Published July, 1962

Effects of Time of Symptom Expression of the Leaf-Crumple Virus on Yield and Quality of Fiber of Cotton[1]

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THE Leaf-crumple disease occurring in cotton-growing areas of southern California and Arizona was first described in 1954 (2). The incidence of the disease became more severe with increasing popularity of perennial (stub or rattoon) cotton between 1954 and 1959. Growing trends to mechanization, particularly in harvesting, and greater insect problems have reduced the popularity of stub cotton and thereby the incidence of the Leaf-crumple Virus disease in 1960 and 1961.

Laird and Dickson (5) showed that the virus was transmitted by the sweetpotato white fly (*Bemisia tabaci* (Genn.)). Additional information on resistance and susceptibility of certain varieties and species of *Gossypium*, and the existence of a mild and a severe strain of the virus were reported (3, 4) in 1961. Allen et al. (1), measured the effect of the virus on yield of individual plants within a variety test block at Yuma, Arizona, and showed that plants with symptoms yielded 20.6% less than healthy ones in first year cotton and 16.8% less in stub cotton. Normally occurring variability between plants was not taken into account. They showed an increase in incidence of disease with advance of the growing season but did not measure yield losses on individual plants infected at different times.

Since field evaluation of the effect of an insect-transmitted virus disease is difficult because of the natural spread into disease-free control plots, the effect of the virus was evaluated by recording the incidence of disease in the field at intervals throughout the growing season. Yield and quality determinations were then correlated with time of symptom expression. The results of a three-year study are reported here.

MATERIALS AND METHODS

In the 1958 experiment Acala 4–42 cotton plants grown in the greenhouse were inoculated by approach graft with the Leaf-crumple Virus (LCV). Check plants were grafted but not inoculated. On May 29, plants were transplanted to the field. The experiment included 4 replications (9 plants in each) of artificially inoculated plants and 4 replications of uninoculated. Symptoms on uninoculated plants were recorded twice in this experiment (Figure 2).

In May 1959 and 1960 plants inoculated with LCV were transplanted from the greenhouse to a field of cotton seedlings to provide a source of inoculum for natural insect transmission. Plants with LCV were placed 6 feet apart and in alternate rows. In 1960 the seedling plants were thinned to a 3-foot spacing in an attempt to decrease some of the individual-plant variation that occurred in the 1959 experiment. Yield data were taken only from the plants inoculated naturally. Since the rows of seedling plants were bordered on each side by rows of inoculated plants, each seedling plant was considered to have an equal opportunity to become infected naturally. In both experiments each plant was considered a replication randomly determined by insect inoculation and subsequent symptom expression. The treatments were the dates on which symptoms of LCV were recorded. Plants were tagged at intervals throughout the summer when symptoms were seen. At harvest time bolls from each plant were collected, counted, and weighed. Fiber quality was determined from subsamples from several replications of each treatment.

In all experiments a severe strain of the virus was used as inoculum.

RESULTS

1958 experiment—Inoculation by grafting with LCV resulted in a yield of only 5.4 bolls per plant compared to 21.6 bolls per non-graft-inoculated plant (Figure 1). This difference was highly significant. Of 45 plants inoculated, 19 did not produce any bolls. Although average weight of seed cotton per boll was reduced from 4.6 to 3.6 grams by

