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Evaluation and Screening of Local Germplasm under Joint Project On, the Development of Leaf Curl Virus Tolerant Varieties of Cotton

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Abstract: Fifty-three different indigenous genotypes of cotton screened for CLCuV disease and other traits were found not to be possessing good combination of desirable traits alongwith resistance to cotton leaf curl virus disease. It was noted that the genotypes carrying some identified novel genes of economic value can be manipulated and utilized for the synthesis of the requisite desirable genotypes which would better suit to the varying climatic conditions of the country. Out of the selected genotypes, Pak-3, Pak-7, Pak-13, Pak-28 and Pak-50 are being improved for specific lacking characters i.e. yield, earliness etc. to develop desirable genotypes to achieve the desired objectives. While other promising genotypes viz., Pak-23, Pak-25, Pak-27, Pak-48 and Pak-38 possessing some desirable traits but are susceptible to CLCuV disease are being utilized as valuable genepool in the project as well in our cross breeding programme. Moreover the existing germplasm resources will be further enhanced when the germplasm from Kazakhstan will be added to the existing one after the exchange with the local germplasm. Progress made, future strategies/problems, efforts relating to the project are being described and discussed.

Key words: Pak-Kazakh joint project, evaluation, cotton germplasm, CLCuV disease, development of tolerant varieties

Introduction

Cotton (*Gossypium hirsutum* L.) being the most important cash crop of Pakistan and is grown over about 2.8 million hectares; i.e. 10 percent of the arable land in the country. It provides the raw material to more than 90 percent of the local textile mills, ginning factories and constitutes 60 percent to domestic edible oil production for human consumption and also provides feed for dairy animals. It besides providing livelihood to farmers and workers of ginneries, textile mills and garment factories, contributing 60 percent towards foreign exchange earnings. But during the past few years cotton leaf curl virus (CLCuV) disease emerged in an epidemic form in the province of Punjab, Pakistan. Due to this emance, there had been a sharp decline in cotton production and consequently the production dropped from 12.8 million bales in 1991-92 to about 8.0 million bales during 1993-94; equivalent to a decrease in gross domestic product (GDP) of 3-4 percent As a result the impact of this clamity on Pakistan's farm and household income, downstream manufacturing sector and foreign exchange earnings has been severe. Cotton leaf curl virus (CLCuV) disease was first observed near Multan in 1967 (Hussain and Ali, 1975) and was noted consistently since then. The disease reached economic importance in 1987-88 and became epidemic in 1991-92. The CLCuV disease is characterized by upward curling of leaves, thickening of leaf veins (more pronounced on the underside). In extreme cases, the formation of cup-shaped or leaf laminar outgrowths called "enations" appears on the underside of the leaf. The feeding of the whitefly, Bemisa tabaci (Genn) transmits the CLCuV disease and it has many alternate hosts among cultivated and wild *Malvaceae* (mallows, including cotton). It was confirmed that CLCuV belonged to the *Gemini* group, whose vector is whitefly (Mohsin *et al*., 1992). Measures such as control of insect vectors or crop rotation help to control the disease, but resistant cotton varieties must be developed to overcome this epidemic. In view of the contribution of cotton to to the economy of Pakistan, the cotton plant has since long been subjective to extensive research. However the variability for desirable traits in the existing germplasm is scanty as well need to be properly explored and utilized.

Therefore a collaborative joint project between Pakistan and Kazakhstan, entitled, Joint Project on the, Development of Leaf Curl Virus Tolerant Varieties of cotton, sponsored by the Ministry of Science and Technology (MoST) was initiated during the year, 1998. The objective were i) to enhance the germplasm resources, to be utilised in cotton breeding programme and ii) to develop higher yielding cotton varieties, resistant to leaf curl virus (CLCuV) disease through the use of modern cotton breeding approaches which will ultimately lead to enhanced cotton production of both the countries.

