THE PLANT DISEASE REPORTER

Issued By

THE PLANT DISEASE SURVEY

Division of Mycology and Disease Survey
BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING
AGRICULTURAL RESEARCH ADMINISTRATION
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SUPPLEMENT 165

THE 1946 EPIPHYTOTIC OF LATE BLIGHT OF TOMATO

Supplement 165

November 15, 1946

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THE PLANT DISEASE SURVEY
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Plant Industry Station Beltsville, Maryland

THE 1946 EPIPHYTOTIC OF LATE BLIGHT ON TOMATO

Plant Disease Reporter
Supplement 165 November 15, 1946

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SUMMARY

In order to present as complete a record as possible on the final outcome of the threatening tomato late blight outbreak reported in Supplement 164, the Survey asked its collaborators to summarize their information on certain phases of its development in their States. The answers are given in this Supplement. Since this summary deals primarily with late blight on tomato, reports of the disease on potato that were included in some of the answers will be placed in a future issue of the Plant Disease Reporter.

Certain specific questions asked in the request sent to collaborators are repeated below, with brief summaries of the answers to some of them.

1. Can you supply estimates of loss from your State?

Losses reported are listed in Table 1. It is of interest to note that in spite of the epiphytotic many States reported an unusually good crop.

Table 1. Losses from late blight on tomato, 1946. (See also map, Figure 1).

State	Loss reported
Alabama	75% early commercial crop (800 acres southeast) 25% late crop (8000 acres north and central)
Florida	40% Homestead area (Borders, PDR 30 (5): 170. May 15) 50% Palm Beach-Martin-Broward County area (Townsend et al. PDR 30 (7): 240. July 15)
Georgia	Early green wrap fields 60-70%; in late planted about 40%
South Carolina	From 10 to 65% in principal tomato-producing counties, average 55%
North Carolina	In Eastern, 5% early, 25% late crop Western, 90%, in home garden and commercial

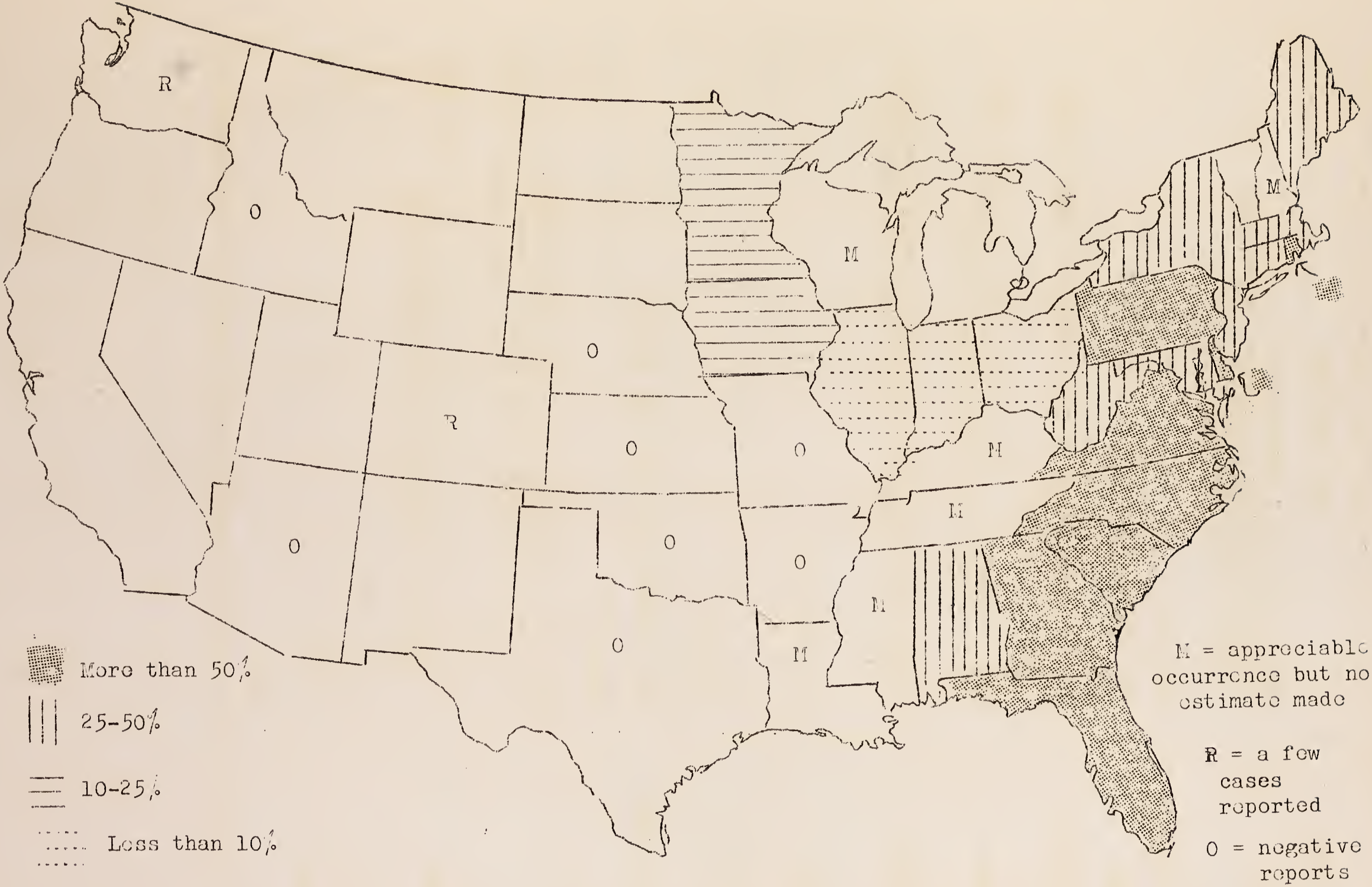


Figure 1. Loss from tomato late blight in 1946. (See also Table 1.)

Table 1. Losses, cont.

State	Loss reported
Virginia	Green wraps 75%; canning 50% In Norfolk-Eastern Shore area green wraps 75%; canning crop negligible
West Virginia	40-50%
Maryland	40% of potential crop
Pennsylvania	60% average, range 5-95%; severe on young plants and mature crop
Delaware	50% of potential yield, 3/4 of this loss on late, 1/4 on early and mid-season tomatoes
New Jersey	20-30% potential crop in south; 30-40% in central; 50-60% in north. Largest acreage in southern half
New York	Possibly 25%
Connecticut	25%
Rhode Island	70-90%
Massachusetts	50% commercial; 75% home garden
Maine	25-35%
Ohio	8% -- 3% fruit loss, 5% from plant stand. 3% loss in canning area, 20-25% staked tomato area. About 50% of fields reset to some degree
Indiana	Perhaps 10%, including early stand losses and subsequent foliage and fruit destruction.
Illinois	Less than 1%
Minnesota	10-20%
Iowa	15%

2. Was the loss on young plants or did it occur on the mature crop?

In general, major damage was to maturing plants, from yield reduction and fruit infection. However, in many States infection of young plants, whether imported or home-grown, was severe and caused a considerable amount of replanting and some abandonment.

3. What control measures were taken?

Table 2 lists the materials used for spraying or dusting in the States reporting on control measures.

Table 2. Fungicides used for the control of tomato late blight, 1946

Spraying materials reported	State	Dusting materials reported	State
Dithane plus zinc-lime	Florida	Fixed copper compounds	Maryland
	Delaware		Pennsylvania
			West Virginia
Fixed copper compounds	Maryland		Ohio
	Pennsylvania		Illinois
	North Carolina		North Carolina
			South Carolina
Neutral copper	Delaware		
	Massachusetts	Neutral copper	Delaware
			Massachusetts
Metallic copper	Ohio		Maine
Dithane Reaction Product (He 178e)	Delaware	Bordeaux	Massachusetts
		Copper-lime	West Virginia
Dithane	Connecticut	Copper	Virginia
	Massachusetts		Indiana
	Alabama		
Phygon	Connecticut	Insoluble copper	New York
Bordeaux	Connecticut		
	Massachusetts		
	Maine		
	Virginia		
	West Virginia		
	Ohio		
	Pennsylvania		

Table 2. Fungicides, cont.

