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Quantitative and Qualitative Response of two Cotton Cultivars to Pre-Sowing Heat Stress

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ABSTRACT

Crop growth responses of two Cotton cultivars namely, NIAB-Karishma and CIM-443 grown after exposing the seeds to heat stress at 0, 50, 60, 70 and 80°C for 24 and 48 hours were studied. The results revealed that NIAB-Karishma and CIM-443 were more responsive to heat stress at vegetative and reproductive growth phases, respectively. Leaf area index and sympodial branches per plant were higher in NIAB-Karishma than CIM-443 and these were increased with heat stress above 50°C. Flowers and bolls formed per plant were more in CIM-443 than that of NIAB-Karishma; whereas, boll drop was less in CIM-443. The effects of temperature stress and their duration on the performance of two cotton cultivars are discussed.

Key Words: Cotton cultivars; Temperature stress; Growth parameters

INTRODUCTION

In cotton, pre-mature flower and fruit drop may be as high as 35% in flowers and 50-75% in bolls in different environments (Khan, 1971) and thus cause considerable reduction in the final yield. Pre-sowing exposure of seed to high temperature stress is one of the simple, effective and practical methods to get higher yields and to minimize the pre-mature flowers and boll shedding losses in cotton (Khan *et al*., 1973). Moreover, cotton is grown during May and June which are the hottest months but pre-sowing heat stress is beneficial to the seed and enhances germination and seedling growth (Malik, 1971). Similarly stimulated germination, vigorous seedlings and subsequent better plant stand (Ahmad & Banars, 1981), reduction in shedding of flowers (Khan *et al.,* 1973), increase in lint percentage, yield and fibre quality (Ahmad *et al*., 1993) of cotton in response to pre-sowing exposure of seed to high temperature stress have been reported. Positive stimulation following high temperature treatments is due to increased chemical activity, increased gaseous permeability, accelerated mobilization of reserve material and release of energy, faster imbibition rate and a decrease in the water soluble inhibitor of the stressed seed (Khan *et al*., 1973).

Availability of new cultivars, however, demands to determine their response to temperature stress of seed so that maximum yields can be obtained. This paper describes the effect of pre-sowing temperature stress on growth, yield and quality parameters of two new genotypes of cotton i.e. NIAB-Karishma and CIM-443.

MATERIALS AND METHODS

Studies were conducted at the Agronomic Research Area, University of Agriculture, Faisalabad. The experiment was conducted in pots and was replicated thrice. Pots were filled with 11 kg of normal soil and kept in a wirenet house under natural conditions. The crop was sown in the first week of June using five seeds pot^{-1}. Before sowing, seeds of two varieties of Cotton i.e. NIAB-Karishma (V_1) and CIM-443 (V_2) were stressed at 50°C (T_1), 60°C (T_2), 70°C (T_3) and 80°C (T_4) for 24 (D_1) and 48 hours (D_2); while non-stressed seeds were used as control (T_0). A basal dose of P and K @ 75 kg ha^{-1} and 65 kg ha^{-1} on weight basis, respectively, was applied to each pot at sowing time. Nitrogen was applied @ 175 kg ha^{-1} in three doses to each pot i.e. first at sowing, second at flowering and third at fruiting stage. After one week of sowing, plants were thinned out to one plant pot^{-1}. Crop was sprayed with Phenthrin, Talstar and Trend to protect against insect pest attack during the growth period. Data on growth, yield and quality characteristics of the crop were collected and were analysed statistically. Treatments showing significant F-Values were compared by applying Least Signinficant Difference (LSD) test at 5% probability level (Steel & Torrie, 1984).

RESULTS AND DISCUSSION

Leaf area index (LAI) of the plants of NIAB-Karishma grown from seeds stressed at 80°C for 24 hours ($V_1D_1T_4$) was the highest (1.53) of all the treatments except that of $V_1D_1T_2$ where the seeds of the same variety were stressed at 60°C (Table I). Non significant differences were found in the leaf area indices among the treatments when the seeds of NIAB-Karishma were stressed at 60 or 70°C for 24 hours and also stressed for 48 hours at 0, 50, 60 and 80°C and that of CIM-443 stressed at 50°C for 24 hours or for 48 hours, for 48 hours at 60, 70 and 80°C and the values recorded were 1.26, 1.07, 0.93, 1.13, 0.98, 0.96, 0.91, 0.94, 0.96, 0.94 and 0.98, respectively. The LAI for CIM-443 stressed at 80°C for 24 hours was 0.46 but it did not differ significantly from that of NIAB-Karishma either without stressing the seed or stressing it for 24 hours at 50 or 70°C for 48 hours or the seeds of CIM-443 without heat stress or with stress treatment for 24 hours at 60 or 70°C. LAI of

Table I. Effect of pre-sowing heat stress on plant growth characteristics of two cotton cultivars

