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Conclusion on Growth Development and Quality of Potato

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ABSTRACT:
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.

KEY WORDS: Potatoes, cultivation

INTRODUCTION:

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.

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:

A large root system is thought to be one of the plants drought adaptation mechanisms (Levitt, 1972). Another good indicator of drought adaptation is root to shoot ratio which was shown to increase in response to drought (Begg et al., 1976; Harris, 1978; Jefferies, 1992). Ageeb (1968) found that the difference in drought tolerance between cv. King Edward and Majestic was partly due to the differences in rooting depth and root extension. Steckel and Gray (1979) determined rooting depth at the time of tuber initiation in four varieties. In a three year study rooting depth of King Edward proved to be shallower than that of the more drought tolerant Pentland Crown. However, Tourneux et al. (2003) reported that strong root expansion exhibits a high negative correlation with total yield ($P<0.01$), indicating that genotypes exhibiting a strong root expansion produced a high amount of root dry biomass at the expense of tuber yield.

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.

Blake K S (2004) found root depth of potato considerably less than for sweet corn and tomato. Durrant *et al.* (2002) determined maximum depths of roots for three crops. They found a depth for potato approximately 90 cm and for sugarbeet and barley >100 cm. Potato extracted less water from the soil than barley (*Hordeum vulgare* L.) and sugarbeet (*Beta vulgaris* L.) and the differences were accentuated below 0.6 m depth. The relatively week root system seems to be one of the factor which causes the sensitivity of the potato to water shortage.

Taha D.A. (2010) reported a direct linear relationship between tuber yield and the number of days during which leaf area optimum is maintained. Krug and Wiese (1972) showed that low soil moisture during first 24 days after emergence, followed by high soil moisture initially decreased leaf area than those of continuously high moisture of the soil. Wolfe *et al.* (1983) found a high correlation between leaf area duration and final plant dry weight. Smaller leaf area at the time of tuber initiation had been attributed to be responsible for lower rate of bulking and lower final yields (Moorby *et al.*, 1975). Van Loon (2002) concluded that water stress in the period of normally maximum foliage growth, between emergence and tuber bulking will lead to reduced leaf area and reduced foliage weight. Similar conclusions were made by other workers.

Jefferies (1993) found that reduction in leaf size due to water stress lead to reduction in the amount of intercepted radiation and caused a decrease in tuber dry matter accumulation. They showed that the final size of individual leaves was reduced by drought but the magnitude of the effect differed significantly between cultivars.

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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