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Effect of Soil Salinity/Sodicity on the Growth and Yield of Different Varieties of Cotton

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ABSTRACT

This study was conducted on saline and saline sodic soils at six different locations of Bahawalpur and Bahawalnagar districts of Pakistan. Four different cotton varieties (namely CIM-446, CIM-473, CIM-499 and FH-900) were compared to check the effect of salinity/sodicity on their growth and yield pattern characteristics including plant height, branches per plant, Bolls per plant, seed cotton weight per boll (g) and seed cotton yield. Results revealed that various yield components varied significantly among the varieties tested in the field. Out of all the varieties tested, CIM-473 showed an excellent overall performance with a yield potential of 2879 kg ha^{-1}, followed by CIM-499 with a yield of 2596 kg ha^{-1}. The soil salinity/sodicity in general showed an adverse affect on the plant growth and yield but one of the cotton varieties tested i.e. CIM-473 showed more resistance to the salts and is recommended for salinity affected areas.

Key Words: Cotton; varieties; Saline sodic; Yield components; Seed cotton yield

INTRODUCTION

Soil salinity and sodicity are among the major contributing factors/constraints responsible for low yield of cotton crop. Such problems being encountered by the soils in the Punjab and Sindh regions of Pakistan are generally the consequence of shortage of canal water and high temperature prevailing in the area. Realizing the importance of cotton crop in the economy of Pakistan, the present study was conducted with an aim to screen the cotton varieties for selecting those for cultivation, which result in better yield under the saline and saline sodic soil conditions.

MATERIALS AND METHODS

The experiments were conducted on four varieties of cotton namely, CIM-446, CIM-473, CIM-499 and FH-900, under saline and saline sodic soil conditions at six different locations of Bahawalpur and Bahawalnagar districts (Table I) in the season of Kharif 2003-04.

Table I. Chemical Characteristics of the Soil Collected from Different Locations Selected for the Trial.

Locations	Tehsil	Soil Texture	Soil pH	EC (dS/m)	G.R. per acre
Chak No.14-I/R	Haroonabad	Loam	8.5	4.8	8 bags
Chak No.140-Murad	Chistian	Loam	8.1	5.4	Nil
Mouza Gamon Mailkhi	Khairpur	Loam	8.4	5.6	Nil
Chak No.103-DB	Yazman	Clay loam	8.0	4.4	Nil
Chak No.70-F	Hasilpur	Loam	8.7	4.4	25
Mouza Hasilpur	Hasilpur	Clay loam	9.7	6.3	60

GR = gypsum requirement

The soil samples were collected from different locations and analyzed in the Government of Punjab's Soil and Water Testing Laboratory, Bahawalpur. Gypsum was applied in the saline sodic soil fields for reclamation purposes in accordance with the laboratory's recommendations. Lay out was planned according to the RCBD with three replications. The net plot size in each case was 6 x 20 m^2. The seed was sown by drill method with 75 cm row-to-row and 20 cm plant-to-plant distance. Seed rate was applied @ 25 kg ha^{-1}. A recommended basal dose of 100: 60 NP kg ha^{-1} was applied in the form of Urea (46%) and Single Super Phosphate (18%), respectively. The whole quantity of phosphorus and 1/3 of N was applied at the time of sowing and the remaining N was applied in split doses along with 1st and 2nd irrigation. Thinning was done before the application of 1st irrigation. All the routine agricultural practices and plant protection measures were adopted in all the plots uniformly. Data on different morphological traits were recorded and analyzed statistically by fisher's analysis of variance technique. Least Significance Difference (LSD) test at 5% was employed to compare the varieties mean (Steel & Torrie, 1980).

RESULTS AND DISCUSSION

Plant height (cm). Significant variations were recorded in the plant height among different cotton varieties under saline and saline sodic soil conditions (Table II). The maximum plant height (159.4 cm) was attained by CIM-473 compared to other varieties; whereas, the minimum plant height (78.2 cm) was recorded for CIM-499. Increasing level of salinity/sodicity were found to markedly suppress the plant height. This may be due to the fact that an increase in the soil salinity/sodicity decreases the uptake of nitrogen and phosphorus which had a direct effect on the plant growth and ultimately on the plant height. These results are compatible with those reported by Ahmad *et al.* (1991) and De-Oliveira *et al.* (1998).

Branches per Plant. Different cotton varieties differed

significantly in the number of branches per plant under varying soil conditions. It was found that as the magnitude of salts increased, the branches per plant decreased in all the cotton varieties. Actually, high salt concentration reduced the uptake of soil nutrients, a phenomenon which affected the plant growth thus resulting in less number of branches per plant. These results are similar to those reported by Ahmad *et al.* (1991) and Khan *et al.* (1998). The cotton variety CIM-473 showed maximum number (23.3) of branches per plant; whereas, the minimum number (11.3) of branches per plant was observed in case of CIM-446. Furthermore, CIM-473 also produced the highest number (12.3) of branches when planted under high salt concentration with EC of 6.3 dS/m as compared to other varieties.

