Crown Blight of Cantaloupe

experimental plots established in Imperial Valley to refute or confirm observations made in earlier studies of disorder

R. T. Wedding, J. B. Kendrick, Jr., J. T. Middleton, T. W. Whitaker, G. W. Bohn, R. A. Kortsen, A. O. Paulus

The following article is the second of two progress reports on cantaloupe crown blight studies.

Crown blight—premature breakdown and death of the crown leaves—of cantaloupes in the desert regions of California and Arizona became of economic importance in 1952, when a series of investigations was undertaken to study the factors involved. The usual symptoms of crown blight—a chlorosis and necrosis of leaf tissue—were suspected to be the result, at least in part, of a root system inadequate for supplying water and nutrients to vine and fruit crop.

The high temperature, low humidity conditions—usual in the Imperial Valley during the spring when the crown-set fruit of cantaloupes are undergoing a rapid increase in size—tend to stress the plants so severely that death of the older, less active, leaf tissues might occur. Also, the loss of nutrients—under conditions of inadequate supply—by transfer from the older crown leaves to rapidly developing fruits and growing points could cause the development of chlorosis.

To test the effects of an inadequate root system, experiments in root pruning were conducted. Four treatments were used in the trials: *1*, no root pruning; *2*, roots pruned to a depth of 18″ completely around each hill at a distance of 18″ from the center of the hill; *3*, roots pruned at a radius of 12″ from the crown; and 4, roots pruned at a radius of 9″ from the crown.

There were no significant differences in the appearance of leaf necrosis in the unpruned plants and those pruned 18″ from the crown. The plants pruned 12″ from the crown developed more or less typical crown blight symptoms within 7–10 days after the pruning operation, 2–3 weeks ahead of the unpruned plants. The plants pruned 9″ from the center of the hill suffered a rapid desiccation and death of most of the above-ground portions within 3–5 days.

The symptoms produced by the death of the leaves of the pruned plants were quite distinct from those usually found in crown blight and appeared to result from an almost complete cessation of water supply to the leaves. Even with the severe 9″ root pruning treatment, the youngest leaves were not killed and roots were soon reestablished and vine growth resumed.

During the tests an attempt was made to produce artificially a more favorable balance between the supplying roots and the aerial portions of the plant. All but a fixed number of pollinated flowers were removed to prevent the development of more fruit than could be matured by an inadequate root system without resulting in an excessive drain on the crown leaves. Again, four treatments were used: *1*, removal of all fruit as soon as it could be determined that the flower was set; *2*, removal of all but two fruit from each plant; *3*, removal of all but four fruit from each hill; and *4*, removal of all but six fruit from each hill. In most cases, treatment *4* involved no fruit removal because no more than five or six fruit were set.

No difference was found in the time of crown blight onset between the six-fruited and four-fruited hills, while the appearance of symptoms in the plants with only two fruits was delayed 10–14 days. The plants from which all fruit had been removed did not show symptoms of crown blight up to early June when the experiment was discontinued.

Continued on next page

Bed covering plot at Brawley. The three beds in the immediate foreground show the treatments used. From right to left, plastic covered frame, uncovered check and aluminum covered bed.

CANTALOUPE

Continued from preceding page

The frequent field observation that crown blight usually appeared earlier in the sandy portions of cantaloupe fields also seemed to indicate that a deficient water supply was one factor in producing the disorder. Therefore, two plots were set up in which identical replicated treatments were repeated on a heavy clay soil and adjacent very light sandy soil.

Both plots were irrigated by tensiometer and the soil moisture tension maintained below a value of 800 centimeters of mercury in both locations. This required a much more frequent application of water on the sandy soil than on the clay. The plants on the light soil were delayed an average of three weeks in showing crown blight symptoms—as compared with those on the clay soil—suggesting that crown blight may be easier to control in light soils than in heavy soils if sufficient water is applied.

The importance of irrigation practices in producing crown blight was also demonstrated by a number of irrigation plots maintained in growers' fields in all parts of the Imperial Valley. Adequate irrigation of the test plots by tensiometer resulted in a delayed appearance of crown blight and an increased yield as compared with the growers' usual irrigation practices.

The possibility that a deficiency of one or more micronutrient elements might be responsible for the leaf symptoms of crown blight was investigated by analyzing leaf blade and petiole tissues from apparently healthy plants, leaves of normal appearance from affected plants, and chlorotic and necrotic tissues from plants showing crown blight.

Analyses for magnesium, manganese, boron, iron, copper and zinc were made, in addition to potassium, sodium, calcium, nitrogen and phosphorus. No consistent differences in concentrations of any of the elements—except phosphorus—could be detected between healthy leaves from unaffected plants and apparently healthy leaves from plants showing crown blight. Phosphorus was lower in the leaves from the affected plants.

