and designed more ruggedly for the crop to be harvested.

Current work on this project also involves the use of a mechanical cutter for bulk handling of a new variety of southern peas (Fig. 2). This variety grows with its pods above the vine. The machine cuts the pods off and elevates them into bulk boxes. Preliminary field trials of this unit indicate that it has merit and warrants further study.

Fig. 2. Experimental pea harvester operating in a field of southern peas.

The harvester aid is just what the name implies and might be fitted into present production patterns to advantage as a means to reduce the labor requirements and costs of production of certain vegetables.

More complete mechanization of the production and harvest of these crops seems possible, however. In furthering this study of the production of vegetables, a systematic analysis is being made of the various production operations, particularly harvesting, for the purpose of determining the functional specifications of machines which can perform these operations mechanically.

Summary

Mechanizing the harvest of Florida's vegetables is a complex problem requiring careful consideration of the many operations involved. It will require the best planning and thinking of researchers, growers, marketing groups, and the commercial machinery manufacturers.

Designs for successful vegetable harvesters for Florida conditions have not yet been developed except for potatoes and radishes. Work is underway for making a systematic analysis of the harvesting operations of some of Florida's more important vegetable crops. Work on machines to meet the functional specifications needed to harvest the specific crop will be undertaken as time and facilities permit.

To alleviate immediate labor problems, studies will be continued on harvester aids.

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VERTICILLIUM WILT OF TOMATO IN DADE COUNTY, FLORIDA

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Verticillium wilt (*Verticillium albo-atrum* Reinke & Berth.) has been recognized recently as one of the principal causes of decline in vigor and productivity of tomatoes grown on "old" rockland soils of Dade County. The disease appears to be widespread, and its importance to the tomato industry is likely to increase as "new" land becomes unavailable. Since most growers are unfamiliar with Verticillium wilt, a description of the disease as it occurs in Dade County and a review of certain of the known facts about it seems desirable.

Bewley (2), an English plant pathologist, made the original description of Verticillium wilt of tomato in 1922. The disease was first reported in the United States in eastern Ohio and in Erie County, Pennsylvania, by Bryan in 1925 (3). Since that time Verticillium wilt has been reported from a number of tomato-growing areas in the United States, but except for California and Utah, the disease is considered of minor importance (9). The disease

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has been known to occur in Florida, but the records examined do not indicate that it was serious.

Verticillium wilt, as it occurs in Dade County, is an inconspicuous disease, and difficult to diagnose with certainty without resorting to laboratory techniques. Some of the symptoms, though obvious, are transitory; others are similar to symptoms caused by other diseases or injuries. In the field external symptoms are not evident until the beginning of fruit set when there is a wilting of the bottom leaves of affected plants. At first most wilted leaves recover during the night. Affected leaves are somewhat pale green when wilting begins, but after a few days yellow blotches appear in the blade and around the margins. As yellowing progresses, brown necrotic areas and V-shaped lesions develop, and the leaf eventually dries up. The V-shaped lesion, which develops mostly at the tips of leaflets, appears characteristic and is useful in diagnosing the disease. The fungus occasionally sporulates on these lesions, especially after a day or two in a moist chamber. There is much variation in the expression of these symptoms among individual plants and also during the course of a season. Wilting and yellowing may involve only a few terminal leaflets, or the leaves on one branch, or it might occur on most of the bottom leaves. Yellowing and the development of necrotic areas can occur without prior wilting. Loss of foliage due to this aspect of the disease may reach 50 percent or more on Manalucie tomatoes grown on trellises, but on the Homestead variety grown "on the ground" the loss fluctuates between 5 and 20 percent. This difference is probably due to the length of time the plants are in the field rather than to differences in susceptibility of the varieties.

The most reliable symptom of Verticillium wilt is browning of the woody tissues of the root and lower stem. This discoloration is very light tan and is easily over-looked. Browning is rarely found above the ground line before fruits are mature, but as the plants age the fungus progresses upward in the stem.

Verticillium wilt, as it occurs in the field in Dade County, does not kill the plant. Rather, the over-all effect of the disease is to stunt the plant and reduce its vigor. Affected plants grow slowly and fail to respond normally to applications of fertilizer. Recovery from adverse circumstances, such as inclement weather or the attacks of other diseases, is very slow. The yield of fruit is reduced, perhaps as much as 30 to 40 percent, and the size and quality of the fruit is below normal.

