crops that will give maximum yields for minimum control cost must be ascertained. A study of soil management practices in Florida probably will give much helpful information for the control of nematodes. Nematode population studies in relation to crop rotation are now in progress. At present the utilization of existing soil nematode fumigants and resistant or tolerant host plants in conjunction with good crop rotations seems to be the best control procedure. Soil fumigants are generally not selective in that they kill or retard most of the soil organisms. For this reason many of the beneficial organisms needed to maintain biological controls are destroyed during fumigation. It is possible that this would allow the parasites to become even more devastating in the event that they were not completely destroyed during fumigation, or in the event of reinoculation of the soil with plant parasitic nematodes.

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FACTORS ASSOCIATED WITH CREASE-STEM OF TOMATO

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Introduction

Crease-stem of tomatoes is a physiological disease which has attracted considerable interest in scientific circles in the past few years. Although observed from time to time over many years in nutritional studies in the research greenhouse, no serious effort was made to investigate it further because of its infrequent appearance in commercial fields. However, in the spring of 1948 severe crease-stem occurred on Rutgers tomatoes in an experimental field at the Gulf Coast Experiment Station at Bradenton (2). Through discussion with commercial growers and technical field men at that time it was learned that this trouble had been observed on a limited scale in the past, but usually only on the Rutgers variety. In October of 1950, serious outbreaks occurred in commercial fields over a large area of the Florida West Coast (3). Since then it has appeared sporadically each season in scattered locations along the Gulf Coast from Ruskin to Fort Myers.

Experienced tomato growers have little trouble in recognizing symptoms of the disease in the field. In the early stages of the disorder the stem begins to pinch together longitudinally so that a crease is formed on opposite sides, hence the name "crease-stem." A cut lengthwise of the stem at this stage shows internal necrosis and the presence of cavities where cells have completely disintegrated (Figure 1). As the disorder develops, this creasing from the two sides becomes so deep that a hole is formed through the stem (Figure 2).

This internal breakdown is always associated with a severe stunting and dwarfing of the plant. In many cases the growing tip becomes malformed resembling a "witches-broom." After several days—usually 10-14, depending on weather conditions—a partial recovery from this condition may take place. However, the fruits from such recovered plants will not only be greatly reduced in size, but also will be late in maturing.

In the initial field observations it was thought that this malformation might be due to insect punctures at or just below the growing tip. However, subsequent observations both in the greenhouse and in the field have

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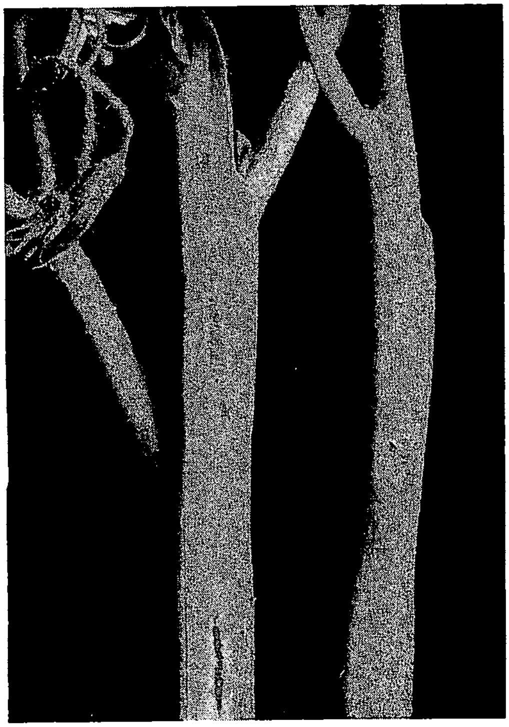

Fig. 1. Tomato stem showing early symptoms of crease-stem: internal breakdown on the left, faint creasing externally on right.

failed to show that an insect or other parasitic organism is involved.

At the present time we have no actual records from either experimental field plots or commercial operations showing how severely yields may be reduced by this disorder. Some conclusions might have been obtained from the fall crop of 1950, had the crop that season not been terminated prematurely by cold weather late in November. At that time it was the general opinion of experienced growers familiar with the crop that had it matured, yields would have been reduced by more than 50 percent.

