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AUTHORITY OF WATER STRESS ON GROWTH AND DEVELOPMENT OF CROP PLANTS

Deepak Chauhan
Research Scholar
SunRise University
Alwar, Rajasthan

Kamakshi Saxena
Research Supervisor
SunRise University
Alwar, Rajasthan

ABSTRACT:

Water stress or drought is one of the most important a biotic constraints in rice, reducing yield on 23 million (M) ha of area in South and Southeast Asia. In Asia alone, the average loss in rice production in years of drought can exceed one billon US dollars. In water-limited regions, drought risk reduces yield because growers avoid investing money in inputs when they fear crop loss. In irrigated areas, too, water shortage is becoming an increasing problem because of the rising demand for water in urban areas. Water shortage has been historically associated with food shortage, especially in Asia and Africa. By 2025, 13 Mha of irrigated wetland rice in Asia may experience physical water scarcity and 22 Mha of irrigated dry-season rice may suffer from economic water scarcity. Therefore, limited water availability in the future may decrease the capacity of growers to irrigate their fields frequently in irrigated areas, resulting in water stress for crops as well as weeds.

Key words: Water stress, risk

INTRODUCTION:

Potatoes are widely grown in India, but the greatest concentration by far occurs along the Indo-Gangetic Plain to the north east, where most potatoes are grown during the short winter days from October to March. Potato cultivation in the south is generally limited by an excessively hot climate. In India the states of Uttar Pradesh, West Bengal and Bihar accounts for more than 75% of total area under cultivation and about 80% of total potato production. Punjab state contributes roughly 7% in area and production. In higher altitude areas in north, a summer crop accounts for about 5% of total production. Regarding the southern peninsula, where approximately six percent of the total crop is grown on relatively high altitude plateaus, such as the Nilgiri and Palini hills of Tamil Nadu, under alternating rainfed and irrigated conditions through out the year.

Generally, there are two major cropping seasons in India. *Kharif*, during the south-west monsoon (June-July through September-October), when agricultural production takes place both in rainfed areas and irrigated conditions. *Rabi*, during the winter, when agricultural activities takes place only in the irrigated areas. India's climate is highly variable over the enormous range of the country, there are distinct seasons. A failure of the monsoons can occur due to climatic or geographical phenomena such as *El Nino* Southern Oscillation (ENSO), causing severe long term and extensive drought as happened several times from 1876 to 1902 and thereafter in the last century.

REVIEW OF LITERATURE

Moorby *et al.* (1975) showed that increase in leaf resistance (closure of stomata) and relatively larger increase in the residual (mesophyll) resistance in droughting potato plant were associated with decrease in the rate of photosynthesis. They did not find any effect of droughting on the activities of RuDP carboxylase. However Ackerson *et al.* (1977) reported that water stress appeared to affect the activity of photosynthesis carboxylating enzymes of potatoes. Munns and Pearson (1974) found that reduced photosynthesis as a result of water stress is not caused by accumulation of photosynthate in the potato leaf.

Considerable varietal variation exists in the chlorophyll content of soybean leaves. It decreased continuously from full expansion to senescence (Buttery and Bezzell, 1981). Sirohi and Ghildhiyal (1975) have also reported similar results in wheat. Investigations on the relationship between chlorophyll content and photosynthetic rate in soybean revealed that 44 per cent of the variability in the photosynthetic rate was due to variability in chlorophyll content (Buttery and Bezzell, 1981). Shantakumari and Sinha (1972) observed a variation in chlorophyll content at different growth stages in chickpea cultivars.

Moisture stress influences the synthesis of chlorophyll, possibly through nutrient availability. On the other hand, Nir and Poljakoff Mayber (1967) found more or less equal ratios of protein and chlorophyll in control and desicating plants. It was suggested that, it is not the destruction of chlorophyll which causes the damage; it may be structural changes occurring as a result of the loss of water. Shubhra *et al.* (2003) found that soluble protein contents increased with water stress while chlorophyll 'a' and chlorophyll 'b', total chlorophyll and chlorophyll 'a' chlorophyll 'b' ratio decreased to some extinct under water stress conditions. Liu Lingling *et al.* (2004) showed the relationship of soluble protein chlorophyll and ATP contents with drought resistance of potatoes under water stress. They found that soluble protein content (SPC) increased under water stress. Chlorophyll 'a' and chlorophyll 'b' content, total chlorophyll content, and chlorophyll 'a': chlorophyll 'b' ratio in the water stress treatment decreased to some extent, as compared with those in the control treatment. Highly significant correlations were recorded the indices SPC, chlorophyll 'a', chlorophyll 'b' ratio and ATP content and drought resistance of a potato variety.

