Progress Report Series No. 47 May 1951

AGRICULTURAL EXPERIMENT STATION
of The Alabama Polytechnic Institute, Auburn, Ala.
E. V. SMITH, Director

CONTROL of DISEASES and INSECTS of TOMATOES in ALABAMA

R. L. SELF, Associate Plant Pathologist
W. G. EDEN, Associate Entomologist

Disease and insects are often limiting factors in production of tomatoes in Alabama. Tomato growers in the State have suffered severe losses from diseases and insects for at least the past 2 years.

This report is a presentation and an analysis of results from experiments involving the use of newer chemical compounds in control of tomato diseases and insects.

TOMATO BLIGHTS

Early, late, and Septoria blights are the main fungus diseases of the tomato in Alabama. Late blight has been the most destructive of the three during the past 4 years in northern Alabama. Early blight has caused most of the damage in central and southern Alabama; Septoria blight has caused damage only to occasional fields.

Description

Late blight, a cool wet weather disease of both potato and tomato, is caused by *Phytophthora infestans*. It overwinters in potato tubers--not in the seed of tomatoes and probably not in the soil or crop refuse. It is spread by wind-blown spores and by infected plants obtained from other areas. Symptoms of the disease are purplish-black, rapidly enlarging areas on leaves and stems. Under humid conditions a downy white growth is present on the lower leaf surface. Infected fruits have grayish-green, water-soaked spots, which turn brown and have a firm, rough surface. These spots increase in size. Plants may become infected at any stage of growth.

Early blight is caused by *Alternaria solani*, which may overwinter on the seed surface, in the soil, and old crop refuse. It develops most rapidly under warm, humid conditions and spreads by wind-blown spores. Most damage occurs on the older leaves, beginning soon after fruit start to set. Symptoms on fruit, leaves, and stems consist of irregular, brown, concentrically-marked dead spots, which enlarge up to one-half inch in diameter. The phase that sometimes occurs on the younger stems is known as stem canker and causes breaking over or stunting of young plants. Another species of Alternaria causes nailhead disease. Symptoms of this disease on the leaves and stems are similar to those of early blight, but the fruit lesions are sunken and are about the size of a nailhead.

Septoria blight is caused by Septoria lycopersici which produces spores that are spread by splashing rain. The organism overwinters on infected crop refuse of tomato, Jimson weed, horse nettle, and ground cherry plants. It is favored by wet seasons and moderate temperatures. Symptoms consist of numerous small water-soaked spots on the leaves. The spots are roughly circular and have gray centers with dark margins. Later the centers show tiny dark specks in which spores are produced. Initial infections occur on the lower leaves of young plants. Under favorable conditions all the leaves may soon be killed.

Tomato-Disease-Control Experiments in Central and Southern Alabama

Experiments were conducted with spring tomatoes at the Gulf Coast Substation, Fairhope, in 1948 and 1949, at the Plant Breeding Unit, Tallassee, in 1949, and at the Chilton Area Horticultural Substation, Clanton, in 1950. All dusts were applied with hand dusters at rates to give good coverage of the plants, ranging from about 10 pounds per acre when the plants were small to about 40 pounds near the end of the season. Sprays were applied with knapsack sprayers at Fairhope and Tallassee, and with a power sprayer at Clanton. The sprays were applied to give complete coverage of both the upper and lower leaf surfaces. Rates varied from about 40 to 125 gallons per acre, depending upon stage of growth.

One per cent rotenone was used for the control of both aphids and fruit worms in 1948 and 1949. In 1950 two materials were used. Aphids were controlled with nicotine sulfate applied as a 3-per cent dust or as a spray of 1 pint of 40 per cent concentrate per 100 gallons of water. Fifty per cent cryolite dust or 6 pounds of 90 per cent cryolite per 100 gallons of water was used for fruitworm control.

Substantial yield increases followed the application of all fungicidal dusts except Phygon XL, Tables 1 and 2. In 1948 and 1949, 6.5 per cent zineb (zinc ethylene bisdithiocarbamate) dust resulted in yield increases of 24 and 43 bushels, respectively, over those from the 6 per cent metallic copper treatment. On the other hand, the 6 per cent metallic copper treatment resulted in 43.3 bushels more than the 6.5 per cent zineb in one experiment in 1949. Since the lowest yield increases in 1949 were realized from the use of 3.9 per cent zineb, 5 and 7 per cent zineb dusts were tested in 1950. The copper dust was also increased to 7 per cent metallic copper.

