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SHORT COMMUNICATION

TRAITS RELATED TO DROUGHT RESISTANCE IN COTTON HYBRIDS

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Responses of five hybrid varieties of cotton to moisture stress were assessed in the field for their relative tolerance to drought. The study revealed that moisture deficit adversely affected the chlorophyll stability index and nitrate reductase activity, while proline accumulation enhanced irrespective of varieties. Yield and its attributes decreased conspicuously in all the varieties in response to water stress imposed at flowering stage. Amongst the cotton hybrids, PKV Hy-4 and PKV Hy-2 were noted to be relatively more drought tolerant than others on the basis of assessment of their yield performance. The flowering stage in cotton was found to be more critical to moisture stress than vegetative and ripening stages.

***Key words*: Cotton hybrids, flowering stage, moisture deficit, physiological and biochemical traits.**

The newly emerging cotton hybrids possess higher yield potential than the established high yielding varieties. However, in the present changing agricultural scenario their adaptability to varying habitats and environmental conditions is most important (Kar *et al.* 2001). Though plants have naturally evolved several stress adoptive strategies, most of them pertain to survival of plants under stress. However, from the agricultural point of view, any stress adoptive strategy, drought stress in particular, would be useful only if it is associated with superior crop growth rates under a given stressful environment. Selection of such types was traditionally done based on empirical screening methods that did not always result in the expected increase in productivity under water limited condition. To improve crop productivity it is being suggested that a 'trait-based' approach be adopted (Shesh shayee *et al.* 2003), which would provide a strong impetus to the efforts in assessing the genetic variability under moisture stress condition. The present endeavour is an attempt to identify such desirable putative traits related to drought resistance in some cotton hybrids grown under moisture deficit condition.

Five cotton hybrids namely; PKV Hy-4, PKV Hy-2, Savita, Surya, Ankur and one check variety MCU-5 were used in the present experiment. All the varieties were grown in the field during *Rabi* (2001-02 and 2002-03) at the Central Research Station, OUAT, Bhubaneswar. The soil was sandy loam type having a pH of 6.7 and the native N, P and K contents were 0.10%, 18.6 kg and 110.2 kg ha^{-1} respectively. The average annual rainfall received during June to October and November to May was 1350 and 275 mm respectively. The hybrid seeds were sown with a spacing of 90 x 45m and N, P and K were applied @ 120, 60 and 60 kg ha^{-1}. Moisture stress treatment imposed at vegetative, flowering and boll development stages by withholding irrigation till temporary wilting appears and thereafter irrigated till harvest. The experiment was replicated thrice with a factorial split plot design. Total chlorophyll was calculated using the formula given by Arnon (1949) and chlorophyll stability index (CSI) was calculated as follows:

$$CSI = \frac{\text{Chlorophyll in the stressed plants}}{\text{Chlorophyll in control plants}}$$

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Proline content and nitrate reductase activity in leaves were determined following the protocol of Bates *et al.* (1973) and Hatam and Hume (1976) respectively. Yield and its attributes were recorded at harvest. Statistical analyses were done following the methodology as outlined by Panse and Sukhatme (1985).

Chlorophyll stability index, proline content and nitrate reductase activity in leaves were determined at different stages before and after the stress inductive cycle (Table 1). It was noticed that under stress condition PKV Hyb-2 and PKV Hyb-4 registered greater chlorophyll stability index (CSI) compared to Sabita and Surya, the lowest

Table 1. Effect of moisture stress imposed at different growth stages on (a) chlorophyll stability index (CSI), (b) proline content (mg g^{-1} fw) and (c) nitrate reductase activity (µmol g^{-1} fw h^{-1}) in the leaves of cotton varieties.

Varieties		* Control	Stress imposed at different growth stages			
			Vegetative (1)	Flowering (2)	Boll (3)	Mean (1+2+3)
PKV Hy-2	(a)	-	0.82	0.68	0.78	0.76
	(b)	1.72	30.5	29.8	19.6	26.6
	(c)	0.96	0.86	0.68	0.72	0.75
PKV Hy-4	(a)	-	0.84	0.72	0.68	0.74
	(b)	1.89	30.2	28.6	18.8	25.8
	(c)	0.90	0.88	0.70	0.71	0.76
Sabita	(a)	-	0.68	0.62	0.63	0.64
	(b)	3.93	25.0	20.2	16.5	20.5
	(c)	0.86	0.79	0.54	0.62	0.65
Surya	(a)	-	0.70	0.61	0.62	0.64
	(b)	3.82	26.6	38.6	19.2	28.1
	(c)	0.84	0.82	0.65	0.62	0.69
Ankur	(a)	-	0.58	0.54	0.60	0.57
	(b)	3.12	30.2	33.4	17.5	27.0
	(c)	0.78	0.58	0.54	0.60	0.57
MCU-5 (check)	(a)	-	0.52	0.51	0.56	0.53
	(b)	2.42	12.4	14.6	12.2	13.1
	(c)	0.72	0.48	0.51	0.50	0.50
		Variety		**Treatment**		
CD (0.05)	(a)	0.065		0.073		
	(b)	0.258		0.235		
	(c)	0.027		0.018		