Verticillium albo-atrum is a soil-inhabiting fungus which, because of the microsclerotia it forms, is able to survive for long periods in the soil. Wilhelm (11) reported that the fungus survived in California soils for 14 years following a tomato crop. During this period the field had been planted to grains and pasture. The fungus also produces spores which have been reported to infect tomato leaves (8). Although these infections probably have little to do with the development of wilt in the current crop, the spores serve to disseminate the fungus over wide areas, thus introducing the fungus to uninfested soils or accelerating its build-up in lightly infested fields.

Verticillium albo-atrum has been reported to infect a wide variety of plants. The host index prepared by Engelhard (4) lists 124 woody plants and 143 herbaceous plants as suscepts. Although *Verticillium* attacks a considerable number of vegetables, only tomatoes, potatoes, eggplant and okra are severely affected. It also causes serious diseases of strawberry, cotton, brambles, stone fruits. Certain shade trees are also seriously affected.

The fungus is quite variable, and a number of strains of varying pathogenecity have been reported. Apparently virulent strains are not restricted to given hosts, as is the case with the wilt-inducing species of *Fusarium*, but may attack a number of the more susceptible but unrelated hosts. Thus the strawberry or stone fruit grower is advised not to plant in areas where a previous crop of tomatoes or eggplant was affected by Verticillium wilt (1, 6).

Verticillium wilt should not be confused with Fusarium wilt (*Fusarium oxysporium* f. *lycopersici* (Sacc.) Snyder & Hansen) which also affects tomatoes in Dade County. Fusarium wilt is a more severe disease than Verticillium wilt and its symptoms are more obvious. Affected plants may be killed or severely stunted, and the yellowing of foliage is much more prominent. The vascular tissue of Fusarium-infected plants is darker in color than is the case with Verticillium wilt. The dark colored vascular strands found at the base of the petiole, which are characteristic of Fusar-

ium wilt, do not occur with Verticillium wilt. Most Fusarium-resistant varieties are susceptible to Verticillium wilt.

According to plant disease literature the severity of Verticillium wilt is influenced by several factors, but just how these relate to Dade County conditions remain to be seen. Continuous cultivation of a susceptible crop appears to be one of the principal factors in causing an increase in severity of the disease. Verticillium wilt is affected by temperature and is known as a "cool weather" disease. Bewley (2) reported that Verticillium wilt might occur when "average temperatures" ranged between 58 and 75° F. with optimum temperatures being 70 to 72° F. He also reported that affected plants recovered from the disease when temperatures were 77° F. It is evident that the usual temperatures of south Florida winters are within the range favorable for development of Verticillium wilt.

There are several reports that the amount and composition of fertilizer affects the severity of Verticillium wilt. Presley (7), working with Verticillium wilt of cotton, states that "Fertilizers, particularly those high in nitrogen, seem to promote the development of the disease. The percentage of wilt on fertilized plots increased as the amount of nitrogen was increased. On the other hand, when the amount of potash was increased the percentage of wilt decreased." Isaac (5) reported that less wilt developed in Antirrhinum with additions of potassium and also with the use of ammonium sulfate as the nitrogen source.

Many writers state that Verticillium wilt is more severe in alkaline than in acid soils, but Wilhelm (10) concluded that in California soils ". . . the occurrence and severity of Verticillium wilt is not greatly affected by soil reaction within the ranges in which susceptible crops are commonly grown." Soil moisture within the limits required for good growth does not have much effect on the severity of Verticillium wilt.

At the present time there is no satisfactory solution to the Verticillium wilt problem available to the Dade grower. Although the incidence of *Verticillium* in infested fields gradually diminishes in the absence of susceptible crops (11), the length of time involved is such that crop rotation offers no hope of effectively combating the disease. Use of resistant varieties offers the best practical solution of the Verticillium wilt problem. Seven of the Verticillium-resistant varieties offered for sale by seedsmen were tested during the 1958-59 season. Yields of all were very low, and the fruits were rough, flat, and soft. None appeared to be suitable for use in Dade County.

The Sub-Tropical Experiment Station, in cooperation with the Gulf Coast Experiment Station, is engaged in an extensive breeding program to develop Verticillium-resistant varieties adapted to Florida conditions and possessing, in addition, other disease resistances. Verticillium resistance is not difficult to incorporate in the tomato, but to get it in combination with all the other factors required in a tomato adapted to Dade County conditions is a difficult and time-consuming task.

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