Severely affected leaves showed decreases in most of the minor elements as well as nitrogen, potassium and phosphorus. However, those differences seemed more likely to be related to the death of the leaf as an effect than as a cause. The normal leaves from the affected plants were of the same physiological age as the blighted leaves. Testing leaves of the same age was possible because crown blight frequently shows an alternate leaf pattern in affecting a single runner.

Early in the studies, the possibility that crown blight was due to the activity of soil-inhabiting fungi was considered and for several years attempts were made to affect the occurrence of the disorder by soil fumigation. A commercial soil fumigant—Vapam, sodium -N-methyldithiocarbamate—was applied to plots in a number of locations in the Imperial Valley. In no case has there been a detectable decrease or delay in the incidence of crown blight in the treated plots. The young plants are frequently more vigorous in the fumigated soil, but the differences in plant vigor have not persisted until the time of fruit set.

The results of the soil fumigation tests do not eliminate soil fungi as possible causative agents for crown blight. The phytotoxic nature of the fumigant makes it necessary to apply it well ahead of planting, and its effect is mostly dissipated by planting time. Samples taken from fumigated soil show that reinvasion by fungi is rapid and complete with respect to probable pathogens of cantaloupe roots.

Root-Shoot Ratio

During a study in the 1954–55 Imperial Valley spring cantaloupe season, attempts were made to alter the root-shoot ratio of the plants by manipulation of soil temperatures and the microclimatic environment of the vines. Several types of coverings over the bedded plants were used. The plot was replicated and treatments included a normal south-facing cantaloupe bed; a bed shaded with several layers of cheesecloth suspended 2′ above the bed, reducing the light intensity under the shade to approximately one half that normally found; a bed covered with a 3′ wide strip of paper backed aluminum foil with the reflective surface upwards; and a bed covered with a 3′ strip of black asphalt impregnated paper. All coverings were installed on the southern slope of the triangular shaped beds used in the area.

The differential treatments were initiated at the time the hot caps were removed in late March. At that time recording thermocouples were installed in all beds 6″ below the soil surface in the plant row and 1′ in the air above the plants to obtain a continuous record of the temperature changes resulting from the treatments. Alterations in average soil temperatures as great as 10°F were brought about by the treatments.

The soil under the cheesecloth shade was consistently cooler than in the other treatments, and the soil under the black asphalt paper had the highest temperature. The soil temperature of the uncovered bed was slightly lower than that under the asphalt paper. The soil temperature in the aluminum covered bed was intermediate between that in the uncovered and the shaded beds.

Crown blight occurred first and most severely under the cloth shade. The plants in the aluminum covered bed were the last to show symptoms. This ranking was the same whether crown blight was rated subjectively by several different observers or was related to the date at which a decrease in the average fresh weight of vines in the plot was first found. The decrease in fresh weight is thought to be a sensitive index of crown blight, because plants not affected normally increase in fresh weight until well into the harvest period. Affected plants undergo an earlier decrease in the average fresh weight of the vines.

The average weight and number of roots were greatest in the aluminum covered bed, where crown blight appeared last. The average root weight and number were least in the shaded plot, where the symptoms first appeared.

The ratio of root weight to shoot weight—which indicates the size of the aerial portion of the plant relative to the roots which must supply nutrients and water for the shoot—was greatest for the aluminum covered plot, and least for the plants in the shaded plot. The plants in which crown blight symptoms first appeared were also the plants with the smallest root system relative to the size of the vine. This fact tends to confirm the idea that an inadequate root system—for whatever reason—is related to the

Recovering cantaloupe roots from soil sample. Cylindrical core from soil probe placed in nylon net bag and the soil removed by the action of an agitator washing machine. Roots are then carefully picked out, counted, weighed and fungus isolations made.

development of crown blight. The aluminum covered plot showed the greatest yield of both numbers and weight of marketable fruit and the smallest percentage of culls of any of the treatments, while the shaded plants produced the poorest yield on either a number or weight basis.

The growth of cantaloupe roots and vines was significantly correlated with the temperature at 6" below the soil surface when the temperature is expressed as degree-days—heat units—above a 60°F base temperature. This may indicate that a soil temperature in the vicinity of 60°F is required for significant amounts of growth to occur and that growth is dependent on temperature at higher levels.

Recoveries of fungi from soil and root samples taken from the test plots indicated that some root pathogens might be related to the incidence of crown blight.

Studies in 1955–56

The results of the 1954–55 experiment led to the establishment of a similar plot in the 1955–56 season for continued attempts to alter the temperature of the soil in which cantaloupe plants were growing and—in addition—to maintain two moisture levels in the plot.

One of the moisture levels was adequate for the good growth of cantaloupes. The second moisture level was higher because water was supplied by the usual furrow irrigation and by a smaller furrow running along the peak of the slanting bed. The smaller furrow was intended to produce a high moisture level in the upper-central portion of the bed, where the previous year's study had shown a large root population but a rather low moisture content after the time of the first fruit set.