Field Observations

In the fall of 1950 during the first economically important outbreak of this disease in commercial acreage, a rather extensive survey was made to determine the factors that might be responsible for the disorder. The season was characterized by a very rapid growth of young plants. This resulted from ideal growing conditions which prevailed through the first half of October. Then, about October 20, growth retardation and definite symptoms of crease-stem first began to appear. In some areas every plant in the field became affected, but in other sections only a few scattered plants were abnormal. It occurred in the older farming areas as well as in sections recently placed under cultivation.

The outbreaks did not seem to be correlated with fertilizer ratio, rate or time of fertilizer application, or with minor element supplements as applied in the fertilizer. All tomato varieties did not seem to be equally susceptible. The Rutgers variety was most susceptible; Grothen's Globe and Jefferson showed intermediate susceptibility; and Manasota seemed to be relatively resistant.

Since the fall of 1950 only sporadic outbreaks of the trouble have occurred. Several serious outbreaks of crease-stem threatened in February 1953 in scattered areas, but the weather turned cool just in time to slow down the rate of growth. Observations carried out over these past few years have revealed that plants are most sensitive during their early stages of growth and that young plants which

Fig. 2. Tomato plant showing characteristic symptoms of crease-stem, such as bunching of foliage and splitting of stem near tip of plant.

receive an ample supply of fertilizer develop crease-stem very readily under weather conditions favoring rapid growth. In many cases, although creasing has been hardly noticeable, a longitudinal section through the center of the stem just below the first flower cluster has revealed necrotic tissue and cavities within the stem.

It was during the 1950 fall crop period that many growers were shifting from the use of copper fungicides to the dithiocarbamic acid derivatives for the control of fungus diseases. A few growers who were troubled with crease-stem had used these derivatives entirely instead of alternating them with the various forms of copper. This shift in cultural practice led to the question as to whether or not crease-stem might be due to a deficiency of copper or calcium.

Greenhouse Trials

In 1951 a series of nutrient sand culture studies involving various minor elements was initiated. It was thought that these would give answers to some of the questions raised by field observations. However, these experiments, covering a period of three years, have failed so far to demonstrate clearly the exact cause of crease-stem.

In general, plants making the more rapid growth in solution cultures were more susceptible to crease-stem. Rutgers continues to be the most susceptible variety tested so far. Manalucie, on the other hand, has shown only faint evidence of being susceptible even though its growth rate exceeded that of Rutgers under the same growing conditions (Table 1).

Table 1. Relative growth and severity of crease-stem (internal symptoms) of Rutgers and Manalucie grown in sand cultures (Average of 32 plants harvested at second flower cluster).

	Green Weight (gms.)	Crease-Stem*
Rutgers	153.4	4.3
Manalucie	163.3	1.1
Sig. Diff.	7.6	0.8

* Symptoms: 1 (faint)—5 (severe).

Variations of the boron level from 0.1 to 1.0 parts per million and of the molybdenum level from 0.001 to 0.1 parts per million had little or no effect on the severity of the symptoms. Variations in the iron-manganese ratio were also ineffective in changing susceptibility. The response to varying levels of copper (0.1 to 2.0 parts per million) was inconsistent. Under conditions conducive to rapid growth, crease-stem symptoms were more severe with the lower level of copper.

In every experiment to date on nitrogen source, it has been observed that plants supplied with nitrate as a source of nitrogen were more severely affected than plants which received a combination of both ammoniacal and nitrate nitrogen. However, nitrate-fed plants grew faster; this should be considered significant since repeated observations have shown that rapidity of growth is an important factor in the development of crease-stem symptoms.

When it was shown experimentally that neither boron nor copper was effective in preventing the disorder, it was suspected that a deficiency of calcium might be involved, since most of the tissue breakdown appeared near the growing tip, and calcium is one of the elements which is not readily translocated. Therefore, during the past year several tests have been carried out with this idea in mind. Using the susceptible variety Rutgers, it has been shown that increasing the supply of calcium from 50 to 250 parts per million decreased susceptibility without producing any consistent change in the rate of growth. An increase in the calcium level of the culture solution resulted in a higher level of calcium in the young growing tip (Table 2).

