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Worldwide Scenario of Drought in General and Effect on Mulberry in Particular-A Review

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Abstract Drought is one of the major environmental threat to world’s food security. The limitations in water supply aggravate the problems of food production sufficient to meet the demands of increased population explosion. Effects of drought on plants range from morphological to molecular level. The severity of drought depends on many factors like rain fall distribution, temperature, water holding capacity of soils and the severity varies from crop to crop. In the present review paper an attempt was made to put forth the studies made by different scientists on effect of drought on different crops including mulberry. This review which comprises of various investigations on drought gives some knowledge to researchers, academicians who are working on drought and helps in carrying out further research.

Keywords: Drought, physiological changes, proline levels

Introduction

Water availability is one of the most limiting environmental factors affecting crop productivity. Water stress reduces plant growth and manifests several morphological and biochemical alternations in plants ultimately leading to massive loss in yield (Dubey, 1994). Droughts are recognized as an environmental disaster and have affected the attention of environmentalists, ecologists, hydrologist, meteorologists, geologists and agricultural scientists. Temperatures, high wind velocity, low relative humidity, timing and characteristics of rains, including distribution of rainy days during crop growing season, intensity and duration of rain and onset and terminates play a significant role in the occurrence of droughts.

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Drought is defined as “deficiency or dearth of water severe enough to check the plant growth”. In India drought is experienced for major part of the year in vast areas of arid and desert lands. Yevjevich (1967) stated that, widely diverse views of drought definitions are one of the principal obstacles to investigations of drought. When defining a drought, it is important to distinguish between conceptual and operation definitions (Wilhite and Glantz, 1987).

Types of drought

The drought are generally classified into four categories (Wilhite and Glantz, 1985; American Meteorological Society, 2004), these are meteorological drought, hydrological drought, agriculture drought and socioeconomic drought. In recent years floods and droughts have been experienced with higher peaks and severity levels. The period between extreme events seems to have become shorter in certain regions. Lettenmaier *et al.,* (1996) and Aswathanarayana (2001) have made references to this change in the occurrence of extreme hydrologic events.

Of all the 20th century natural hazards, drought is the greatest detrimental impact (Bruce, 1994; Obasi, 1994). In recent years large scale intensive droughts have been observed on all continents, affecting large areas in Europe, Africa, Asia, Australia, South America Central America and North America (Le Comte, 1995; Le Comte, 1994) and high economic and social costs have led to increasing attention to droughts (Downing and Bakker, 2000). In North America, the impact of the 1988 large area drought on the US economy has been estimated at $40 billion, which is 2-3 times the estimated loss caused by the 1989 San Francisco earthquake (Riebsame *et al.*, 1990). In Europe the drought situation in many Europian regions has already become more severe (Demuth and Stahl, 2001). Lehner *et al.* (2006) presented a continental, integrated analysis of possible impacts of global change. According to IPCC (Intergovernmental Panel on Climate Change) study, production of rice, maize and wheat in the past few decades has declined in many parts of Asia due to increasing water stress, arising partly from increasing temperature, increasing frequency of El Nino events and reduction in the number of rainy days (Bates *et al.*, 2008). Drought is a recurring theme in Australia, with the most recent, the so called ‘millennium’ drought, now having lasted for almost a decade (Bond *et al.*, 2008). The Australian bureau of Agricultural and Resource Economics estimates that the 2006 drought reduced the national winter cereal crop by 36% and cost rural Australia around AUD $3.5 billion, leaving many formers in financial crisis (Wong *et al.*, 2009). In Africa since the last 1960s, the Sahel a semiarid region in West Africa between the Sahara desert and the Guinea coast rain forest has experienced a drought of unprecedented severity in recorded history. The drought has had a devasting impact on this ecologically vulnerable region and was a major impetus for the establishment of United Nations Convention on combating Desertification and Drought (Zeng, 2003). India is amongst the most vulnerable drought-prone countries in the world; a drought has been reported at least once in every three years in the last decades. What is of concern is its increasing frequency. Since the mid nineties, prolonged and wide spread droughts has also increased in recent times (FAO, 2002; World Bank, 2003). The objectives of a review paper was to present compilation of research work on drought to get knowledge for the researchers, academicians and students who are working on drought and helps in carrying out further research.

Effect of drought on plants

Droughts rank first among all natural hazards when measured in terms of the number of people affected (Obasi, 1994; Hewitt, 1997; Wilhite, 2000b). Although as a natural hazard, droughts differ from other natural hazards in several ways (Wilhite, 2000a). Drought injury incurs primarily from deficiency of soil moisture but atmospheric factors such as high temperature, low humidity fast wind etc. aggravate the effects of it. Thus drought has been classified into two broad categories soil drought and atmospheric drought. Soil drought often leads to atmospheric drought and if both combine, it becomes disastrous. Plants are more difficult to struggle against soil drought than against atmospheric drought. Atmospheric drought occurs due to low atmospheric humidity, high wind velocity and temperature which cause a plant to lose most of its water. Counting drought injuries it becomes obvious how harmful drought is to the normal growth of plant and yield of crop. Some functions are changed in plants these are functioning of stomata, carbohydrate metabolism in green leaves, photosynthetic activity, osmotic pressure and permeability. (Pandey and Sinha, 2006).

Water performs the main role of absorbing nutrients from soil and transporting them to different parts of the plant (Rajendiaran *et al.,* 1993). Deficiency of water is important factor and responsible for various symptoms in plants. (Mandal, 1993). If the water deficit becomes more severe the photosynthetic machinery is damaged, further reducing the rate of photosynthesis per unit area and the common physiological symptoms of water stress are retarded leaf growth, reduced stomatal opening and lowered photosynthetic capacity.