The bed covering treatments in the 1955–56 studies consisted of an untreated check; an aluminum foil covering of the type used previously; and a polyethylene plastic covered cold frame 3′ wide with a 4" air space between the soil—covered with asphalt impregnated paper—and the plastic covering. The 4" space was sealed by packing soil around the frame. As a result, temperatures in the soil under the frames were raised appreciably, even during the coldest part of the winter.

The bed coverings were applied at planting—middle of December—with provision for hot cap covers over small holes in the aluminum foil. No hot caps were needed for the plastic covered beds, because the plants were protected by the cold frames.

When the plants in the cold frames were ready to be uncovered, a cardboard sleeve was placed around the stems of the plants in each hill and the top of the sleeve stapled to the plastic. The plants were brought out through small holes in the plastic covering. This was done to maintain the heat trapping effect of the cold frame and thereby produce a maximum elevation of the soil temperature in the beds.

Complete samplings were made eight times during the 1955–56 season, starting in early January before the hot caps were removed and continuing until early June, when no more marketable cantaloupes remained on the vines.

Root and soil samples were obtained from a regular grid located across the end hill in each plot at every sampling date. This grid provided for samples from each foot laterally across the bed and for three depths of 1′ at each lateral sampling location. On the sampling dates the weight and number of live roots per unit volume of soil; the number of dead roots; the fresh weight of the vines; the fresh weight of immature fruit; the percentage of moisture in the soil; the percentage recoveries of 10 selected species of fungi from both roots and soil, and observational data such as crown blight rating and plant vigor were recorded. In addition, continuous temperature records and tensiometer readings were obtained.

The 1955–56 investigations produced a large mass of data and, although analysis is not completed, information available indicates a high correlation of live root weight and numbers with temperature—degree-days above 60°F base—and with per cent soil moisture. Total vine weights and root-shoot ratios were also correlated with temperatures in each plot.

A highly significant correlation of crown blight rating and numbers of dead roots was found. An increase in the number of dead roots preceded the appearance crown blight in those plots which showed the earliest and most severe symptoms. The populations of several species of fungi were found to be correlated with both crown blight ratings and numbers of dead roots.

Crown blight appeared earlier and made further inroads in those plots with the highest soil moisture, and those with an intermediate temperature level. When crown blight first started to appear, there were sharp lines of demarcation between the blighted plants of one plot and the healthy plants of the adjacent plot in the same row.

In this experiment, the greatest yields of marketable cantaloupes were obtained from the plastic covered beds, where the soil temperatures were highest and crown blight expression was intermediate.

During the 1955–56 season the soil in which seedling cantaloupes were growing was artificially infested with a variety of fungi from cantaloupe roots in an attempt to determine their effect upon growth, fruit production, and appearance of crown blight. Fusarium, Pythium, Rhizoctonia, and Sclerotium were grown on grain and the developing growth placed in a trench 4" deep and 6" away from the seedlings. Plots with and without sterile grain additions provided controls. Measurements of vine weight and length, fruit weight and size, and amount of crown blight were taken periodically through the growing season. Isolations were made from both roots and stems of cantaloupes and the number and kind of fungi present were noted. The results showed that, generally, the addition of grain—with or without fungi—did not increase the incidence nor severity of crown blight in this experiment.

The greatest number of fungi recovered were from cantaloupes inoculated with Pythium. Additions of Pythium to the soil greatly increased the presence of fungi in the crown. Although Pythium may not be the primary causal agent it predisposes cantaloupes to infection by other fungi and possibly provides a mechanism for toxin response in the plant.

These investigations indicate that the leaf symptoms of crown blight are probably caused by a root system inadequate to supply the needs of vines and fruit—during unfavorable weather conditions at the time following crown fruit set—when vegetative and fruit growth is rapid. It seems probable that the inadequacy of the root system is due to pruning of the roots by one or more soil pathogens active under relatively cool and moist soil conditions earlier in the season.

It is likely that the actual situation is by no means so simple and that the symptomology may also represent the effects of toxins produced by root invading fungi, local nutrient deficiencies or a variety of as yet unstudied factors.

Present field work on crown blight is designed for developing methods to overcome or escape the possible root-pruning effects of soil fungi. The pathogenicity of a number of fungi—isolated from cantaloupe roots during the course of these studies—is being investigated.

R. T. Wedding is Assistant Plant Physiologist, University of California, Riverside.

J. B. Kendrick, Jr., is Associate Plant Pathologist, University of California, Riverside.

J. T. Middleton is Plant Pathologist, University of California, Riverside.

T. W. Whitaker is Geneticist, Horticultural Crops Research Branch, U.S.D.A., La Jolla.

G. W. Bohn is Pathologist, Horticultural Crops Research Branch, U.S.D.A., La Jolla.

R. A. Kortsen is Farm Advisor, Imperial County, University of California.

A. O. Paulus is Extension Plant Pathologist, University of California, Riverside.

The U. S. Southwestern Irrigation Field Station at Brawley and the U. S. Soil Conservation Service in Imperial and Riverside cooperated in the studies reported in the above article.