Spraying materials reported	State	
Fermate or Zerlate and Bordeaux in staggered program	New York	
Insoluble copper	New York	

4. Which gave better results, spraying or dusting?

Most of the answers commenting on this subject reported spraying as more effective. Generally, however, lack of equipment and late starting, rather than type of application, were responsible for poor control.

5. If dusting was done by airplane was it effective?

See Table 3. As with other methods of application, late starting was partly responsible for mediocre results.

Table 3. Effectiveness of airplane dusting for control of tomato late blight, as reported in 1946.

State	Effectiveness of airplane dusting
Georgia	Less effective than tractor dusting
South Carolina	In one case no basis for comparison; in another, both plane and power dusting moderately successful
Virginia	Not very effective
Maryland	Most dust applied with airplanes; results disappointing. One case spraying by airplane a failure.
Pennsylvania	Checked disease but less effective than ground dusting
Delaware	Last choice of methods

Table 3. Airplane dusting cont.

State	Effectiveness of airplane dusting
New Jersey	Last choice
New York	Airplane dusting effective where used -- started early
Ohio	Partially effective
Indiana	Dry weather confused results
Illinois	Believed effective

6. About what percentage of the growers in your State attempted control measures?

This is summarized in Table 4

Table 4. Percentage of growers attempting control of tomato late blight, 1946

State	Percent of growers using control
Louisiana	Probably none
Mississippi	Very few if any
Florida	Probably only the larger growers
Georgia	100% of plant growers; probably less than 1% of green-wrap growers
Alabama	Not many
South Carolina	10-15% of commercial acreage
North Carolina	Eastern 1% (including home gardeners) Western 10% (home gardeners and market gardeners)
Virginia	Very few; 5-10%
West Virginia	20% of growers = about 10% of acreage
Maryland	About 10% commercial acreage

Table 4. Growers attempting control, cont.

State	Percent of growers using control
Pennsylvania	Very few equipped; 20% tried but only 5% with proper equipment
Delaware	10% of growers = 15% acreage
New Jersey	Not known but practically entire supply of suitable spray materials bought out during tomato season
New York	Not known. Growers not equipped
Connecticut	Very few
Rhode Island	Very few -- not prepared
Massachusetts	5-10%
New Hampshire	About 10% (home gardeners)
Maine	5%
Ohio	10%; in canning area about 50%
Indiana	See text
Wisconsin	Probably none
Minnesota	Only a fraction
Iowa	None

7. Are you preparing expanded control facilities for possible use next year?

For the most part the answer is "Yes", at least to the extent of watching for threatening infections and warning growers in time to take preventive measures.

8. Do you have any specific observations on the manner of dissemination this season?

9. Can you correlate weather variation with fluctuations in the disease?

10. Did you observe any differences in varietal reactions?

The reader is referred to the various reports for discussions on these three topics.

11. Did you observe the late blight fungus on hosts other than tomatoes and potatoes?

Since "No" is the general response to this question it is omitted from most of the answers. In New Jersey peppers showed suspicious symptoms but the cause could not be determined. Infection of pepper was reported from Indiana. In Supplement 164 *Solanum sarachoides* was reported to be a carry-over host in California potato fields.

STATE REPORTS

TOMATO LATE BLIGHT IN LOUISIANA

L. H. Person

There is very little further information regarding the seriousness of late blight and losses from it in this State. We had no reports of a serious disease from county agents or growers from our small commercial area; therefore I would surmise that no serious outbreak occurred there.

The following answers are based on observations made on the Experiment Station plots and in gardens in the vicinity of Baton Rouge.

1. No loss estimates are available.

2. Losses occurred primarily on the mature crop (infection on fruits).

3. No control measures were taken.

6. Probably no growers attempted control.

9. The disease developed during a cool, continued rainy spell, and became less noticeable as the weather cleared and it became warmer.

Most of the commercial area is planted somewhat later than the plots examined by me and probably escaped serious damage, as the crop would have matured under more favorable growing conditions.

LOUISIANA STATE UNIVERSITY
BATON ROUGE. OCTOBER 16

TOMATO LATE BLIGHT IN MISSISSIPPI

John T. Presley

(See also PDR 30 (9): 340-341. September 15)

1. We are unable to supply estimates of loss from our State.

2. The loss occurred on the mature crop rather than on young plants.

3. Very little if any control measures were taken.

7. We are preparing to inaugurate a control program for next year, principally in the Crystal Springs area.

8. We do not have specific observations on the manner of dissemination this season but all evidence points to the organism being windborne.

9. There was a definite correlation between weather and fluctuations in the disease, with late blight appearing in most severe form during rainy periods and becoming appreciably less destructive following a few days of clear weather.

10. We did not observe differences in varietal reaction but certain lines carried at the Crystal Springs Station were definitely more resistant that others.

MISSISSIPPI AGRICULTURAL EXPERIMENT STATION
STATE COLLEGE. OCTOBER 14

TOMATO LATE BLIGHT IN KENTUCKY

W. D. Valleau

I made no study of the disease but fruits that were decaying were sent in from several parts of the State. The disease usually commenced as leaf infections and finally destroyed the majority of the fruits remaining on the plants after the leaves were practically dried up. Some gardens escaped nearly completely.

KENTUCKY AGRICULTURAL EXPERIMENT STATION
LEXINGTON. OCTOBER 1

TOMATO LATE BLIGHT IN GEORGIA

Edward K. Vaughan

Dr. B. B. Higgins has referred your request for information on tomato late blight to me.

1. In early fields of "green wrap" tomatoes losses were probably 60 to 70 percent of the crop. Losses in late planted "green wraps" probably did not amount to more than 40 percent.

2. The late blight infection was first noticed on "green wraps" but caused considerable damage on both young plants in the field which were being grown for shipment to northern growers and on the mature plants.

3. Except in the tomato plant fields practically no control measures were used because the disease was not recognized by most growers until it was too late to control it effectively, and because most growers did not have any equipment for applying sprays. All of the tomato plant fields were either sprayed or dusted but control left much to be desired. Complaints received from northern canning companies and northern tomato farmers indicate that a considerable amount of disease was present in the plants at the time that they were shipped.

5. In general, I believe dusting with tractors was much more effective than airplane dusting.

6. One hundred percent of the tomato plant growers applied control measures but probably less than 1 percent of the growers of "green wrap" tomatoes made any attempt to control the disease.

7. Certification of seedling tomato plants already requires that all fields be dusted or sprayed with proper fungicides at seven- to ten-day intervals. Because of the seriousness of the disease situation in 1946 plant growers should devote special care to the thoroughness and timeliness of fungicide applications in 1947. It is probable that the majority of seedling fields will be dusted rather than sprayed next season. Since late blight has never occurred in two successive seasons in Georgia, the green-wrap tomato growers do not anticipate that it will this time and there probably will be little spraying or dusting of the market crop.

9. During periods of warm dry weather the disease did not die out but it ceased spreading and caused no further damage in fields of mature tomatoes. However, as soon as we had three or four rainy days it again spread like wildfire.

Late blight came into the plant producing area late in the season but caused very appreciable losses during the short time that it was present. I doubt that any load of plants leaving the state after May 20 was entirely free from incipient infections.