	Leaf area index				Sympodial branches plant^{-1}		Flowers plant^{-1}	Flowers dropped plant^{-1} (%)	Bolls plant^{-1}	Bolls dropped plant^{-1} (%)
V_1 D_1 T_0	0.84 cdef	V_2 D_1 T_0	0.63 def	D_1	21.90 a	V_1D_1 23.47 a	V_1 30.17 b	$V_1$15.23	V_1 25.97 b	$V_1$36.67 a
V_1 D_1 T_1	0.69 def	V_2 D_1 T_1	0.91 bcde	D_2	19.93 b	V_1D_2 19.73 b	V_2 38.77 a	$V_2$15.24	V_2 32.77 a	$V_2$27.85 b
V_1 D_1 T_2	1.26 ab	V_2 D_1 T_2	0.71 def	LSD =	1.37	V_2D_1 20.33 b	LSD = 7.18	$D_1$14.60	LSD=6.22	LSD = 7.46
V_1 D_1 T_3	1.07 bcd	V_2 D_1 T_3	0.46 f	T_0	20.92 ab	V_2D_2 20.13 b		$D_2$15.88		$D_1$37.59 a
V_1 D_1 T_4	1.53 a	V_2 D_1 T_4	0.81 cdef	T_1	20.83 b	LSD = 1.94		$T_0$16.58		$D_2$25.93 b
V_1 D_2 T_0	0.93 bcde	V_2 D_2 T_0	0.94 bcde	T_2	19.83 b			$T_1$14.50		LSD = 7.46
V_1 D_2 T_1	1.13 bc	V_2 D_2 T_1	0.96 bcde	T_3	23.08 a			$T_2$18.85		
V_1 D_2 T_2	0.98 bcde	V_2 D_2 T_2	0.94 bcde	T_4	19.92 b			$T_3$13.52		
V_1 D_2 T_3	0.73 def	V_2 D_2 T_3	0.98 bcde	LSD =	2.17 b			$T_4$12.75		
V_1 D_2 T_4	0.96 bcde	V_2 D_2 T_4	0.98 bcde					N.S.		
LSD =	0.38									

V_1=NIAB-Karishma; V_2=CIM-443; T_0=Control; T_1=50°C;T_2= 60°C; T_3=70°C; T_4=80°C; D_1=24 hours duration; D_2=48 hours duration

NIAB-Karishma when subjected to temperature stress at 80°C for 24 hours was significantly increased over that exposed to heat stress at all temperatures for 48 hours. Plants produced from CIM-443 after stressing the seeds for 48 hours at any temperature showed higher LAI values than that stressed for 24 hours. In general, LAI recorded for NIAB-Karishma was higher than that of CIM-443. Differential response of varieties in LAI owing to heat stress was also reported by Reddy *et al*. (1997). It is clear from Table I that number of sympodial branches per plant was significantly affected by different temperature stress levels and the interaction between varieties and duration of heat stress was also significant. Sympodial branches formed per plant were significantly highest (23.08) of all the treatments except that of T_0 when the seeds were stressed at 70°C. Non significant differences were found among T_o, T_1, T_2 and T_4 treatments where the pre-sowing temperature stress levels were 0, 50, 60 and 80°C and sympodial branches were 20.92, 20.83, 19.83 and 19.92, respectively.

Data in Table I further showed that the seeds stressed for 24 hours produced plants bearing higher number of sympodial branches per plant (21.90) than that of 48 hour stress duration producing 19.93 sympodial branches per plant. Similar findings were reported by Tahir (1994). NIAB-Karishma produced maximum number of sympodial branches per plant (23.47) when the seed was stressed for 24 hours and it differed significantly from rest of the combinations, which were on par with one another. Sympodial branches produced per plant from NIAB-Karishma stressed for 48 hours (V_1D_2) and CIM-443 for both 24 hours (V_2D_1) and 48-hours stress duration (V_2D_2) were 19.73, 20.33 and 20.13, respectively. The greater number of sympodial branches per plant in V_1D_1 was attributed to increased number of monopodial branches per plant recorded in this treatment (data not shown).

Both varieties i.e. NIAB-Karishma and CIM-443 differed significantly from each other in the number of flowers produced per plant, which was 38.77 for CIM-443 against 30.17 recorded in variety NIAB-Karishma. It can be due to difference in growth pattern of the two varieties. NIAB-Karishma produced bushy type plants and its vegetative growth was greater than that of CIM-443. Furthermore, the latter showed more reproductive potential than the former one. The effect of other factors as alone or their interactions was not significant. None of the treatments had significant influence on the number of flowers dropped per plant. Number of bolls formed per plant was significantly higher (32.77) in CIM-443 than that of NIAB-Karishma with 25.97 bolls recorded per plant. It is attributed to increase in flowers formed per plant in CIM-443 than NIAB-Karishma. Bolls dropped per plant (Table I) indicate that duration of pre-sowing temperature had significant effect on this parameter. Boll drop was significantly decreased when the temperature stress duration was 48 hours (25.93%) compared to 24 hours where it was 37.59% as also reported by Ahmed *et al.* (1993) and Tahir (1994). Boll drop recorded in variety CIM-443 was 27.85% which was significantly lower than that of NIAB-Karishma (36.67%). The excessive boll drop in NIAB-Karishma may be due to its inability to adopt the environment efficiently as compared to CIM-443.

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