* Average of three stages.

value being obtained in Ankur and MCU-5. Stress imposed at flowering stage resulted in more loss of chlorophyll than the vegetative and boll formation stages irrespective of cultivars as was evident from their mean CSI values (Meena Kumari *et al.* 2004).

A spurt in proline content was found in plants grown under stress-prone environments irrespective of cultivars. The increase in proline content in PKV Hyb-2, PKV Hyb-4 and Ankur was almost in same order and slightly higher than other hybrids. MCU-5 accumulated about 50% of the total proline present in hybrids particularly at vegetative and flowering stages (Kar *et al.* 2001). Proline is known to accumulate in plant under water stress and increase in proline content is effective in increasing osmotic status of the plant. The accumulation of proline in the leaf decreased the osmotic potential (Ψs) and it again increased when the stress was removed with concomitant increase in leaf water potential (Gupta *et al.* 2000).

Nitrate reductase activity (NRA) has also been found to be positively correlated with the crop productivity (Croy 1967, Eilrich 1968) and inversely with moisture deficit. Drought stress invariably decreased the NRA in all the cultivars and the decrease was more pronounced when the stress was imposed at flowering stage. Amongst the cultivars Ankur and MCU-5 registered

Table 2. Effect of moisture stress imposed at different growth stages on (a) number of bolls plant^{-1}, (b) seed cotton yield (q ha^{-1}) of cotton varieties.

Varieties		**Control**	**Stress imposed at different growth stages**			
			Vegetative	**Flowering**	**Boll**	**Mean**
PKV Hy-2	(a)	9.50	9.50	5.50	8.25	8.18
	(b)	30.65	29.00	24.85	25.62	27.53
PKV Hy-4	(a)	9.00	9.25	5.00	8.50	7.95
	(b)	30.12	28.82	23.32	26.21	27.09
Sabita	(a)	7.75	8.50	7.00	8.25	7.87
	(b)	28.50	18.00	20.20	25.20	23.00
Surya	(a)	9.25	8.75	5.75	8.50	7.93
	(b)	29.22	27.59	22.06	24.52	25.85
Ankur	(a)	7.25	7.77	5.57	7.00	6.93
	(b)	28.32	28.50	21.20	22.5	24.57
MCU-5 (check)	(a)	5.75	5.50	4.00	5.00	5.06
	(b)	22.82	20.52	18.50	18.00	20.00
Mean	(a)	8.15	8.10	5.41	7.58	-
	(b)	28.27	27.07	21.70	23.30	-
		Variety		**Treatment**		
S.E. (m)	(a)	0.553		0.192		
	(b)	1.212		0.628		
CD (0.05)	(a)	1.666		0.532		
	(b)	2.825		1.520		

significantly lower NRA under stress conditions around 70% of the control (non stress) as against 78-82% in other cultivars. The NR enzyme is highly unstable one, particularly under stress condition having the half life of only 4 hours (Miflin and Lea 1980). The decrease in NRA under water deficit condition has been attributed to either decrease in NR protein content (Anikiev and Kuramagomedov 1975) or due to conformational changes producing partial denaturation (Plaut 1974).

Number of bolls per plant and cotton yield were higher in all the hybrids composed to check (MCU-5). In latter the number of bolls was nearly half of that PKV Hy-4. In other four hybrids it was nearly more than 30-35% as compared to the check variety (MCU-5). Water deficit caused reduction in boll number in all the varieties. Maximum reduction in the attribute was recorded in the stress treatment imposed at flowering stages (60 DAS). Stress imposed at 90 DAS (boll development), also reduced the boll number while little or no reduction was noticed at 30 DAS (vegetative), rather in most of the hybrid varieties, there was slight increase in boll number when stress was given at vegetative stage. The present observation suggested that moisture deficit at 60 DAS (flowering) is more critical as compared to vegetative and reproductive stages. Out of all the varieties tested, PKV HY-4 excelled over other varieties probably due to its high yielding potential and better stress adaptive mechanism followed by PKV Hy-2, Surya and Sabita. The hybrid Ankur was though better than high yielding variety but it produced less number of bolls per plant. Kaur and Singh (1991) reported similar results corroborating our finding.

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