U. S. BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING
DIVISION OF FRUIT AND VEGETABLE CROPS AND DISEASES
TIFTON, GEORGIA, OCTOBER 11

LATE BLIGHT ON TOMATOES IN ALABAMA, 1946

Coyt Wilson and J. L. Seal

Late blight caused losses of 75 percent or more of Alabama's early crop of commercial tomatoes in 1946. The early plantings amounted to about 500 acres in Southeastern Alabama. The disease appeared to spread from potatoes to tomatoes in May, during periods of heavy rainfall. Very few of the growers were equipped to spray or dust properly, and before equipment and materials could be obtained, serious damage had been done.

The late crop of tomatoes, totaling slightly over 8,000 acres in Northern and Central Alabama, suffered less damage. Rainfall was less, temperatures were higher, and a few of the growers, being forewarned, followed a dusting or spraying program that reduced the damage considerably. Late blight appeared on the plants of the late tomatoes soon after they were set in the field, but, as was true of the early crop, most of the damage was on the mature plants and the ripening fruit. John Bagby, Extension Specialist in Fruit and Vegetable Marketing, estimates that the loss on these tomatoes was approximately 25 percent. This would bring the total loss of commercial tomatoes for the State to approximately 220,000 bushels. Tomatoes in home gardens also suffered considerable damage.

There are no accurate data on the percentage of growers who attempted control measures. Most people did very little or nothing toward controlling the disease. Excellent results were obtained with Dithane spray by one or two growers in central Alabama. Where a thorough job of dusting was done, the results were equally good. It is expected that a high percentage of the tomatoes in Alabama will be dusted next year. Small plantings, less than 10 acres, are the rule, and consequently, very few producers will feel justified in purchasing expensive power sprayers.

In most instances, late blight appeared first in fields reasonably close to infected potatoes. However, the disease did appear in some fields located a mile or more from any potatoes. Dissemination by wind from field to field evidently played an important role.

There was no apparent difference in susceptibility among the standard field varieties. Some selections on the Alabama Agricultural Experiment Station plots at Auburn showed considerably more resistance than some of the commonly grown varieties.

Phytophthora infestans was not observed on any plants other than potatoes and tomatoes this year, but no extensive surveys were made.

ALABAMA AGRICULTURAL EXPERIMENT STATION

TOMATO LATE BLIGHT IN SOUTH CAROLINA

William M. Epps

Late blight appeared on potatoes in South Carolina about the first of May just as early harvesting was beginning. It spread slowly and losses to the potato crop were slight. Very soon afterwards it appeared on tomatoes in the potato-growing coastal area and in Orangeburg County. Later in the month it appeared in Dillon County. The weather during the most of May was relatively cool with several periods of damp cool weather favorable for the spread of late blight. The advent of hot dry weather early in June completely checked the disease in all of the commercial tomato-producing areas of the State; so that few actively sporulating lesions could be found by the middle of the month.

The damage caused by late blight of tomatoes in South Carolina in 1946 was widespread over the entire State. Losses amounted to almost nothing on certain farms and were almost complete on others. Losses to commercial plantings varied from a low of about 10 percent for Dillon County to a high of about 65 percent in Orangeburg County. The average loss for the entire State due to this disease was about 55 percent. This figure represents a weighted average of loss estimates from the county farm agents in the principal tomato-producing counties. In addition to the damage caused on farms where tomatoes are grown commercially, losses in home gardens were quite general over the State. No attempt was made to estimate the loss in these home gardens.

The loss on tomatoes occurred largely to plants that were nearing maturity. In most parts of the State the disease appeared during the latter half of May from one to two weeks before picking began. The early crop of fruit over the entire area was severely damaged by fruit rot. Damage to the later crop was dependent on the amount of foliage damage caused. In some sections, notably in Dillon County, the damage was largely limited to a rotting of the early fruit. The foliage was not seriously damaged and the later crop was quite good. The losses in such fields were relatively small, estimated at about 10 percent by the Dillon County Agent. In other sections, as at the Truck Station at Charleston and in Orangeburg County, damage to the foliage in many fields was so severe that the later fruits either failed to develop to adequate size or else were badly sunburned and the crop was almost a total loss, even though a period of hot dry weather in early June checked the disease almost completely.

The application of copper fungicides to tomatoes has in past years proved to be of no value in increasing the yields of tomatoes in Coastal South Carolina. Therefore, no fungicide has been applied to the crop at the time the late blight appeared. A fixed copper dust containing

6 percent metallic copper was recommended for use on fields where the disease had not become established. This dust was used by a few growers with variable results. The county agent of Orangeburg County wrote that approximately 5 percent of the farmers in his county used a copper dust, but most of these men started dusting after the disease had become established. Their results were not very encouraging. In Beaufort and Charleston Counties about 50 percent of the tomatoes were dusted. No fungicide was used in Dillon County. It is estimated that only 10 to 15 percent of the commercial tomato acreage in South Carolina received one or more applications of a copper fungicide. In the few known cases where dust was properly applied before blight became established, satisfactory control was obtained. With few exceptions, tomatoes are grown in relatively small acreages as a secondary crop on cotton farms or cotton and tobacco farms. Few of these growers are equipped with adequate dusting or spraying machinery. Only a few larger truck farmers in the coastal truck region have such equipment and it was only on these farms where a satisfactory job of dusting was done.

No instance is known where copper was applied as a spray, so that there has been no opportunity to compare the effectiveness of the spray with that of the dust. Airplane dusting was used on one large farm in Charleston County and at least one in Beaufort County. On the Charleston County farm 4 to 5 applications of a 6 percent fixed copper dust were made within the three weeks after late blight appeared. Effective control was obtained; while a neighbor, a small grower who used no fungicide, lost his entire crop. No power or hand dusters were used in that vicinity so that it was impossible to compare them with the airplane. In Beaufort County both airplane and power dusting were used with only moderate success. The two methods appeared to be about equally effective.

A fixed copper dust containing 6 percent metallic copper will be recommended for use in 1947 only if late blight should threaten. It does not seem advisable to recommend the routine application of copper to tomatoes on the chance that late blight might appear. It will be recommended, however, that those growers, who normally find it necessary to apply an insecticide dust, should incorporate the copper into that dust. A careful check will be made at frequent intervals and contact will be maintained with the Florida and Georgia Stations and, in the event the disease should threaten, the State extension service will be notified and dusting can be started before late blight becomes established in the State. The same fixed copper dust is now recommended for use on potatoes and cucumbers and a supply should be readily available locally on short notice.

Resistance to late blight was noted in several varieties and in many of the breeding lines of the Truck Experiment Station. The most resistant varieties were Garden State and selections from Targinnie Red. Most of the resistant breeding lines apparently inherited their resistance from either the currant tomato, Lycopersicon pimpinellifolium, or Targinnie Red. Several lines, however, that resulted from crosses involving only susceptible parents, showed some resistance. The resistance appeared to be limited to foliage resistance, since the fruits of all lines, with the possible exception of some of the Targinnie Red selections, appeared equally susceptible. The apparent resistance of the Targinnie Red might be attributed to sparse foliage, to the lateness of the selections, or to their tough skin. Thus, even though some variations in susceptibility were noted, no immune or highly resistant material was found and no definite resistance to the fruit rot phase was found.

Late blight lesions were present thoughout the summer on the summer and fall plantings at the Truck Station at Charleston. Observations made on October 17, 1946, indicated that blight was present and was causing considerable damage to fall tomatoes in the station planting. It had not yet become generally distributed over the field.

SOUTH CAROLINA TRUCK EXPERIMENT STATION
CHARLESTON, SOUTH CAROLINA, OCTOBER 18

LATE BLIGHT OF TOMATOES IN EASTERN NORTH CAROLINA

D. E. Ellis

As reported earlier, late blight occurred generally on tomatoes in Eastern North Carolina up to about June 6, when its development was checked by warm weather. The disease remained quiescent until late August when it again became active. It has caused extensive damage to fall plantings mostly in home gardens throughout the area. Losses in the early crop are estimated at about 5 percent and to the late crop at 25 percent. Losses were largely confined to the mature crop but younger plants were affected to some extent. Copper dusts were used much more extensively than sprays but most growers started dusting too late to obtain effective control and it is estimated that less than 1 percent of the growers (including home gardeners) made any attempt to control the disease.