Materials and Methods

As per approved programme of work, the cotton germplasm comprising of about Fifty-three genotypes was obtained from different ecological zones of Pakistan. The seed thus collected was divided into two parts. One half of which was kept for evaluation and screening under local environmental conditions alongwith the germplasm collected by the P.I. from Kazakhstan. While the remaining half of the seed was reserved for exchange with the seed of the germplasm collected by the counter-part of the project from Kazakhstan. Because of some un-avoidable circumstances, the exchange visit of my self could not be completed as per schedule. Therefore to advance the project work; half of the seed of all the genotypes collected from different ecological zones of Pakistan was planted during 1998-99, at NIAB for screening against CLCuV disease and for valuable economic traits. The NIAB,s experimental area usually has abundant inoculum of CLCuV disease every year. This year too 100 percent CLCuV disease infestation was noted on the highly susceptible variety S-12, which was used as disease spreader, to achieve optimum and uniform disease inoculum throughout the experiment. The disease intensity was measured as described by Siddig (1968). The size of the individual plot was 0.75 m $\times$ 10 m and the standard agronomic practices and plant protection measures were adopted throughout the crop-growing season. The observations on different morphological/economic traits and CLCuV disease were recorded. On the basis of better combination and /or specific traits, different novel genotypes were selected and planted in the field. However due to the delay in the purchase of Auto Microinjection System, to enhance the project work, instead of microinjection technique, the pollen irradiation technique (Shi *et al*., 1987; Xu, 1985) was applied. Different crosses were attempted as described by Doak (1934) and before

Table 1: Characteristics of various genotypes of cotton, evaluated under Pak- Kazakh joint project during the year 1998-99

Genotypes	Reaction to CLCuv	Main Characteristics	Remarks
Pak-1	susceptible	medium height, late, normal foliage, less boll formation.	poor
Pak-2	"	medium height, round boll, less hairy, few bolls.	poor
Pak-3	resistant	tall, broad leaf, late, yellow pollen, long internode, less boll formation.	resistant
Pak-4	moderately susceptible	tall, late, round/ big boll, broad leaf, good hairiness.	good boll size
Pak-5	"	medium height, good boll size, less hairy, round and big boll.	good boll size
Pak-6	"	short, early, good boll formation, more sucking.	more sucking
Pak-7	"	tall, quick growth, pointed boll, good boll formation.	good yielder
Pak-8	"	medium height, good hairiness, round boll, less boll formation.	poor
Pak-9	"	very early, stunted, less hairy, few bolls.	less hairy
Pak-10	highly susceptible	stunted growth, more sucking less bearing, early.	less hairy
Pak-11	"	stunted growth, less boll formation,	poor
Pak-12	susceptible	tall, good growth, less boll bearing. hairy leaf, late.	broad leaf
Pak-13	resistant	good growth, long inter- node, yellow pollen, long branches, less bearing.	resistant/ low yield
Pak-14	susceptible	red stem/branches/leaf, late, less fruit.	poor
Pak-15	highly susceptible	stunted growth, less boll formation.	poor
Pak-16	"	late, pointed boll, medium height, less boll formation.	poor
Pak-17	"	late, less fruit formation.	poor
Pak-18	moderately susceptible	tall, broad leaf, red stem/branches/calyx, very late.	very late
Pak-19	"	round good boll size, late, less bearing	resistant
Pak-20	susceptible	very late, branchy, broad leaf, few bolls.	poor
Pak-21	"	tall, branchy late medium leaf/ hairiness less boll formation.	"
Pak-22	"	medium height, late, less boll formation.	"
Pak-23	moderately susceptible	very early, short stature, good boll size.	good boll size
Pak-24	"	tall, very late, red stem/ calyx, broad leaf, more shedding.	poor
Pak-25	"	yellow pollen, good growth good hairiness, medium maturity, less fruiting.	good hairiness
Pak-26	"	more sucking, poor growth, very less fruit formation.	poor
Pak-27	susceptible	erect type, round boll, short sympodial, medium maturity.	erect type plant
Pak-28	resistant	very good boll size, medium tall, yellow pollen, good bearing more sucking.	resistant/ more sucking
Pak-29	highly susceptible	medium height, big /rounded bolls, less hairy, more foliage, late.	late
Pak-30	susceptible	late, less bearing, tall, more sucking.	poor
Pak-31	moderately susceptible	big boll, less bearing, non- hairy, late, yellow pollen.	big boll
Pak-32	"	tall, branchy, broad leaf, non-hairy, few bolls.	non-hairy
Pak-33	susceptible	short stature, less hairy, few bolls, late.	poor
Pak-34	"	short stature, stunted, less bearing, late.	poor
Pak-35	"	stunted, medium boll size, less boll bearing.	"
Pak-36	"	early, short stature, few bolls.	"
Pak-37	"	early, short stature, few bolls.	"
Pak-38	"	more height, big boll, few bolls, late.	big boll
Pak-39	"	stunted, more sucking, non- hairy, round/few bolls.	non- hairy
Pak-40	"	tall, non-hairy, stunted, more sucking, few bolls, late.	"
Pak-41	-	no germination.	-
Pak-42	"	tall, non-hairy, more sucking, few bolls, late.	non-hairy
Pak-43	moderately susceptible	erect type, non-hairy, big boll, late, more sucking.	erect type
Pak-44	susceptible	late, less hairy, erect type, few bolls.	erect type
Pak-45	-	no germination.	-
Pak-46	moderately susceptible	erect type, less hairy, conical boll, late.	erect type
Pak-47	susceptible	medium height, late, few bolls, medium hairiness.	poor
Pak-48	"	big boll, erect type, late, medium hairiness.	big boll
Pak-49	"	short inter-node, less hairy, few bolls.	short inter-node
Pak-50	resistant	tall, broad leaf, less hairy, late, yellow pollen, big boll, few bolls.	resistant/ low yielder
Pak-51	moderately susceptible	tall, late, less hairy, medium boll size.	low yielder
Pak-52	susceptible	short stature, few bolls.	poor
Pak-53	"	poor germination, few bolls.	poor

