The Effect Of Cotton Leaf Crumple On Cotton Inoculated At Different Growth Stages

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Summary

The effect of cotton leaf crumple disease on symptom expression and yield of plants inoculated at three growth stages was examined. Early season infection resulted in severe foliar symptoms and yield reduction due to reduced boll set and delayed boll opening. Despite the mild foliar symptoms of plants infected later in the season, significant yield losses were observed.

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Cotton leaf crumple (CLC) is a disease of cotton Gossypium hirsutum L., which occurs predominantly in the southwestern United States. The symptomatology is characterized by foliar distortion, floral enations, stunting, and yield loss. The CLC disease agent is transmitted exclusively by the sweetpotato whitefly Bemisia tabaci Genn. (Laird and Dickson, 1959) and not by seed or sap (Dickson et al., 1954). Virus-like particles were recently associated with CLC-affected plants and thus, the disease is believed to be incited by a plant virus (Brown and Nelson, 1984).

Cotton leaf crumple has occurred only sporadically in Arizona from 1960-1979, but recently, epidemics have become common (Brown and Nelson, 1982; Russell, 1982). Epidemics appear to be dependent upon early-season whitefly population levels. Whiteflies are known to survive the winter in the Southwest on local weeds, some of which are potential CLC virus(CLCV) hosts, and to buildup to high levels during the spring or early summer (Butler et al., 1984). Overwintering, viruliferous whitefly adults may thus inoculate cotton at various times during the growing season.

Yield loss studies have been carried out using naturally-infected cotton or graft-inoculated, field-transplanted cotton and yield losses range from 21-76%. In both field (Russell, 1982; van Shaik et al., 1962) and preliminary greenhouse (Brown and Nelson, 1982) studies, greater losses ensued and symptoms were more severe when plants became infected at an early age. Visual inspection of foliage for typical CLC symptoms is the only method by which disease estimates are currently made. Because greenhouse tests indicate that typical symptoms do not develop in late growth-stage affected cotton, current estimates are likely inaccurate. Mid- to late-season infections, therefore, may result in losses that are neither recognizable nor quantifiable. The objectives of this study were to utilize plants which were experimentally inoculated by the natural vector, at three specific growth stages to investigate (1) the effects of CLCV on each of four growth components affecting yield, (2) to determine if foliar symptom development is dependent upon plant age at inoculation time, and (3) to determine if the severity of foliar symptoms is a useful indicator of the presence/absence of CLCV and/or the subsequent yield loss relative to plant growth-stage at time of inoculation.

Material and Methods

Cotton, 'Delta Pine 70', plants were inoculated with CLCV, using viruliferous B. tabaci (Brown and Nelson, 1984) at three growth stages (2-3, 8-10, and 14-16 leaf stage) to simulate early-, mid-, and late-season virus infection. Inoculated plants and non-inoculated controls were treated with a systemic insecticide, maintained in the greenhouse (20-26 C), and transplanted to a field plot one week after the third inoculation time. A randomized complete block design of four treatments and four replications with 30 plants/treatment in each block was used. Throughout the season, plants were assigned symtpom severity ratings based upon the extent of typical CLC symptom development in foliage and/or flower petals (0 = no symptoms, 1 = floral enations and/or 1-3 symptomatic leaves, 2 = 3-5 symptomatic leaves, and 3 = greater than 5 symptomatic leaves). Average ratings of 0-1 and 2-3 were considered to be indicative of 'mild' or 'severe' symptoms, respectively. Plant performance, based upon plant height, the number of open flowers, the number of open and closed bolls, and the total number of bolls, was assessed four times at 3-wk intervals. At the end of the season, all plants were pruned to 0.5 m in height and allowed to regrow for 4 wk. Disease ratings (+, -) based upon the presence or absence of typical CLC symptoms were recorded to allow determination of the % infection.

Results and Discussion

At the first sampling date (67 days after transplanting), 100% of the plants within the first and second inoculation age (IA) groups exhibited severe symptoms, while 32% and 12% of the IA-3 and non-inoculated control (NC) plants, respectively, exhibited only mild symptoms. The presence of disease symptoms in NC plants indicated that at least a portion of the controls were accidentally infected. By the fourth sampling date (134 days), 53% and 48% of the IA-3 and NC plants exhibited mild symptoms (Table 1) which suggested that some within-field spread to controls had resulted. At the same time, symptoms were more severe and had higher ratings in IA-1 and IA-2 plants than IA-3 or NC plants (Table 1), and a similar trend occurred at earlier sampling dates as well (unpublished).

A partial summary of plant performance data, represented by the fourth sampling date (Table 1) indicated that, of the four parameters examined, only the number of flowers set was the same among treatments. The number of open bolls and closed bolls for IA-1 and IA-2 plants was significantly lower than for IA-3 and NC plants, and IA-2 plants had the fewest total bolls (Table 1). In addition to the reduced number of bolls set, another source of yield loss appeared to be related to the failure of set bolls to open, since fewer open and more closed bolls were associated with earlier- (IA-1 and IA-2) vs. later- (IA-3) inoculated plants.

The results of this study indicate that early-season infection (2-10 leaf stage) by CLCV leads to significant yield loss due to reduced boll set and a failure of set bolls to open. Mid-season virus infection (14 leaf stage) also results in yield loss, though estimates based upon the data presented here are conservative since contamination of controls occurred. Accurate

disease estimates based upon visual inspection of foliage were possible only with plants that were inoculated at 2-10 leaf stages, since disease ratings (+, -) in subsequently stubbed plants were comparable to those obtained at the four sampling dates during the season (unpublished). Disease ratings (+, -) associated with the IA-3 plants were dramatically different from those at the four sampling dates, since only 53% of the plants appeared infected at the last sampling, while 93% were symptomatic when assessed following regrowth of stubbed plants (unpublished).

Preliminary examination of these data suggest that detection of early-season CLCV infection for disease estimates is possible, while mid- to late-season infections are not as easily assessed. Severe, mild and symptomless CLCV infections can potentially occur in Arizona cotton fields and are likely dependent upon the timing and dynamics of vector populations. Though early-season CLCV infection is relatively obvious, exclusively mid- to late-season infections will likely be undetectable, and yield losses attributable to CLCV infection will not be acknowledged.

Table 1. Effect of cotton leaf crumple on plant components[1]

Treatment[2]	Height (cm)[3]	Bolls Open[3]	Bolls Closed[3]	Total Bolls[3]	Average Symptom Rating
Inoc. age 1 (IA-1)	76.5 a	8.2 a	6.9 a	15.1 a	1.49
Inoc. age 2 (IA-2)	75.2 a	7.4 a	6.0 a	13.4 b	2.31
Inoc. age 3 (IA-3)	78.5 ab	12.3 b	3.9 b	16.2 a	0.90
Non-inoculated controls (NC)	80.8 b	11.5 b	4.5 b	16.1 a	0.80

1 All data presented are from the last sampling date, 134 days after transplanting. Each value is the mean of 4 replications.

2 Inoculation age 1 = 2-3 leaf stage; 2 = 8-10 leaf stage; 3 = 14-16 leaf stage.

3 For each column, means followed by the same letter are not statistically different at P .05.

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