Table 2. Effect of calcium levels on growth and severity of crease-stem (Average of 16 plants harvested after 5 weeks in solutions).

Ca (p.p.m.)	Green Weight (gms.)	Symptoms* External	Symptoms* Internal	Calcium in tip (%)
50	164.0	1.5	3.9	0.25
250	156.4	0.4	1.4	0.59
Sig. Diff.	15.8	0.4	1.0	0.13

* Severity: Range 0-4

These results with calcium, together with the recent findings of Geraldson (1) on the effectiveness of calcium sprays in controlling black-heart of celery, suggested the possible use of such sprays as a control of crease-stem. However, weekly spray applications using 0.05 molar solutions of calcium nitrate, calcium chloride or calcium chelate, had no noticeable effect on the relative susceptibility of the Rutgers variety.

Conclusions

The experimental work to date indicates that rapidity of growth, nitrogen source and calcium level acting separately or together are important factors in governing the severity of crease-stem of tomato. Further study is now underway on each of these factors.

The evidence still supports the hypothesis advanced in 1952 (4) that crease-stem occurs during periods of rapid growth and seems to be associated in some way with a temporary shortage at the growing point of one or more minerals. Most of the data accumulated this past year indicate that calcium may be an important factor in this connection.

Our only advice to the commercial grower at the present time is to avoid any possible over-fertilization of the tomato crop during its early stages of growth. Such over-fertilization would render the plants very susceptible under weather conditions favoring rapid plant growth.

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PREVENTION OF SKINNING OF POTATOES

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Since potato consumption per capita has been falling for many years, every effort should be made by the potato industry to present as attractive a product as possible to the potential consumer. Florida-grown potatoes are attractive when washed and handled properly. However, one defect—skinning or "feathering" —mars the appearance of many of the potatoes produced in some of the production areas. Not only do the skinned potatoes appear untidy due to the bits of protruding skin, but the skinned areas may become discolored. This discoloration ranges from a light brown to a very objectionable dark brown or black.

Aside from what might be termed an esthetic objection, skinning may be the cause of a direct economic loss. The skinned areas may offer a means for soft rot to become established. Since soft rot is a grade defect, a buildup in transit could throw the load out of grade or cause it to be rejected.

Another source of economic loss is the greater loss in weight of skinned potatoes as compared to unskinned ones. In tests at Gainesville, skinned and unskinned potatoes, harvested 92 days after planting, were held at 60° F. for seven days and then at air temperature for two days during May of 1951 and 1953. The average percent loss in weight is given below:

	1951	1953
Skinned	7.3	5.2
Not skinned	4.9	3.1

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From the above results it can be seen that the skinned tubers lost 2.4 percent and 2.1 percent more weight in 1951 and 1953, respectively, than those not skinned. These differences were highly significant in 1951 and significant in 1953.

Since skinning occurs mainly during the harvesting and packing operations, any methods to reduce skinning must be applied before or during these operations.

Other states producing early-crop potatoes have recognized the skinning problem and have investigated methods of reducing the amount of skinning. Dietz (1) and Krause (2) of Idaho have reported reductions in skinning when vines were killed 10 to 14 days before harvesting. Kunkel, Edmundson and Binkley (3) got similar results in Colorado.

Studies have been made at Gainesville to determine the effect of vine-killing, delayed harvesting and delayed grading on skinning of potatoes under Florida conditions of spring harvest.

Methods

To determine the effect of delayed harvest on the incidence of skinning, an experiment was conducted using the Sebago variety in 1951 and 1952 in which the potatoes were dug at five-day intervals beginning 90 days from planting.

Another experiment was conducted in 1951, 1952 and 1953 to determine the effect of vine killing upon skinning of potatoes. In this experiment the amount of skinning was compared at the time of killing the vines and 7 and 14 days later. Non-killed check plots were also dug at each date. The Sebago variety was used all three years and, in addition, the