UNIVERSITY OF NORTH CAROLINA
RALEIGH, OCTOBER 30

LATE BLIGHT OF TOMATOES IN WESTERN NORTH CAROLINA

H. R. Garriss

As reported earlier late blight occurred unusually early in the Upper Piedmont and Mountain Areas in 1946. By the first week in June the disease had already caused severe damage on early set tomatoes and in most plant beds in the Southwestern Counties. Severe damage from blight occurred generally throughout the Mountain Area and Upper Piedmont through the summer and early fall. Losses in home garden and commercial plantings for local markets are estimated at 90 percent of the crop.

Fixed copper dusts and sprays were used by 10 percent of the home gardeners and local market gardeners in the Mountain Area. However, applications were not generally begun in time on the early crop to check the disease satisfactorily. Both dusts and sprays gave satisfactory control where properly used on later plantings.

Results obtained by many growers who dusted or sprayed properly in 1946 substantiate claims that fixed copper fungicides will adequately control late blight of tomatoes when applied thoroughly and timely. The Extension program for control of tomato late blight will be expanded in 1947.

UNIVERSITY OF NORTH CAROLINA
RALEIGH, OCTOBER 30

FINAL REPORT ON TOMATO LATE BLIGHT IN VIRGINIA - 1946

S. B. Fenne

The final estimates of the loss caused by tomato late blight during the past season are: green wraps - 75 percent, and canning tomatoes - 50 percent. There was, of course, considerable variation in the severity of the disease in different counties and even in different parts of counties. The loss was primarily confined to maturing crops.

Control measures were recommended at the very beginning of the season and publicity was continued throughout the season. A considerable number of home gardeners either dusted or sprayed their tomatoes and a few commercial growers did likewise. Where dusting with copper was started early and the leaves kept covered, satisfactory control was obtained. Best results, however, were obtained by the use of Bordeaux mixture. In many cases Bordeaux checked late blight even after it had developed to a considerable extent on the plant. Perhaps from 5 to 10 percent of the growers in the State attempted some form of control. However, in most cases, the fungicide was applied too late by inadequate equipment, and in an insufficient number of applications. Growers and home gardeners have been warned that tomato late blight may appear again next year and if it does, they should be prepared to spray or dust.

From numerous observations made during the past season, it appears that tomato late blight was much more severe in those fields adjacent to or nearby potatoes. Late blight appeared early on potatoes throughout the State. Weather conditions were ideal for the development of the disease and in some cases it spread rapidly to tomatoes. During the latter part of August a period of dry weather set in and in most parts of the State the disease was immediately checked to the extent that some tomatoes were produced on formerly heavily diseased plants. However, since the inoculum was present, the disease reappeared after each shower of rain, and late blight is still active throughout Southwest Virginia and doing considerable damage. There have been no observations made on the difference of susceptibility amongst varieties; nor have any other hosts of the late blight fungus been observed.

VIRGINIA POLYTECHNIC INSTITUTE
BLACKSBURG, VIRGINIA, OCTOBER 8

TOMATO LATE BLIGHT IN THE NORFOLK AND EASTERN SHORE AREAS OF VIRGINIA

Harold T. Cook

Mr. S. B. Fenne has sent a report covering his observations in various parts of the State. My report will cover only the Norfolk and Eastern Shore area and will differ in some details from his report.

1. Estimated loss. -- Loss to the early or green wrap crop was about 75 percent. In many fields it was practically 100 percent and the crop was plowed under without picking any fruit. Loss to the canning crop was practically negligible. The disease nearly disappeared about the end of July and an excellent yield of healthier than normal fruit was obtained.

2. Age of plants. -- Loss in the early crop was from reduction in foliage and from infection of the fruit. Probably infection of the fruit was the most serious damage. Damage to the main crop was mostly from reduced foliage and some stunting, but the yield was apparently not greatly affected.

3, 4, 6. Growers were advised to spray or dust when it became evident that low temperatures and high rainfall were going to continue into the summer. Very few of them practiced control measures and no information is available on the results that were obtained. Most of the damage had been done to the early crop before control measures were advised and the disease was on the decrease before they could be applied to the main crop.

5. No data are available on the results of airplane dusting. Recent dusting of fall potatoes by plane indicates that that method of application is not too effective.

7. Standard recommendations for spraying or dusting will be made next season providing weather conditions are favorable for blight development. No general recommendation to spray is planned at present since blight is seldom important on tomatoes in Eastern Virginia.

9. The development of blight this year appears to be definitely correlated with abnormal temperature and rainfall. Studies are being made of this correlation and will be reported later.

10, 11. No observations were made on varietal differences or of the occurrence on hosts other than tomatoes and potatoes.

VIRGINIA TRUCK EXPERIMENT STATION
NORFOLK, VIRGINIA, OCTOBER 21

TOMATO LATE BLIGHT IN WEST VIRGINIA

H. L. Barnett

The following information regarding late blight on tomato and potato in West Virginia during the past season was furnished by Mr. C. F. Bishop and Mr. J. R. Vaughn.

Late blight on tomato may be summarized by briefly answering the questions in your recent letter as follows:

1. The estimated loss over the entire State averaged 40 to 50 percent of the tomato fruits.
2. Loss was to the mature crop; no infection of young plants was observed.
3. The most common control practices were dusting with fixed copper dust or copper-lime dust, and spraying with Bordeaux mixture. Attempts at control were rather spotted and often hapazard. No control measures were taken in the largest tomato-growing areas, since they are located in areas which previous to this year have escaped late blight.
4. In general, spraying gave the better results. However, when dust

was properly applied to achieve adequate coverage and was applied frequently enough, good control was obtained.

5. No dusting was done by plane.

6. An estimated 20 percent of the growers attempted control measures. This represented approximately 10 percent of the tomato acreage in the State.

7. Plans are being made for expanding the control program along three major lines: (a) Custom spraying and dusting; (b) Close cooperation between manufacturers, dealers and the Agricultural Experiment Station to provide more adequate and orderly distribution of control materials; (c) More demonstration plots showing the use of the more effective spray materials.

8. No specific observations were made on the manner of dissemination.

9. In areas where late blight occurred it developed when weather conditions were very favorable. Under the dry conditions during late summer the blight was checked.

10. No varietal differences were observed on tomatoes.

WEST VIRGINIA UNIVERSITY
MORGANTOWN, WEST VIRGINIA, OCTOBER 14

TOMATO LATE BLIGHT IN MARYLAND

R. A. Jehle, F. C. Stark, and C. E. Cox

Late blight of tomatoes was first observed in the three lower counties on the Eastern Shore on June 6. At that time, while a trace of late blight was found in every field visited, it was most severe in tomato fields adjacent to severely affected potato fields. The indication was that potatoes had served as the original source of inoculum. Apparently there was little early spread of the disease out of these three counties as late blight did not appear in serious proportions in the other Eastern Shore counties until later in the season.

During the last of June and early in July late blight appeared in Harford County and the upper part of Baltimore County and soon afterward appeared in other counties of the northern tier. The indication was that it may have spread into these areas from Pennsylvania to the north rather than upward from the Eastern Shore. The disease apparently spread gradually southward through central Maryland, appearing on the western shore in Southern Maryland in August. Spread of the disease followed the abnormal occurrence of cool nights with heavy dews throughout the Piedmont regions and Southern Maryland. In extreme Western Maryland, where drought conditions were general and no late blight was observed on potatoes, the disease appeared in a mild form in most tomato plantings. In home gardens where close planting or a heavy growth of weeds prevented rapid drying of the plants, late blight was severe.