Five per cent zineb gave the highest yields of the dusts tested at Clanton in 1950. Both 7 per cent metallic copper and 7 per cent zineb appeared to be somewhat toxic to the plants.

At Fairhope, Dithan D-14 spray reduced yields by 45.0 and 118.3 bushels per acre, respectively, in 1948 and 1949. It increased the yield 20.6 bushels at Tallassee in 1949. Since early-blight control was excellent at both locations, the poor performance appeared to be due to toxicity of the material to the plants. This toxicity was very pronounced at Fairhope, where it caused plant stunting and leaf malformations similar to that of 2,4-D injury. A yield reduction of 19.6 bushels (26 per cent) was also recorded at Clanton for liquid Parzate, a compound similar to Dithane D-14.

Table 1. The Effect of Three Fungicidal Dusts and of Dithane D-14 Spray on the Yield of Marketable Tomatoes, Fairhope and Tallassee, 1948 and 1949

Treatment	Yield per acre 1/ Fairhope 1948 2/ 4 replicates	Fairhope 1949 3/ 5 replicates	Tallassee 1949 4/ 5 replicates
	Bushels	Bushels	Bushels
No treatment	405.6	303.0	248.3
Copper dust, 6 pct.	477.3	379.6	269.0
Zineb dust, 3.9 pct.	____	322.6	280.0
Zineb dust, 6.5 pct.	501.6	336.3	312.3
Dithane D-14 Spray (2 qts. plus 1 lb. $ZnSO_4$ + 1/2 lb. lime)	361.6	184.6	270.3

1/ One bushel contains 60 pounds.
2/ Fungicides were applied 7 times at 7- to 10-day intervals from April 17 to June 12.
3/ Fungicides were applied 8 times at 7- to 10-day intervals from April 9 to June 18.
4/ Fungicides were applied 11 times at 4- to 10-day intervals from June 1 to August 16. Five of the applications were washed off within 24 hours and were reapplied.

Table 2. Effects of Fungicidal Sprays and Dusts on the Yields of Marketable Tomatoes, 1950

Treatments	Average yield per acre, 4 replications		
	Clanton1/	Cullman2/	Etowah3/
	Bushels	Bushels	Bushels
Phygon XL dust	61.6	___	___
Zineb dust, 7 pct., (Z-78 formulation)	87.0	72.0	___
Zineb dust, 5 pct., (Z-78 formulation)	96.0	76.3	___
Copper, 7 pct., (Tribasic)	88.3	53.0	___
Zineb, 7 pct., alternating with copper, 7 pct., (Tribasic)	___	62.6	___
Liquid Parzate (2 qt. + 1 lb. $ZnSO_4$ + 1/2 lb. lime/100 gal.)	54.6	92.6	170.9
Dithane D-14 (2 qt. + 1 lb. $ZnSO_4$ + 1/2 lb. lime/100 gal.)	___	89.0	215.6
Z-78 Concentrate (2 lb./100 gal.)	___	73.3	211.9
Parzate Concentrate (2 lb./100 gal.)	___	___	170.3
Tribasic Copper Spray (4 lb./100 gal.)	___	___	174.6
Copper A Spray (4 lb./100 gal.)	___	___	174.6
Phygon Spray (3/4 lb. Phygon XL/100 gal.) ...	___	___	184.3
No treatment	74.3	39.3	110.6

1/ Seven applications between May 9 and June 16. The last two applications were washed off within 24 hours. Early blight was severe, but early termination of the experiment prevented proper evaluation of effectiveness of the various treatments.
2/ Nine applications between August 9 and September 27. No application between August 22 and September 7. Early infections of mosaic and late blight.
3/ Three early aerial applications of copper dust plus nicotine sulfate to the entire plot, followed by eight applications between August 8 and October 4. August 17, 24, and September 4 applications were washed off within 24 hours.

Tomato-Disease-Control Experiments in Northern Alabama

An experiment was conducted with fungicidal dusts and sprays on fall tomatoes in 1950 at the North Alabama Horticultural Substation, Cullman. A spray plot was run simultaneously in Etowah County. Sprays were applied to the Etowah plot with a power sprayer. All other materials were applied with hand equipment.

Although late blight was severe, data from the Cullman plot were somewhat unreliable because of early infection of all plants with tomato mosaic. All materials in the Cullman plot gave good control of late blight. The highest yields were obtained from Liquid Parzate and Dithane D-14 sprays. The highest yielding dust treatment was 5 per cent zineb. The 7 per cent zineb dust was toxic to the plants, resulting in dead and puckered leaf areas. Noticeable stunting resulted from use of 7 per cent metallic copper.