Water stress inhibits protein synthesis; induces the synthesis of small sets of stress specific proteins; promotes important modifications in gene expression; cause activation or inhibition in activity of many enzymes ultimately leads to change in the ultra structure of tissues (Dubey, 1994).Water stress cause an alteration in gene expression in plants leading to an inhibition of protein synthesis as well as enhanced synthesis of water specific proteins in different crops. Deficit introduction of water in plants trigger off a number of biochemical changes and consequently various stress metabolites are accumulated. The accumulation of proline upon dehydration due to water stress is also reported by Water is vital natural resources available on earth. The demand of water has been consistently rising in the recent past for industrial and domestic sectors, which may also encroach upon the water availability for agriculture sector. Thus in future availability of water for agriculture is reduced as a result of which, agriculture will have to face the challenge of producing more utilizing less water (Siddalingaswamy *et al.,* 2008).

Effrect of drought on mulberry

Mulberry is being cultivated all over tropical, subtropical and temperate regions where range of temperature is extreme. It is well known that, mulberry can tolerate low and high temperature up to a certain limit. Water is important factor for the mulberry plant because succulence of the mulberry leaves is depending upon the water availability from the soil. Growth of the mulberry plant is stunted and leaves become pale green to light yellow in colour. Water deficiency symptoms are more prevalent in pot condition. Wilting of mulberry plants is commonly associated with severe water deficiency which results from the loss of turgor pressure. Drying and desiccation of mulberry leaves are common symptoms which appear due to water deficiency (Mandal, 1993).

Water deficiency seriously influences photosynthesis in mulberry leaves and will inhibit the synthesis of carbohydrates, proteins, nucleic acids and other organic constituents and hinder the growth and division of cells, thus inhibit or even stop the growth of mulberry leaves and shoots made a survey of the distribution of root system in soil. The root system of mulberry is greatly influenced by the conditions of the soil. If the soil is dry, the absorption efficiency of roots deteriorated and when it is severe, the absorption becomes curtailed altogether. This ultimately causes wilting of mulberry (Minamizawa, 1997). Water stress during mulberry plant development limits leaf production and is probably the largest limiting factor in sericulture productivity. This problem is usually frequent in sericulture and regions with limited precipitation or relatively high evaporation potential. Mulberry crop is affected by acute moisture stress in soil during post rainy season resulting low leaf yield and coupled with poor quality silkworm survival (Benchamin *et al.,* 1997). Ohyama (1988) studied the relationship between the water content of the soil and the growth of mulberry (Minamizawa, 1997). Where plants grow, their development is limited to some extent either by too little or too much water, but mostly by the former. Furthermore, in most regions, soil moisture supplies are rarely at optimum level during the growth season. Because of the essential role water plays in the plant metabolism at both the cellular and whole-plant, any decrease in water availability has an immediate effect on plant growth and processes ranging from photosynthesis to solute transport and accumulation are seriously affected (Hsiao *et al.,* 1976), affecting the plant growth and yield adversely. Hence, tremendous loss in plant growth occurs annually because of imbalance soil moisture supply. The amounts of such losses are staggering and usually are not realized. As well, by altering physical and chemical composition of tissues, water deficit stress also modifies various aspects of plant quality. The studies carried out in Japan showed that the growth of mulberry was very poor in dry soil (Minamizawa, 1997).

The full potential of mulberry crop production is seldom reached because of limitations on physiological and biochemical processes imposed by environmental stress. Mulberry leaf production is limited more by unfavourable physic-chemical environments than by all other factors combined. Although the amount of water used directly in the biochemical reactions of photosynthesis so small compared with that transpired or stored by plants at any given time, plant water status strongly influences plant growth and biomass production particularly through its effect on leaf and root extension (Chang *et al.,* 1974). The rate of photosynthesis of a crop canopy will also decline under water stress because of stomatal closure and the effect of water deficits on chloroplast processes In general biomass production is directly proportional to the supply and use of water. Therefore, measurement of plant water status is an important part of understanding biomass production and in conjunction with a consideration of soil water stress for maximizing yield. In general net assimilation rate is closely correlated with leaf water potential with tendency for stomatal closure (Kaufmann, 1976) emphasized that common physiological symptoms of water stress are retarded leaf growth reduce stomatal opening and reduced photosynthetic capacities. Water deficit inhibits the synthesis of carbohydrates, proteins, nucleic acids etc., and hinder the growth and cell division, cuticle thickness, stomatal frequency, stomatal length, palisade or parenchyma ratio.

Chaitanya *et al.* (2009) reported that ornithine is the major substrate for proline synthesis in mulberry leaves. Song *et al.* (1993) observed that the permeability of plasma membrane and free proline content in mulberry leaves increased with the decrease of water in soil. The extent of increase in free proline content was more than the permeability of plasma membrane. The extent of changes of the permeability of plasma membrane and free proline content were different in different varieties of mulberry. Based on their studies they inferred that permeability of plasma membrane was well able to present the extent of drought resistance and suited as one of the criterion of mulberry drought resistance.

Conclusions

In recent times most continents around the world have been experiencing drought since three decades. The severity of drought is being aggravated by due to increased demand for water, increased temperatures, erratic and less rainfall etc. Studies on the effects of drought help in planning execution of various projects properly to mitigate the effects of drought and also face drought without much damage to the crop plants. In the present paper a number of literature sources have been cited which gives a brief knowhow about drought.

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