It has been estimated that 40 percent of the potential 1946 crop of tomatoes was lost as a result of late blight. Had late blight not appeared, a bumper crop of tomatoes was indicated. For the most part, fields which escaped or in which late blight was controlled yielded crops well in excess of the 10-year average. On the lower Eastern Shore as well as in the more northern counties losses in some fields approached 100 percent. Such losses were quite prevalent in Worcester County where potatoes are extensively grown.

All of the losses reported in Maryland were from fruit rots and defoliation of mature plants. No cases were observed or reported in which young plants were so severely attacked as to necessitate replanting.

Approximately 10 percent of the total commercial acreage was sprayed or dusted with fixed copper compounds. Orchard sprayers were used extensively in one county with good results. Dusting was more widely practiced than spraying. Some dust was applied with row-type bean dusters but most of it was applied with airplanes. Airplane dusting generally gave disappointing results and the one case in which airplane spraying was tried was a failure. Lack of proper equipment was probably the chief factor that limited the wider application of fungicides. Lack of experience in using fungicides on tomatoes and failure to apply them soon enough were probably chiefly responsible for the disappointing results experienced by many growers. When the first application was made in time and where good coverage was maintained by three or four additional applications, good control of the disease was obtained with fixed copper sprays or dusts.

Growers and canners are being urged to make preparations now to apply fungicides next year should late blight appear.

No differences in varietal reactions were observed.

The late blight fungus was not observed on plants other than tomatoes and potatoes.

UNIVERSITY OF MARYLAND
COLLEGE PARK, MARYLAND, OCTOBER 19

TOMATO LATE BLIGHT SITUATION IN PENNSYLVANIA, 1946

R. S. Kirby

1. The average loss from late blight in Pennsylvania in 1946 is estimated at about 60 percent. The loss ran as high as 90 to 95 percent in some south central counties like Bedford, Blair and Juniata and was as low as 5 percent in Erie County.

2. Loss on Young Tomato Plants: Late blight was found on May 21 on heeled-in tomato plants in Columbia County. Survey of over a hundred tomato fields in May and June showed that late blight was carried into a large proportion of the fields on young plants. Wet cool weather enabled the fungus to spread in the fields and kill out many small plants. In numerous fields growers had to replant two or three times and set 6,000 to 9,000 plants per acre instead of the normal 3,000 plants. In Columbia County over 200,000 young plants were killed with blight. In Schuylkill County blight killed so many young plants that 700 acres were plowed down. Late blight was very severe on the mature crop.

3. Control measures taken: As soon as late blight was found news articles were sent out. On June 12 a spray letter was sent in all commercial tomato growing counties to tomato growers urging them to spray or dust at once all tomato fields in which late blight was present. A careful check on blight was maintained and a second spray letter was sent to tomato growers on July 10 and a third letter on August 2. A general summary of the tomato late blight situation was prepared and over 6,000 copies were distributed early in August.

4. Spraying was more effective than dusting but growers who dusted often enough and maintained coverage saved a good proportion of their crop. Sprays were needed at 7- to 10-day intervals and dusts at 3- to 6-day intervals.

5. Airplane dusting checked blight but was apparently not quite as effective as ground dusting. It appeared that the airplane operators did not get enough dust on the plants.

6. Very few growers were equipped to spray or dust. Twenty percent tried some spraying or dusting but only about 5 percent had equipment to do the job properly. In Luzerne County two tomato spray rings were started in 1946. These did a very fine job and excellent blight control was obtained. [See report by Weaver and Burke, page 344]

7. For 1947 growers will be urged to plant tomatoes either in (1) rows 5 1/2 to 6 feet between, or (2) leave driveways every 12 to 14 rows in the field so the tomatoes can be sprayed with row crop sprayers,

or (3) plant tomatoes in narrow fields so they can be sprayed with orchard equipment. A tentative spray schedule will be put out and a careful watch will be maintained for late blight. Tomato spray service letters will be sent out as in 1946.

8. The fungus causing late blight was apparently wind-borne. It became destructive first in fields planted with infected plants and appeared much later in fields planted with blight-free plants. (Late June to early August).

9. Weather conditions constituted one of the most important factors. Dry periods in June and July checked the disease in certain areas such as Berks and Lehigh Counties, while nearby counties like Chester with more rainfall had severe loss in July. A dry period in late September and early October checked blight and allowed many late ripening tomatoes to mature.

10. There were no striking differences between the common canning varieties grown in the State.

11. Late blight was not observed on hosts other than tomato and potato.

PENNSYLVANIA STATE COLLEGE
STATE COLLEGE

LATE BLIGHT OF TOMATOES IN DELAWARE - 1946

J. W. Heuberger

Late blight disease caused a loss of approximately 50 percent of the potential yield. Three-quarters of the loss occurred on late tomatoes and one-quarter on early and mid-season tomatoes. In individual fields, losses ranged from a trace to 50 percent on early and mid-season tomatoes, whereas on late tomatoes losses ranged from 80 to 100 percent of the crop. Losses were entirely on the mature crop. As late blight did not appear in epidemic proportions until July 10, no loss of seedlings was experienced.

Late blight was first found on tomatoes on May 29 in two fields, both of which were planted with southern plants. The disease did not spread to adjacent fields from these two sources of infection, even through weather conditions during early June were favorable for the development of the disease. The initial heavy wave of late blight infection occurred during the first week of July. Weather conditions during the last few days of June and the first part of July were favorable for late blight infection (heavy rains from June 28 extending through July 2, accompanied by cool weather). Infection developed rapidly until by July 12 tomatoes were seriously affected, some fields showing heavy foliage infection and 50 percent fruit infection. On July 12 and 13 rainfall at Newark totalled 1.23 inches which, along with cool weather, permitted late blight development to continue at a rapid rate. When 2.85 inches of rain fell on July 23, it looked as though late blight would wipe out the tomato crop. Fortunately, however, the weather after July 22 turned off warm and dry until August 7, a period of 16 days. During this period, late blight "dried up" on the plants, except in low areas along the coast. A heavy rain on August 7, followed by a period of cool nights which permitted heavy dew formation, allowed late blight to start development again. Thus, a second wave of infection built up which practically wiped out the late tomato crop during the period of August 16 to 23. During this period temperature and rainfall (1.82 inches) were ideal for late blight development. Late blight development practically ceased after September 1 as it stayed dry from September 1 to 21. However, the damage had been done. The course of the disease in Delaware was directly correlated with periods of wet weather, warm days, and cool nights.

In connection with the first wave of infection (first part of July) it is interesting to note that this corresponded with a period of heavy foliage and fruit infection in the Cape Charles area of the lower end of the Delmarva Peninsula. This area lies approximately 75 miles south of Delaware. It is felt that the spores causing the initial wave of infection in Delaware were wind-borne spores from this area. This is supported by the fact that there was practically no local source of inoculum in Delaware.

Practically all tomatoes in Delaware for canning and fresh market are Rutgers. A few Marglobes are grown. Various varieties are found in home gardens. All varieties observed in Delaware were found susceptible to late blight disease.

The late blight fungus was only observed on tomato and potato in Delaware.

After late blight disease was found on tomatoes on May 29, weekly surveys of tomatoes and potatoes were made. No further cases of blight were found on tomatoes and only one case on potatoes, until the week of July 1. A news release containing pertinent facts on the fungus and its control was prepared on July 6. Also, visits were made to all canning companies in the State during the week of July 1 and control recommendations presented. Based on a report by H. I. Borders, Sub-Tropical Experiment Station, Homestead, Florida (PDR 30(5): 170-172. May 15, 1946), and on personal observations of the writer in Florida during February, 1946, Dithane plus zinc sulfate-lime spray was recommended as first choice, for control. The neutral copper sprays were second choice, ground dusting with neutral copper dusts was third choice, and airplane dusting was fourth choice.