All treatments except Phygon gave excellent control of late blight on the fruit and foliage in the Etowah plot. Phygon resulted in poor late blight control even though a high yield of marketable greenwrap fruits resulted.

During the period when late blight was most severe, 28 and 64 per cent of the culls from the Phygon and no-treatment plots, respectively, had late blight. At the same time only a trace of the culls from all of the other treatments were infected with late blight. The high yield of the Phygon treatments was attributed to the better fruit worm control from the use of DDT rather than cryolite, as suggested by the manufacturer of Phygon.

All sprays in the Etowah plot resulted in yield increases of 60 to 105 bushels per acre. The compounds fell into the following four classes rated from greatest to least yield increases of marketable green-wrap fruit:

1. Dithane D-14 (105 bushels) and Dithane Z-78 (101.3 bushels)
2. Phygon spray (73.7 bushels)
3. Tribasic copper and Copper A (64 bushels each)
4. Liquid Parzate (60.3 bushels) and Parzate concentrate (59.7 bushels).

INSECTS of TOMATOES

Tomato Fruitworm

The tomato fruitworm, *Heliothis armigera*, also known as the corn earworm and cotton bollworm, does severe damage each year to the fall tomato crop in Alabama.

The adult of the tomato fruitworm is a moth with a wing expanse of about 1½ inches. Color of the moth varies. In general, the front wings are light grayish brown, marked with dark gray irregular lines and with a dark area near the tip of the wing. The rear wings are white with some dark markings.

The worms vary greatly in color from a light green or pink to brown or nearly black with lighter under parts. They are marked with alternating light and dark stripes running lengthwise of the body. The stripes are not always the same on different worms, but there is usually a double dark line lengthwise of the body in the middle of the back. The head is yellow and unspotted, and the legs are dark or nearly black. The moth lays her eggs singly on leaves of the tomato plant. As the larvae hatch, they feed sparingly while crawling over the leaves of the plant. They finally find their way to the fruits, into which they cut holes and burrow, usually at the stem end. A worm may feed on a single tomato until fully grown, or it may move from one tomato to another, injuring several before it completes its growth. The mature worm leaves the fruit and enters the soil, where it changes to the pupal or resting stage. There may be several generations in one season.

Potato Aphid

The most important aphid, or plant louse, of the tomato is the potato aphid, *Macrosiphum solanifolii*.

The potato aphid when full grown is nearly one-eighth of an inch long. It is a clear green or pink glistening color. The insect overwinters as the egg, which is deposited chiefly on roses. The insects may be found regularly on the succulent parts of rose bushes in the spring. During the summer winged forms fly to potato and tomato fields. A generation may be developed every 2 or 3 weeks. Each unmated female may give birth to 50 or more active nymphs in a 2-week period. The tomato vine will become covered rapidly with aphids.

The aphids suck the juices from the leaves and tender portions of the plant. The most noticeable injury is the devitalizing of the blossom clusters so that the blossoms fall and no tomatoes are set. The aphid may also cause serious injury by infecting tomato plants with virus diseases. Tobacco mosaic can be carried from one plant to another by this insect. Severe stunting of plants may result from early infection with mosaic, and the yield may be drastically reduced. In the fall the aphids move back to roses or other favored overwintering plants. On these plants wingless, egg-laying females develop. After mating occurs, the winter eggs are laid on the leaves and stems of the rose.

Tomato-Insect-Control Experiments

Two experiments were conducted in 1950 on control of tomato insects on fall tomatoes. A test at the North Alabama Horticulture Substation, Cullman, included controls for both the aphid and fruitworm. An experiment conducted on an Etowah County farm included only controls for the tomato fruitworm.

Both experiments involved the use of insecticidal dusts. The dusts were applied by hand-operated rotary dust guns. Eight applications of dusts were made at weekly intervals during August and September. The dusts were applied to give complete coverage of the plants. The rate varied from 10 pounds per acre when the plants were small to 40 pounds per acre near the end of the season. The dusts included 6 per cent zineb (Z-78 formulation) for blight control. The plots consisted of five rows of tomatoes 50 feet long. The treatments were replicated four times and were randomized. The yield data were obtained by harvesting worm-free tomatoes from the three inside rows of each plot. The results of the experiments are presented in Tables 3 and 4.