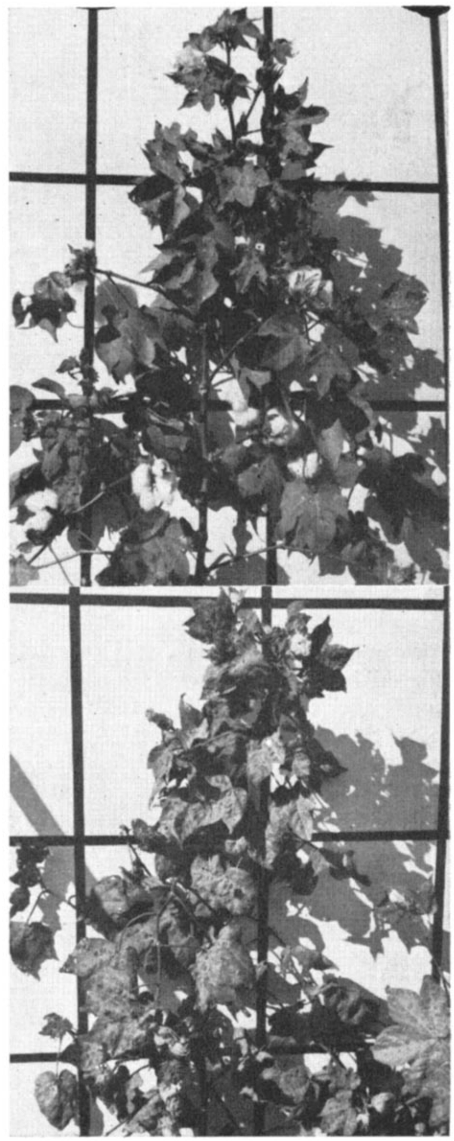

Figure 1—Effect of the Leaf-crumple Virus on Acala 4–42 cotton plants in 1958 field plots. Top. Symptomless plant showing many open bolls; Bottom. Plant inoculated by grafting in May showing abnormal growth and very few bolls.

[1] Contribution from Crops Research Division, ARS, USDA, and University of California, Riverside. Received for publication Oct. 27, 1961.

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graft-inoculation, no reduction in boll size occurred when plants were inoculated naturally.

Since some of the non-graft-inoculated plants showed LCV symptoms during the summer due to natural spread of the virus, yield of seedcotton from these was compared to that from symptomless plants. The number of bolls per plant was strikingly decreased when symptom expression occurred before July 21 but not when it occurred after August 6. The difference in boll number per plant was highly significant (Figure 2). The yield of seed cotton per plant was statistically correlated with the number of bolls (r values 0.93 to 0.99) indicating that yield loss was due to reduction in numbers rather than weight of individual bolls.

Since the plants were not transplanted to the field until late May, they were considerably smaller than those started from seed. This may have accentuated the effect of the virus.

1959 and 1960 experiments—In both experiments the yield of seed cotton and number of bolls per plant were reduced more when plants showed symptoms early in the season (Figure 2). This effect was not as marked as in the 1958 experiment; however, in that experiment transplanting of plants to the field may have retarded growth enough to allow a more severe effect of the LCV. In both 1959 and 1960 the reducing effect of LCV infection on boll number and seed cotton per plant was highly significant. The numbers of bolls and weight of seed cotton per plant were statistically correlated (r value for 1959, 0.94; for 1960, 0.92) showing (as in the 1958 experiment) that the main effect of the LCV was to reduce the numbers of bolls per plant.

The disease occurred earlier in 1959 than in 1958 or 1960 in both field plots and in growers' fields and probably was correlated with earlier appearance of the white fly vectors.

The percentage of lint and lint index (the weight of lint per 100 seeds) were not affected by the disease. Although early-infected plants generally had fewer seeds per boll and seed size was somewhat greater, differences were not statistically significant. Although some plants severely affected in 1958 and 1959 appeared to be more vegetative and taller than non-affected ones, measurements at the end of the 1960 experiment did not indicate any statistically significant differences in plant height due to LCV infection.

Fiber length, strength, and fineness—criteria of quality—were not affected by LCV (Table 1).

DISCUSSION

These data conclusively indicate that LCV may reduce the yield of cotton although under natural conditions the disease does not appear to be limiting. In the 1958 experiment, very few bolls were set on plants inoculated in the greenhouse and transplanted to the field. This effect may have been due to the retarding of plant growth as a result of transplanting, but even plants infected naturally early in the season produced very little cotton. Although transplanting is an artificial condition, these data suggest that any conditions that retard rapid plant growth in the spring could enhance the effect of the virus if an epidemic occurred early.

Of interest are the much greater reduction in number of bolls and subsequent lower yield of seed cotton that occur in plants affected early in the season (Figure 2). These data are in agreement with those from a greenhouse experiment (4) in which yield was reduced greatly when plants were inoculated at 28 days of age but only slightly when they were inoculated at 42 days. Time of infection is undoubtedly of great importance. Cereal yellow dwarf virus also causes greater yield loss when plants are inoculated in the seedling stage (6). The nature of the severe early-season effect of LCV is not known but may be related to its effect on flower initials. The yield-retarding effect of LCV occurred at different times in each of the 3 years. In 1958 no yield reduction occurred after August 1, and in 1959 none after July 10.