One canning company succeeded in getting 80 percent of their contracted acreage of early and mid-season tomatoes dusted by plane from one to seven times. Yields were, on the average, double in the treated fields. Some growers who dusted seven times with a neutral copper dust obtained a yield of 17 tons per acre. Certain growers who sprayed their early tomato fields seven times with Dithane + zinc sulfate-lime or a neutral copper obtained yields of 20 tons per acre. These fields were in areas where untreated fields were seriously damaged by late blight and yielded less than 5 tons per acre.

On the late tomato crop, five sprays with Dithane Reaction Product (He 178e) or with Copper Compound A gave yields of approximately 5 tons per acre whereas the yield on the untreated plants was less than 1/4 tons per acre.

From results obtained this season, the relative efficiency of various control methods appears to be as follows:

1. Ground spraying
2. Ground dusting
3. Airplane dusting

Considerable airplane dusting was done in Delaware during 1946. Where the first and succeeding applications were timed correctly, results were much better than expected -- control of late blight was quite good, particularly on the fruit. However, where the first application was timed too late, or where succeeding applications were spaced too far apart, airplane dusting gave poor control.

It is estimated that 10 percent of the growers, representing 15 percent of the acreage, attempted control measures. More growers would have attempted control if equipment had been available.

Many growers, particularly the larger ones, are making preparations to treat their acreage during 1947. Also, the tomato canning companies are making arrangements to have their contracted acreage treated during 1947.

Late blight has taught our tomato growers a lesson--that they must be equipped to use control measures if the disease reappears in future years.

Late blight was destructive on late potatoes in Delaware this fall. Many fields were completely destroyed. The fungus will have ample opportunity to overwinter on potato tubers and provide an abundant source of inoculum for 1947 if weather conditions next spring are conducive to late blight development.

UNIVERSITY OF DELAWARE
NEWARK, DELAWARE, OCTOBER 16

TOMATO LATE BLIGHT IN NEW JERSEY

C. M. Haenseler and B. H. Davis

(1) An accurate report on economic losses caused by late blight in New Jersey cannot be made but a summary compiled from estimates made by several Plant Pathologists, reports obtained from several large canners, surveys made by County Agricultural Agents and opinions of others familiar with the tomato situation, indicates that approximately 20 to 30 percent of the potential tomato crop was lost in the Southern New Jersey Counties, 30 to 40 percent in the Central Counties and 50 to 60 percent or possibly more in the northern market garden areas. Since the largest tomato acreage occurs in the southern half of the State, the total losses may be somewhat less than the mean of these estimated percentages would indicate.

The average State yield of tomatoes when finally reported may suggest that these estimated losses are too high. If this proves to be the case, as it probably will, the apparent discrepancy between State yield and estimated blight losses may be explained by the very high potential yields in 1946. In more normal seasons our losses from poor fruit set, anthracnose, blossom end rot, mosaic, soft rots, sun scald, drought, and August and September storms are rather high. This year, losses from these various causes were far less than usual. Consequently the total tonnage delivered to the canner or market this year may not give a true picture of crop loss caused by blight.

(2) We have no confirmed reports of losses in young plants. Late Blight appeared in New Jersey almost two months after canhouse plants were set. Although leaf blighting was abundant in some fields at that time, the major loss occurred later on the green fruit. Almost 100 percent of the crop was destroyed in some fields.

(3) Various methods of applying fungicides were used. Our recommendations were to use row sprayers if available, speed or other orchard sprayers as second choice, ground dusters as third best, and airplane applications if no other method was available.

(4) and (5) Personal observations as well as reports from growers and canners' field men all indicate that airplane dusting was very ineffective but we have no experimental data to show just how effective or ineffective the airplane applications were.

On the other hand replicated plots in tests sprayed at 10-day intervals with a 5-row ground sprayer were compared with adjacent plots receiving no fungicide. Almost perfect control of fruit rot was obtained in the sprayed plots. There was an average of less than one infected fruit per plant on plots that received a neutral copper spray whereas an average of over 31 diseased fruits per plant occurred on the adjacent plot which received no fungicide.

(6) In the principal tomato area one large canner reported that 47 percent of his contracted acreage was sprayed. Another canner in an area where blight was slightly less serious due to lighter soils estimated that control measures, largely airplane dusting, were used on approximately 15 percent of the contracted acreage. No good estimate of the acreage treated throughout the State is available but it is significant that practically the entire supply of suitable spray materials available from New Jersey dealers was bought during the tomato season.

(7) Some of the canners are planning to make spraying and dusting equipment more available to their contractors in 1947 than it was in 1946. It has not been decided whether or not a general blight control program should be carried out by all growers next year. The program for 1947 may be one of preparedness so that control measures might be started on short notice if early spring reports from Florida, Georgia, and other States south of New Jersey indicate that a general blight epiphytotic may be expected. We plan to study all reports closely and to warn our growers to get ready to apply control measures if it should become necessary. As soon as the disease begins to develop in nearby States an alarm will be spread and all growers urged to apply fungicides regularly until it becomes evident that the disease is not spreading.

(8) We have no experimental data on the manner of dissemination. Although there were no confirmed cases of blight on seedlings imported into New Jersey, observations indicate that imported plants with incipient infection were set in some fields. Observations also indicate that there has been wide dissemination of spores by wind. The greater prevalence of blight early in the season in fields planted with southern-grown plants would suggest the former, while the total crop loss in many fields planted with home-grown plants and well isolated from either potatoes or southern-grown plants suggests that the latter must have been common.

(9) Weather conditions greatly influenced the blight in New Jersey. The disease in one section became very prevalent on foliage during a wet period in early July and then spread very little during a 2-week dry period in the middle of July. Spread occurred again during a rainy period, July 20 to 25. After August 7 an extended period of rainy humid weather resulted in rapid spread. The disease broke out in epiphytotic form about August 20. Local storms with cloudburst precipitation that occurred in certain sections of the State caused very heavy fruit infection in these specific areas. It was very evident that any condition that caused the soil or the microclimate about the base of the plants to remain very wet for a prolonged period greatly

increased the losses from blight. Some of these causes were:

(a) long heavy rains or frequent rains followed by a period of high humidity,
(b) very heavy soils,
(c) very heavy succulent plant growth,
(d) too close planting.

In areas with light sandy soils the average losses were less than on heavier soils but local weather conditions in some cases favored development of abundant infection even on very light soils.

(10) We had no opportunity to make a careful study of varietal susceptibility to blight but there was some evidence that on the average, Garden State and Pritchard varieties, with an open vine, had less fruit loss than Rutgers and Marglobe.

(11) Blight was not observed on any plants other than potato and tomato, although two suspected cases on peppers were reported. Both of these cases were investigated and were found to have foliage lesions unlike those caused by our common pepper leaf diseases. By the time the plants could be examined no conidiophores or spores of Phytophthora could be found. It cannot be definitely stated, therefore, that infection occurred on peppers.

NEW JERSEY AGRICULTURAL EXPERIMENT STATION
NEW BRUNSWICK, NEW JERSEY, OCTOBER 19

TOMATO LATE BLIGHT IN NEW YORK

Otto A. Reinking and W. T. Schroeder

1. We have no exact estimates of loss for the State. They varied from none to 100 percent. I should guess possibly that 25 percent of the crop was lost.

2. Our loss was on young plants sent in from Georgia and on the mature crop. The first loss we suffered was from infected young plants sent in from Georgia. Some 100 to 200 acres at least were plowed under from this introduction. However, we could not correlate the severe later infection on the mature crop with this first introduction. The severe loss came to the mature crop in the latter part of July and in August and September.