crosses the male parent pollen was irradiated with optimum radiation doses i.e.5-10Gy (Aslam *et al*., 1994; Aslam and Stelly, 1994) to create more variability/to induce mutations (Pate and Duncan, 1963; Krishnaswami and Kothandaraman, 1976). Matured crossed bolls were harvested to obtain M_0 seed to raise M_1 population.

Results and Discussion

The results indicated that none of out of 53 indigenous genotypes studied, had good combination of all the desirable traits alongwith resistance against CLCuV disease. Most of them were found susceptible to CLCuV disease and were low yielder. However only few of them showed resistance to leaf curl virus disease. But

none of the resistant genotypes possessed good combination of desirable traits. Among all the lines only Pak-7 had good boll bearing but was susceptible to CLCuV disease hence as such it cannot be considered as a good line. An other line i.e. Pak-49, possessed short internodal length, had less number of bolls per plant and was also susceptible to CLCuV disease. Many of the lines were found non-hairy and due to their susceptibility towards jassid as such ware of no economic value. There were quite a few lines, which had big boll trait, but they were also susceptible to CLCuV alongwith fewer number of bolls per plant, and hence were low yielder. Few lines had earliness character, while still others were found to be having good hairiness and better plant type character. Therefore the result revealed that none of the genotypes could be utilised as such to enhance cotton production. All the selected genotypes were planted in the field and further studies are in progress. The genotypes Pak-3, Pak-7, Pak-13, Pak-28 and Pak-50 are being improved for specific lacking characters i.e. yield, earliness etc., while other genotypes i.e. Pak-23 Pak-25 Pak-27 Pak-48 Pak-38 possessing some specific novel traits and are susceptible to CLCuV disease are being utilized as valuable genepool in the crossbreeding programme (Table 1). Following cross-pollinations with irradiated pollen were attempted during 1999-2000.

i) Pak-3 × Pak-23 ii) Pak-7 × Pak-50 iii) Pak-13 × Pak-13*
iv) Pak-28 × Pak-25 v) Pak-50 × Pak-23

*Irradiated self-male parent pollen was used for pollinations.

Harvesting of successful treated bolls was carried out to obtain M_0 seed to raise M_1 population. To save time the M_1 population will be grown during off-season under greenhouse conditions and M_1 seed will be obtained to grow M_2 population in the field for selection during the year 2000-2001. As mentioned above, according to approved programme of work, the cotton germplasm comprising about fifty-three genotypes was collected from different ecological zones of Pakistan. The seed thus collected was divided into two parts. One half of which was kept for evaluation and screening under local environmental conditions alongwith the germplasm collected by the P.I. from Kazakhstan. While the remaining half of the seed was reserved for exchange with the seed of the germplasm collected by the counter-part of the project from Kazakhstan. Therefore the existing germplasm resources would be further enhanced when the germplasm from Kazakhstan will be added to the existing one after the exchange with the local germplasm.

Now if we look on specified objectives of the project, they were as i) to enhance the germplasm resources, to be utilised in cotton breeding programme and ii) to develop higher yielding cotton varieties, resistant to leaf curl virus (CLCuV) disease through the use of modern cotton breeding approaches to enhance cotton production. It is quite evident that a part of the first objective has been achieved and we have able to isolate valuable germplasm, which is further being utilised for cotton improvement. However the exotic germplasm from Kazakhstan could not be added to the local germplasm, since the visit of first author to Kazakhstan was not accomplished due to some un-avoidable circumstances and hence the seed material collected from Pakistan could not be exchanged. Now the donor agency is striving for arranging the visit of the collaborative P. Is., of both the countries as per approved programme.

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