Nothing is known of the incubation period of LCV in cotton plants naturally inoculated at different ages. However, in a greenhouse experiment (4) the range in time for

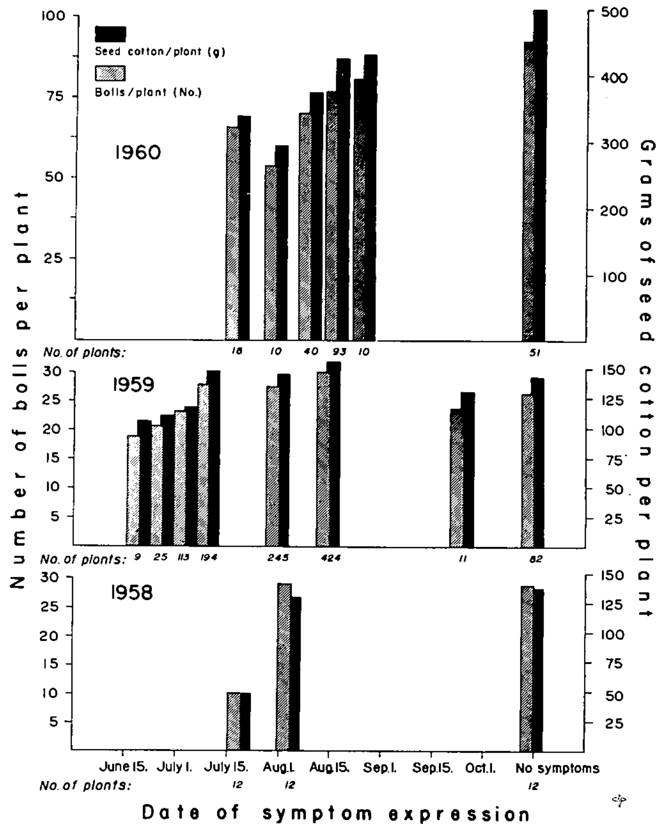

Figure 2—Effect of the Leaf-crumple Virus on yield of cotton as influenced by time of symptom expression.

Table 1—Effects of Leaf-crumple Virus on fiber properties of Acala 4–42 cotton.

Year and symptoms	Fiber length*			Fiber strength, T_1† (g./grex)	Fiber fineness, micronaire‡ (μg./inch)
	U.H.M., inches	Mean, inches	Uniformity, %		
1958					
LCV	1.00	.86	84	2.45	-
None	1.02	.86	84	2.43	-
1959					
LCV	1.07	.91	85	2.67	4.47
None	1.06	.89	83	2.62	4.40
1960					
LCV	1.10	.90	84	2.87	4.16
None	1.07	.91	84	2.69	4.57

* U.H.M. = Upper Half Mean: the average length of fibers longer than the mean length, determined by Fibrograph measurements. Uniformity ratio = relation between mean length of fibers and the upper half mean length; it provides a relative measure of length uniformity of fibers. † T_1 = Stelometer measurements with a 1/8-inch spacer between the clamp jaws. Stronger fibers indicated by higher figures. ‡ Micronaire measures the resistance to the passage of air through a 50-grain fiber sample compressed to a given volume and indicates the fineness and maturity of the fibers as related to their weight which in turn is related to the resistance to air passage.

symptom expression of 28-day-old graft-inoculated plants was 14–46 days, of 42-day-old plants 30–95 days, and of 56-day-old plants 72–134 days. Thus it does not appear that date of insect inoculation of plants can be accurately estimated from the data on time of symptom expression.

Also important is the consideration of the relative prevalence of mild and severe strains of the virus. It was previously shown (4) that mild and severe strains exist. In recent preliminary examinations of several LCV isolations obtained at random in the Coachella, Bard, and Imperial valleys, all were milder on inoculated Acala 4–42 cotton than the severe strain used as inoculum in these experiments. Studies are under way in the greenhouse to compare the effects of the mild and the severe strain of LCV on yields.

It is difficult to determine from these data what the average total effect of LCV on yield might be. One must consider that the loss from infected low-yielding plants might be made up by neighboring uninfected plants. However, since stunting is seldom caused by LCV, one might expect an infected low-yielding plant to compete ecologically with neighboring plants.

SUMMARY

In a series of field tests in 1958, 1959, and 1960, Leaf-crumple Virus disease reduced the number of bolls per plant and seed cotton weight on Acala 4–42 cotton. The reductions became more severe as symptoms of the disease appeared earlier in the season. Maximum yield reduction was 81% in 1958, 23% in 1959, and 41% in 1960. Boll size, lint %, lint index, seeds per boll and seed size were not significantly affected by the disease. Plant-height differences were not significant in the 1960 experiment, but observations in 1958 and 1959 showed excessive vegetative growth on early-infected plants.

Fiber length, strength, and fineness were not affected by the disease.

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