3. Our general control spray program for tomato diseases has been advised each year in areas where the leaf blights, anthracnose, and late blight have been severe. This included a staggered spray program

with Fermate or Zerlate and Bordeaux (4-2-50), or any one of the insoluble coppers at the rate of 4 pounds to 100 gallons of water for those compounds with approximately a 50% metallic copper content. The dusts advised were with one of the insoluble coppers, as above, at the rate of 14 pounds to 86 pounds diluent (talc or pyrax) with 40 to 70 pounds applied per acre.

4. Spraying gave better results.

5. We have a few instances in which dusting by airplane with one of the insoluble coppers was effective. In these cases, the dusting was started before the advent of disease and the operations were very thorough with heavy applications.

6. The percentage of growers attempting control measures is not known. The percentage of those carrying out a complete schedule was low because most growers were not set up for spraying or dusting. Many applied sprays and dusts after the disease had gained a good foothold and then with orchard sprayers or dusters and by airplane.

7. Expanded control facilities for next year are being prepared.

8. We have no observations on the current seasons dissemination. We have transmitted with ease the disease from current season potatoes and tomatoes to tomatoes in the greenhouse. In these tests, there appeared to be no difference in virulence in the fungi collected from both hosts.

9. We believe that the cold August, 5° F below normal, and the widespread drizzly rains during the latter part of July and in August were favorable for disease development. A dry, hot spell in September seemed to check the disease somewhat for that period. As yet, no accurate correlations have been calculated.

10. There seemed no real difference in susceptibility among the commonly grown commercial varieties such as John Baer and Stokesdale. Apparently, some of the Italian types showed some tolerance.

NEW YORK STATE AGRICULTURAL EXPERIMENT STATION
GENEVA, NEW YORK, OCTOBER 17

TOMATO LATE BLIGHT IN CONNECTICUT

J. G. Horsfall

1. 2. Loss is estimated at 25 percent, on the mature crop.

3, 6. Some spraying was done with Dithane, Phygon, or Bordeaux. Very few growers attempted control measures.

8. The disease appeared here two or three weeks after its appearance in New Jersey; possibly carried up from that State.

10. New Hampshire Victor seemed less susceptible than other varieties. Vegetating plants were less affected than heavily fruiting plants.

CONNECTICUT AGRICULTURAL EXPERIMENT STATION
NEW HAVEN, CONNECTICUT

LATE BLIGHT ON TOMATO IN RHODE ISLAND IN 1946

Richard S. Davidson

The tomato late blight epiphytotic was, according to commercial growers and County Agents throughout the State, the most extensive and severe experienced in Rhode Island. The infection of tomato foliage and fruits was first observed on the 9th of August in Washington County. It was reported from every section of the State on approximately this same date. The incidence and severity of the infection on both foliage and fruits increased rapidly. This increase may be attributed to principal factors, excessive rainfall and insufficient control practices.

The average rainfall for the State during the month of August was 12.24 inches. This is the highest rainfall recorded for a similar period in Rhode Island since 1914. Approximately 75 percent of the total rainfall recorded for the month fell during the period of August 7 to 20. Between 4 and 5 inches of rainfall was recorded throughout the State on August 7, and 2 to 2.5 inches were recorded on the 19th. Rainfall was recorded on 13 days during the month of August in Washington County. The northern portion of the State had even more frequent occurrence of rainfall. An average rainfall of 1.7 inches was recorded for September with practically all of it occurring in the last half of the month. Interestingly enough, the rainfall record for September is the lowerst since 1914 for a similar period in Rhode Island.

In addition to the excessive precipitation, very few tomato growers were prepared to apply the proper control measures. This applies to the commercial growers as well as the home gardeners. Growers who were prepared found it impossible to maintain sufficient coverage to adequately control the infestation because of the excessive amount and frequent occurrence of rainfall.

According to reports received from the county agent, 70 percent of the mature crop was lost in the northern portion of the State which includes, Providence, northern half of Kent and Bristol Counties. Newport and southern Bristol counties reported a 75 percent crop loss while the greatest loss occurred in Washington County with a 90 percent crop loss.

In the case of Washington County virtually no marketable tomatoes were available after the middle of August. The remaining areas were able to salvage a very small percentage of the total crop during late August and early September.

The loss in Rhode Island occurred entirely on the mature field crop. No apparent varietal resistance was observed in any of the commercial plantings. The small-fruited plum and pear types of tomato have been reported to exhibit resistance to the late blight fungus, however, this has not been observed by this writer.

RHODE ISLAND AGRICULTURAL EXPERIMENT STATION
KINGSTON, OCTOBER 15

TOMATO LATE BLIGHT IN MASSACHUSETTS

O. C. Boyd

1. Loss estimates: 50 percent of the commercial crop and 75 percent of the home garden tomatoes.

2. The loss was on bearing plants with both immature and fully developed fruits.

3. Although many commercial growers dusted or sprayed during July and into August for control of early blight, the treatment in most instances was not frequent enough nor continued long enough to prove effective against the Phytophthora late blight. Those who did spray weekly with home-made Bordeaux throughout August and into September got almost perfect control. Bordeaux powders, neutral copper fungicides, and Dithane gave varying degrees of control, mostly poor to moderate. Some few home gardners who applied copper dusts or sprays heavily and once a week during the same period experienced very little or no losses from late blight or other foliage and fruit diseases.

4. Spraying, generally, although scattered instances were observed of both home gardners and commercial growers who controlled late blight successfully with copper dusts.

6. No more than 5 to 10 percent made a special effort to control late blight.

7. Preparations are being made for better control facilities next year.

8. Evidence (observations) points to air-borne spores from infested States, south and west of Massachusetts as the source of our initial infection -- rather than a spread from infected potato fields.

9. Late blight made most headway during the period when cool, rainy weather prevailed, and subsided when drier, warmer weather came on.

10. We did not observe varietal differences, except that the disease made considerably slower progress on vines and fruits of Dwarf Stone than on Pritchard growing in adjacent rows in a home garden.

MASSACHUSETTS STATE COLLEGE
AMHERST, MASSACHUSETTS, OCTOBER 4

LATE BLIGHT IN NEW HAMPSHIRE

M. C. Richards

(1) I cannot give you accurate estimates of losses from late blight in New Hampshire, as no survey of the State was made with respect to this disease on potatoes or tomatoes. A great many home gardeners lost practically their entire crop due to late blight on tomato fruits. We have no large commercial growers of tomatoes.

(2) The loss sustained occurred on the mature crop. In no case were the seedling plants affected.

(3) Most of the newer organic fungicides were not used by potato or tomato growers in the State.

(4) Where an efficient job of either spraying or dusting was carried out, effective control of late blight was obtained by both methods.

(6) About 10 percent of the home gardeners attempted control of late blight on tomatoes.

(7) We are not preparing to expand control facilities for next year. Some of the newer fungicides may be given a trial, however, by certain growers.

(8) There are always numerous centers of inoculation. Because of the wet, cool weather which we had in August, there was a widespread movement of spores from these centers to unprotected plants.

(9) The incidence of disease in the State this year could definitely be associated with the weather.

(10) As far as we could observe, there were no differences with respect to infection on tomato varieties.

(11) The late blight fungus was not observed on other crops, although no special effort was made to check on this point.

UNIVERSITY OF NEW HAMPSHIRE
DURHAM, NEW HAMPSHIRE, OCTOBER 14

TOMATO LATE BLIGHT IN MAINE

Donald Folsom

The following information comes from Joseph C. Hickey, Vegetable and Canning Crops Extension Specialist in Maine.

1. Loss averaged 25 to 35 percent.

2. It occurred mostly on the mature fruit, causing much late blight rot.

3. A few growers sprayed with bordeaux 2-2-50. A few dusted with a neutral copper dust. Notices of expected blight losses were sent to all growers July 26. However, many farmers did not think it would be serious and did not carry out control measures.

