive during water stress including Avoidance drought, Escape drought, Adaptation of CO_2 uptake, and Changes in plant metabolism in response to drought stress, however, Tolerant species initiate various defense mechanisms at morphological, physiological and molecular basis to tolerate drought conditions.

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