RESULTS:

Table-1

Effect of water stress on shoot height (cm/plant) at various growth stages of potato cultivars

Treatment*	**2009-10**			**2011-12**		
	Growth stage**			**Growth stage**		
	TI	TE	TM	TI	TE	TM
Kufri Chipsona-1						
T_1	38.8	62.4	64.1	37.5	63.1	65.1
T_2	25.7 (-34%)***	53.5	53.9	25.9 (-31%)	54.0	54.1
T_3	36.0	59.3 (-5%)	52.2	37.1	60.1 (-5%)	52.2
T_4	36.0	61.5	57.1 (-11%)	36.9	62.0	58.1 (-11%)
Mean	**33.4**	**59.2**	**56.8**	**34.4**	**59.8**	**57.4**
Kufri Pukhraj						
T_1	32.9	60.3	61.4	34.1	61.4	62.5
T_2	22.8 (-31%)	45.0	52.3	24.8 (-27%)	44.8	53.3
T_3	33.0	42.0 (-30%)	45.2	33.9	42.4 (-31%)	45.7
T_4	32.9	61.0	52.9 (-14%)	34.0	62.0	53.8 (-14%)
Mean	**30.4**	**52.1**	**52.9**	**31.7**	**52.6**	**53.9**
Kufri Lauvkar						
T_1	34.8	58.2	59.6	36.1	58.6	60.1
T_2	22.0 (-37%)	41.6	45.5	22.4 (-38%)	42.1	46.2
T_3	34.8	49.5 (-15%)	50.0	36.0	50.5 (-14%)	51.2
T_4	34.8	58.4	50.3 (-16%)	35.8	59.4	52.0 (-14%)
Mean	**31.6**	**51.9**	**51.3**	**32.6**	**52.7**	**52.4**
Desiree						
T_1	32.4	46.6	56.5	33.0	47.6	57.3
T_2	20.3 (-37%)	34.1	37.0	21.5 (-35%)	34.1	37.1

T_3	33.0	42.1 (-10%)	47.1	32.9	42.2 (-11%)	47.3
T_4	32.8	47.0	45.1 (-20%)	33.0	48.3	46.2 (-19%)
Mean	**29.7**	**42.4**	**46.4**	**30.1**	**43.0**	**47.0**
Mean Values of Treatments						
T_1	34.8	56.9	60.4	35.2	57.7	61.3
T_2	22.7 (-35%)	43.6	47.2	23.6 (-33%)	43.8	47.7
T_3	34.2	48.3 (-15%)	50.9	35.0	48.8 (-15%)	49.1
T_4	34.4	57.0	51.4 (-15%)	34.9	57.9	52.5 (-14%)
CD at 5%						
Cultivar(C)	1.3	2.1	2.1	1.3	1.2	2.2
Treatment (T)	1.0	1.6	1.6	1.0	1.1	1.8
C × T	NS	3.3	3.2	NS	2.2	3.5

***Treatments:** T_1 = Control (well watered), T_2 = water stress at tuber initiation, T_3 = water stress at tuber enlargement and T_4 = water stress at tuber maturation stage

****Growth stages:** TI = Tuber initiation, TE =Tuber enlargement and TM = Tuber maturation

***** Figures in parenthesis are percent (%)** change in shoot height due to water stress treatment T_2, T_3 and T_4 as compared with respective control

Data on mean values of treatments in Table 1 showed that shoot height increased with the age of plants from tuber initiation stage to tuber maturation stage. Well watered control (T_1) plot maintained tallest plants at all growth stages in both the years. Water stress treatments T_2 (water stress at tuber initiation stage), T_3 (water stress at tuber enlargement stage) and T_4 (water stress at tuber maturation stage) caused the significant reduction in shoot height in comparison to their respective control (T_1) in both the years. Under water stress conditions smallest plants were observed in T_2 (22.7 and 23.6 cm during 2009-10 and 2011-12 respectively), whereas highest plants were observed in T_4 (51.4 and 52.5 cm during 2009-10 and 2011-12 respectively).

DISCUSSION:

The shoot height increased with the increase in age of crop (Table 2). In some observations it was found to be reduced at maturity, it is due to herbaceous nature of potato shoot, as aerial shoot of potato is initially erect but later becomes partially procumbent (Artschwager,1918). Shoot growth is one of the best indices for evaluation plant responses to environmental or abiotic stress (Nilsen and Orcutt, 1996). Water stress caused significant reduction in shoot height at all growth stages but it was found much prominent at tuber initiation stage (T_2). At this stage shoot height was reduced up to 35% as a result of water stress (Table 2) whereas about 15% reduction was observed when water stress was imposed at tuber enlargement stage (T_3) and tuber maturation stage (T_4). Hsiao (1973) also reported reduction in elongation of shoot as a result of water stress. Shoot growth and physiology of plants as a consequence of water stress is modified as a function of soil drying (Janardan and Bhojaraja, 1999). Shoot physiology can often be linked more closely to the changes in soil water status than of leaf water status (Turner, 1982). Plants sense stress of water in soil around the root and communicate this information to the shoot (Bates and Hall, 1981).The cell expansion is correlated with availability of water. Water stress can cause a decrease in cell expansion and cell division (Hsiao, 1973). For cells and tissues to grow, turgor pressure is required to stretch the cell walls at a rate determined by their cell extension properties (Janardan and Bhojaraja, 1999). Decrease in the cell enlargement rate results in reduced cell size in shoots. The consequence of reduced cell size to growth pattern of the whole plant is also dependent on timing of water limitation (Nilsen and Muller, 1981 b).

CONCLUSION

It can be concluded from the study that tuber initiation stage of potato crop is the most sensitive growth stage for water stress followed by tuber enlargement stage. Among the cultivars studied, cultivar Kufri Pukhraj has shown maximum resilience against water stress in different morphological, physiological and biochemical traits. It appears that Kufri Pukhraj adapted better than other cultivars in well watered control as well as water stress conditions.

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