Bolls per plant. All the cotton varieties also differed significantly in the number of bolls per plant on most of the locations of salt affected soils. Highest number of bolls per plant (25.1) was recorded for CIM-473, and the minimum (6.4) for CIM-446. It appears that an increase in salt concentration produced a stressful effect on flowering and boll formation in cotton because a reduction in plant growth decreased the number and growth of sympodia (fruit bearing branches) as reported by Khan *et al.* (1995) and Ahmad *et al.* (1991). The cotton varieties CIM-473 and CIM-499 possessed a good potential to produce greater number of bolls per plant under the salt affected soil conditions as compared to other cotton varieties. Both these varieties also showed greater resistance to salts when compared with other varieties.

Seed cotton weight per boll (g). Like other parameters, seed cotton weight per boll also differed significantly among the cotton varieties tested on different locations in the salt affected soils. Greater salt concentration had a direct effect in lowering the boll weight (Ahmad *et al.,* 1991; Ahmad, 1994). It is believed that the boll weight is directly proportional to the rate of photosynthesis, which is obviously related to the nutrient and moisture uptake from the soil. Moreover, a high salt concentration had an adverse effect on the uptake of both the nutrients and the moisture thus resulting in low boll weight. CIM-473 produced cotton bolls, which gave highest seed cotton weight of 2.94 g followed (2.86 g) by CIM-499. Moreover, both CIM-473 and CIM-499 produced bolls of high seed cotton weight even under high salt concentration as compared to other varieties.

Seed cotton yield (kg ha^{-1}). Results of the present study have shown that the yield differences of various cotton varieties at different locations on salt affected soils were highly significant. The maximum yield (2879 kg ha^{-1}) was found in CIM-473 followed (2596 kg ha^{-1}) by CIM-499. In contrast, lowest seed cotton yield (664 kg ha^{-1}) was shown by CIM-446. As an increasing level of salinity/sodicity significantly affects the yield contributing factors which

Table II. Effect of Salinity /Sodicity on the growth and yield of different Cotton Varieties

	Location	EC (dS/m)	Variety	Plant height (cm)	Branches/Plant	Bolls/plant	Seed Cotton Weight/boll (gm)	Seed Cotton Yield (Kg ha^{-1})
A	Chak No. 14-1/R	4.8	CIM-473	152.9 a	14.1 a	19.6 a	2.91 a	2091 a
			CIM-446	139.9 b	18.3 a	13.8 b	2.73 b	1506 b
			FH-900	138.5 b	17.3 a	14.7 b	2.69 b	1715 b
			CIM-499	125.8 a	15.9 ab	18.6 a	2.67 b	1998 a
			LSD (0.05)	3.81	2.64	1.69	0.11	211.1
B	Chak No. 140-Murad	5.4	CIM-473	119.8 a	12.5 a	19.2	2.85 a	2342 a
			CIM-446	99.5 b	13.4 b	17.3	2.67 b	1847 c
			FH-900	100.0 b	13.3 b	17.5	2.69 b	1890 bc
			CIM-499	118.6 a	16.5 a	20.6	2.81 a	2155 ab
			LSD (0.05)	2.44	1.28	NS	0.89	293.3
C	Mouza Gamon Mailkhi	5.6	CIM-473	159.4 a	23.3 a	11.8 b	2.56	1347 b
			CIM-446	152.7 a	16.7 c	8.0 c	2.49	799 c
			FH-900	136.5 b	18.1 bc	13.5 b	2.51	1177 b
			CIM-499	115.5 c	20.9 ab	17.5 a	2.52	1766 a
			LSD (0.05)	14.9	3.79	2.89	NS	278.1
D	Chak No. 103/DB	4.4	CIM-473	123.8 a	15.1 ab	19.8	2.94 a	1940
			CIM-446	90.1 c	12.3 c	19.4	2.62 c	1708
			FH-900	109.3 b	17.6 a	20.7	2.63 c	1718
			CIM-499	88.7 c	13.5 b	18.4	2.81 b	1816
			LSD (0.05)	6.76	2.69	NS	0.09	NS
E	Chak No. 70/F	4.4	CIM-473	107.7 b	21.8 a	25.1 a	2.86	2879 a
			CIM-446	108.1 b	17.8 b	16.0 c	2.76	1832 c
			FH-900	109.5 b	16.6 b	22.6 b	2.86	2550 b
			CIM-499	114.5 a	17.6 b	23.1 b	2.86	2596 b
			LSD (0.05)	3.74	2.34	1.95	NS	251.5
F	Mouza Hasilpur	6.3	CIM-473	94.8 a	12.3	11.5 a	2.84 a	1305 a
			CIM-446	84.0 c	11.3	6.4 c	2.60 bc	664 c
			FH-900	89.9 b	11.9	7.8 bc	2.51 c	776 bc
			CIM-499	78.2 b	12.0	8.1 b	2.72 ab	882 b
			LSD (0.05)	3.28	NS	1.57	0.19	135.0

NS = Non significant

subsequently results in low cotton yield. These findings are inconsistent with those of Phogat *et al.* (2001), Chaudhry *et al.* (2001), Ahmad *et al.* (1991) and Ahmad (1994). The results indicate that out of four varieties planted at six different locations of salt affected soil, CIM-473 resulted in a better yield and least affected by the presence of salts, when compared to other varieties.

CONCLUSION

It can be concluded that CIM-473 performs better in the saline and saline sodic soils of Bahawalpur region. Thus, CIM-473 is recommended for cultivation in the area of study.

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