indicated that collecting and handling mechanically harvested asparagus in bins is feasible. Damage in the 2- × 3- × 2-ft bin used on the 1965 machine did not appear to be significant unless clods were being discharged into the bin with the spears. A standard 4- × 4- × 2-ft bin usually would be sufficient for 1 to 2 miles of row.

Several lots of asparagus harvested from practice rows with the 1965 machine were put through an experimental fruit washer and onto a sorting belt that was set up in a grower's wash shed. Hand sorters removed the good spears, oriented them with the tips all in one direction, and separated them into two or three groups by length.

In these tests, the material from the bins was transferred into the wash tank by hand, but in a system designed for asparagus, the bin would be dumped while submerged in water. The asparagus was allowed to soak for a few minutes before being elevated out of the tank by the conveyor. After being sorted, the asparagus was put through the grower's regular washing and trimming unit for hand-cut asparagus, where the longer spears were trimmed to 7 inches. Several lots that had been put through the experimental washing and sorting unit were taken to canneries for quality evaluation and for consideration of handling procedures and other problems.

Although the washer and sorter used in these tests were not intended for asparagus, the results were encouraging. Hand sorting of mechanically harvested asparagus in growers' wash sheds is envisioned as an interim system that might eventually be mechanized—and probably would be centralized.

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Yield tests were conducted in fields owned by the M & T Company (Clair Davis, field manager) and Western California Canners, Inc. (Buzz Walker, field manager). The experimental fruit washer and sorter were provided by the Department of Food Science and Technology, University of California, Davis, and were set up at K. R. Nutting Co., Holt.

Eradication of

ANGULAR LEAF SPOT

of Cotton

W. C. SCHNATHORST

ANGULAR LEAF SPOT of cotton (*Gossypium hirsutum* L.) was first reported in California in 1912 and again in 1929. It had become an established disease of cotton by 1951 and was finally eradicated 10 years later. Its spread was attributed to (1) the introduction of sprinkler irrigation; (2) a 100% carryover of the bacterial pathogen, *Xanthomonas Malvaciarium*, each year in affected fields; (3) the use of contaminated seed; and (4) use of a highly susceptible variety (Acala 4–42). This report analyzes measures leading to final eradication of the pathogen from California cotton fields and points out procedures to control the disease should it reappear in the future.

Symptoms of angular leaf spot on Acala 4–42 cotton in California.

The number of known occurrences from 1951–65 are plotted on the graph. The first extensive survey of disease distribution in the San Joaquin Valley was made in 1952, and others in 1957, 1958, and 1959. Some involved 100,000 acres. By 1958 at least 66 fields were reported to be affected. From 1951–1961 there were 70 known different occurrences. In some fields the disease recurred for 8 years. After 1958 the number of occurrences dropped sharply. In 1959 there were only 12; in 1960, 3; in 1961, 2; and from 1962–1965 no angular leaf spot was reported.

The disease occurred primarily on the west side of the San Joaquin Valley where sprinkler irrigation was widely used. The use of sprinklers has steadily increased since the early 1940's. The disease has been known to occur only twice in furrow-irrigated cotton. Only Race 1 of the pathogen is known in California.

Control factors

Some of the factors considered favorable and unfavorable for control of the disease in California are listed in the table. California's low rainfall during the growing season is unfavorable for the development of angular leaf spot, but the use of sprinklers provides the moisture necessary for the spread of the pathogen. Organizational control of planting seed and the restriction on planting varieties other than Acala 4–42 is, in many respects, beneficial. It prevents the production of seed from infected plants and makes it illegal to import from other states seed that may be contaminated with the pathogen. However, the seed can become contaminated in the ginning process. This has occurred when clean planting

seed, produced only on furrow-irrigated cotton, was processed in gins that handled both planting seed and cotton from sprinkler-irrigated fields. This seed contamination has caused the disease to occur in fields that had never been planted to cotton (some were virgin soils), or those which had been out of cotton production for as many as 12 years. Many new occurrences were traced to seed contaminated from one cotton gin.

Acid delinting seed and application of organic mercury seed treatments are beneficial for the control of angular leaf spot, because they tend to reduce the external bacterial infestation of the seed. A very high percentage of the seed is now treated with a fungicide and the practice of acid delinting has grown in recent years.

Cultural practices have an important bearing on the carry-over of the pathogen in the soil. Prior to 1959, fields were generally tilled lightly and refuse could be found undecomposed on the surface of the soil—creating an excellent way for the pathogen to overwinter. Little moisture is added to the soil during the winter in the San Joaquin Valley, which discourages decomposition of plant debris. There was, and still is, a marked tendency on the part of growers to plant cotton continuously. This, coupled with poor cultivation, allows for carry-over of the pathogen in fields from year to year.