Table 3. Yield of Marketable Tomatoes Following Application of Insecticidal Dusts for Fruitworm and Aphid Control, North Alabama Horticulture Substation, Cullman, 1950[1]

Treatment	Yield per acre	Increase over no treatment
	Bushels	Bushels
No fruitworm insecticide; aphicide only	96	—
Cryolite (50 per cent sodium fluoaluminate)	119	23
Cryolite (50 per cent sodium fluoaluminate); aphicide	121	25
Methoxychlor, 5 per cent; aphicide	182	86
DDD, 5 per cent; aphicide	219	123
DDT, 5 per cent; aphicide	161	65
LSD, 5 per cent level	21	

1/ All plots received dust containing 6 per cent zineb (Z-78 formulation) for blight control. Treatments indicated as receiving aphicide were dusted twice with 3 per cent nicotine sulphate for aphid control.

Table 4. Yield of Marketable Tomatoes Following Application of Insecticidal Dusts for Control of Tomato Fruitworm, Gilliland farm, Etowah County, 1950

Treatment1/	Yield per acre	Increase over no treatment
	Bushels	Bushels
None	79	—
Cryolite (50 pct. sodium fluoaluminate)	105	26
Methoxychlor, 5 pct.	108	29
DDD, 5 pct.	139	60
DDT, 5 pct.	99	20
LSD, 5 pct. level	29	

1/ All plots received two applications of 3 per cent nicotine sulphate dust for aphid control. Six per cent zineb (Z-78 formulation) was included in all dusts for blight control.

Aphids did not become numerous enough at any time during the season to seriously affect the plants. Two applications of 3 per cent nicotine sulphate dust resulted in a yield increase of only 2 bushels of marketable tomatoes per acre, Table 3. The tomato plants in all plots in this experiment were severely damaged by early infection with tobacco mosaic. It is not known to what extent this disease was spread by the aphids.

DDD was superior to the other insecticides for fruitworm control. An increase of 123 bushels per acre was obtained following its use at Cullman and 60 bushels per acre on the Etowah County farm. These yields were significantly greater than those resulting from use of any other insecticide. Methoxychlor was the next best insecticide at both locations. There was an increase of 86 bushels per acre following its use at Cullman, but only 29 bushels on the Etowah County farm. DDT was significantly better than cryolite at Cullman where all treatments were significantly better than no treatment. Only DDD and methoxychlor gave significant control on the Etowah County farm.

SUMMARY

Disease Control

1. Both 5 and 6.5 per cent zineb (zinc ethylene bisdithiocarbamate) dusts gave good control of early and late blight and resulted in high yield increases.

2. The 3.9 per cent zineb dust was inferior to 6.5 per cent zineb dust in both disease control and yield, but it was better than no fungicide in both trials in 1949.

3. Both 7 per cent zineb and 7 per cent metallic copper controlled early and late blight, but they were toxic to tomato plants. They resulted in lower tomato yields than did 5 per cent zineb in central and northern Alabama in 1950.

4. Six per cent metallic copper gave high yield increases at Fairhope through control of early blight when late blight was not present.

5. Phygon XL dust resulted in reduced yields at Clanton and gave poor control of early blight.

6. Dithane D-14 spray resulted in reduced yields at Fairhope in 1948 and 1949, while controlling early and late blight. Liquid Parzate, a similar compound, behaved in a similar manner at Clanton in 1950.

7. All materials tested in an Etowah County spray plot gave good yield increases. All gave good late blight control except Phygon XL, high yield from which was attributed to better fruit-worm control. The compounds listed according to bushels of yield increase over that of the check plot were as follows: Dithane D-14 (105); Dithane Z-78 (101.3), Phygon XL (73.7), Tribasic Copper and Copper A (64 each), Liquid Parzate (60.3), and Parzate Concentrate (59.7).

Insect Control

1. Aphids did not do serious damage to the tomatoes and control procedures resulted in very low yield increases in the one-year test.

2. Significantly higher yields were obtained following the use of 5 per cent DDD than from any other insecticide tested.

3. Five per cent methoxychlor was significantly better than DDT or cryolite at Cullman. It was not significantly superior to DDT and cryolite on the Etowah County farm.

4. DDT was significantly better than cryolite at Cullman, but not on the Etowah experiment.

5. All insecticides were significantly better than no treatment at Cullman, while on the Etowah plots only DDD and methoxychlor were significantly better.