Eradication program

In 1957, a program of eradication was initiated by industry and state and federal research and extension personnel. Information dealing mostly with known sanitary practices found effective in reducing disease incidence elsewhere, was given to growers in the problem areas. The eradication program was aimed mostly at intensifying one measure (acid-delinting of seed) that was favorable for control, and at alleviating the effects of two unfavorable conditions (little winter moisture and lightly tilled soil). Growers with a disease problem were therefore advised to plant acid-delinted seed, treat the seed with organic mercuries, rotate crops, deep-plow their soil, and irrigate after plowing. They were also advised to change from sprinkler to furrow irrigation if the disease occurred.

From 1959 through 1961, there was a dramatic reduction in the number of occurrences as shown in the graph, and the last known occurrence was reported in 1961. Deep plowing, with the addition of moisture to the soil, was found to be probably the major factor leading to eradication. Field eradication would eventually result in a lower incidence of gin contamination. Because of the aging effect on the viability of the pathogen (very little bacteria recovered from cotton leaves after five years storage and none after seven years), and the dilution of contaminating refuse, gin contamination should become negligible in time. These factors, added to the restrictions against importing seed, and the steadily increasing use of acid-delinted seed, seem to be the main reasons for successful eradication.

FACTORS FAVORABLE AND UNFAVORABLE FOR CONTROL OF ANGULAR LEAF SPOT OF COTTON IN THE SAN JOAQUIN VALLEY

Favorable	Unfavorable
1. Large acreage furrow irrigated.	1. Increased use of sprinkler irrigation.
2. Little or no rain during growing season.	2. Voriety highly susceptible to the disease.
3. Organizational control of planting seed.	3. Cotton for planting seed and from sprinkled fields processed in the same gin.
4. Seed grown out of "one variety" district cannot legally be planted.	4. After harvest, soil is only lightly tilled, leaving infected refuse on or slighly below soil surface.
5. Increased use of acid-delinted seed.	5. Little winter moisture to aid decomposition of infected cotton refuse.
6. Planting seed taken only from furrow-irrigated fields.	6. Tendency to plant cotton continuously.
7. High percentage of seed treated with fungicides.	

There appear to be only two ways the disease can become reestablished in California: (1) through illegal importation of infected seed (cases are known and documented); and (2) through contamination of seed by ginning planting seed in gins that also process cotton from sprinkler-irrigated fields. It is conservatively estimated that all contaminated gins in California will be free of the pathogen by 1968, if there are no new occurrences. A program to determine the presence of the pathogen in all gins that process seed from sprinkled cotton has been initiated.

In the event of a future outbreak it would seem advisable to process planting seed only in gins that handle furrow-irrigated cotton. Chances that angular leaf spot of cotton may be a rare disease in the future in the San Joaquin Valley appear excellent, even though sprinkler irrigation and a highly susceptible variety are used. If it should reappear, the knowledge gained in the last 8 years would probably lead to its control in 1 or 2 years.

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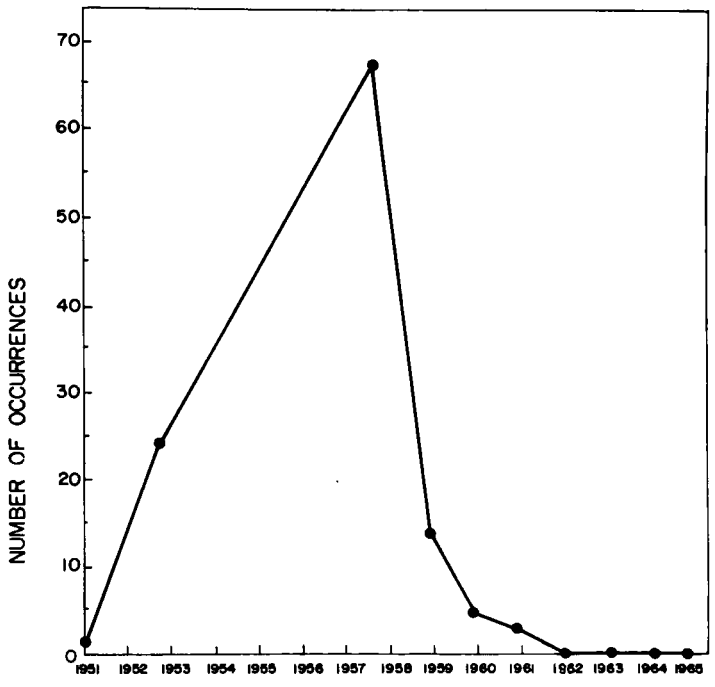

Annual occurrences of angular leaf spot of cotton in the San Joaquin Valley of California for years 1951–1965. The increasing frequency from 1951–1958 reflects almost 100% carry-over in previously affected fields, plus pathogen introduction into new fields through contaminated seed.