4. Apparently spraying and dusting were equally good, but direct comparisons were not made.

5. No airplane dusting was done.

6. Percentage of growers using control practices was 15 percent as a rough estimate.

7. The control measures for blight will be stressed in meetings this winter and timely notices will be sent out next season.

8. Dissemination was by the usual manner.

9. The early part of the growing season was dry and only a very few spots appeared to have blight started. Later on, continued rain plus several cloudy days in August caused rapid spread.

10. It appeared to me as though John Baer and Bonny Best were hit particularly bad.

MAINE AGRICULTURAL EXPERIMENT STATION
ORONO, OCTOBER 17

TOMATO LATE BLIGHT IN OHIO

H. C. Young

1. Loss is estimated at 8 percent -- 3 percent from fruit, and 5 percent from plant stand.

2. Loss was mostly from plant stands.

3. A limited amount of spraying and dusting was practiced.

4. Spraying was more effective according to results from plot tests.

5. Some airplane dusting was done and it was partially effective.

6. About 10 percent of the growers attempted control measures.

7. Expanded control facilities are being prepared for next year. (See note).

8. There are no specific observations on the manner of dissemination this season, except wherever there was heavy vine growth, the disease was more severe. It was also severe in home gardens where they were shaded or poorly air drained.

9. Exceptionally dry weather during July and August prevented spread. A dangerous situation was changed so that only a very slight loss occurred.

10. No differences were observed in varietal reactions.

As late as mid-June we thought we might lose our tomato crop from late blight but the weather changed and became dry and we had one of the finest crops ever produced in this State.

Note. -- A symposium on the late blight situation has been arranged for the Cincinnati meetings. Also special machinery is being arranged for plant bed control of the disease. Also, formulas for field spraying are being arranged.

OHIO AGRICULTURAL EXPERIMENT STATION
WOOSTER, OCTOBER 17

LATE BLIGHT ON TOMATOES IN OHIO IN 1946

Thomas H. King

Late blight was reported as present in 36 counties in the State, first making its appearance May 29 in Ottawa County on southern-grown tomato plants. On June 26 it was found in Washington County on both southern and home-grown plants. Losses ranged from 3 to 25 percent in the State as a whole with about a 3 percent loss in the tomato canning area, except for a few counties in this latter area where losses up to 25 percent occurred. However, in the staked tomato area in Southern Ohio a 20 to 25 percent loss occurred. A conservative estimate in one Southern Ohio county was that growers had lost $40,000 due to late blight.

This year late blight was injurious to the young plants at setting time, necessitating replanting or spot-planting in both the staked and canning areas. Approximately 50 percent of the fields were reset to some degree. In the cases where blight was present, but conditions were not favorable for its growth, the tomato plants were stunted and less vigorous than home-grown transplants set at a later date and also when compared with drilled fields of tomatoes.

A 7 percent fixed copper dust or a spray consisting of 4 pounds of 50 percent metallic copper to 100 gallons of water was recommended for control where there was no evidence of the disease in the field. In cases where late blight had already gained a foot-hold and was present on the fruit, an 8-8-100 bordeaux mixture spray was recommended at the rate of 300 gallons per acre to be applied in three applications at 5-day intervals. However, under Ohio conditions it is practically impossible to spray, and about 90 percent of the growers that attempted control measures used a fixed copper dust.

Some airplane dusting was attempted. In the few fields that were observed that had been airplane dusted, the disease had already gained a foothold and the application of dust was not effective in control. In some diseased fields a portion of the crop was harvested, since the blight subsided as a result of unfavorable weather conditions for the further development of the disease, rather than through the effectiveness of the airplane dusting.

In the tomato canning area approximately 50 percent of the growers attempted some means of control. In the rest of the counties that reported late blight probably less than 10 percent of the growers attempted control.

The losses from late blight were the greatest in the staked tomato area in Southern Ohio, and in the middle one-third of the State, which embraces the lower tier of counties of the tomato canning area. The weather during the month of August was wet and cool. The temperatures in the middle one-third of the State averaged approximately 65°, which was approximately 7° cooler than normal, with normal rainfall occurring intermittently throughout the month; whereas in the northern section of the tomato canning area the weather was relatively cool, but extremely dry. Thus, although the disease gained a foot-hold in the southern portion of the tomato canning area there was no spread after the month of August.

As far as we could determine there were no differences in varietal reactions.

Although the disease is present to some degree every year it seldom causes any appreciable loss. However, we believe that the plants shipped in from the Southern States were an important factor in the epidemic of late blight this year.

OHIO STATE UNIVERSITY
COLUMBUS, OCTOBER 18

TOMATO LATE BLIGHT IN INDIANA

R. W. Samson

Satisfactory estimates of the losses caused by late blight on potatoes and tomatoes in Indiana in 1946 are difficult to make because of the erratic seasonal and geographic distribution of the disease. Temperatures were generally favorable throughout the season. Rainfall was rather frequent and abundant to about August 1 in the southern half of the State, but definitely deficient from the first of July throughout the rest of the State.

Moderate day-time and frequently low night-time temperatures resulted in many nights with heavy dews, as well as fog banks over low-lying areas. These dew and fog conditions alone did not appear sufficient to promote severe blight epidemics. Blight epidemics occurred only when the fogs and dews were supplemented by rainy periods.

The disease was positively identified on many arriving shipments of southern-grown tomato plants last spring. Subsequently, excessive stand damage, due to late blight stem cankers, was observed. This late blight stem infection was frequently co-existent with stem cankers due to Alternaria solani. Late blight on maturing tomatoes was first observed in early July on small plantings in the hilly, wooded sections of southern Indiana. Infection became rather general throughout southern Indiana in late July and early August, with severe damage in localized areas. This late blight development appeared associated with frequent rains. Some severe late blight in northeast central Indiana occurred in low-lying areas, fields surrounded by trees, or in direct-seeded tomato fields with very dense foliage cover.

Subsequent to about August 1, and earlier in northern Indiana, dry weather set in and persisted until after frost. As a consequence, an unusually good canning tomato crop was harvested over most of the State. While individual fields were almost completely destroyed by blight in July or early August, it is doubtful if as much as a ten percent loss for the State as a whole can be charged to late blight. This would include both early stand losses and subsequent foliage and fruit destruction.

Three Indiana canners undertook to spray their contracted tomato acreages and are satisfied with the results, although they admit that dry weather alone would have held the disease in check in their areas.

Many tomato growers dusted by airplane. Initiation of dusting coincided with onset of dry weather in most areas so that the effectiveness of this method could not be satisfactorily determined. Some evidence of partial effectiveness of airplane dusting was reported by one canner in southern Indiana. Six applications of around 40 pounds of a proprietary copper dust per acre were made on 330 acres in this instance.

Spraying with proprietary copper or thiocarbamate fungicides will be promoted in Indiana next year.

It seems likely that most of the late blight developing on tomatoes in Indiana this season came from the initial infection present on the many southern-grown transplants.

The development of the disease on early-spring planted potatoes in southern Indiana could have been another source, but we have no positive evidence of it. The generally more severe development of the disease in direct seeded tomato fields has been obviously correlated with the closer spacing of plants and the generally more dense foliage cover.

No differencesin varietal reactions to late blight were noted. The disease was noted on pepper in one home garden.

PURDUE UNIVERSITY AGRICULTURAL EXPERIMENT STATION
LAFAYETTE, INDIANA, OCTOBER 23

LATE BLIGHT IN ILLINOIS

G. H. Boewe

From August 26 to 30, I examined potatoes and tomatoes in the northern half of the State. I examined three fields (approximately 153 acres) of tomatoes in the southeastern part of Iroquois County and no late blight was observed. However, late blight was severe on tomatoes in the south part of Vermilion County, approximately 40 miles south. Septoria leaf spot had caused severe defoliation in fields set with plants that were brought in from Southern States.

On October 10, I examined potatoes and tomatoes in Jo Daviess County (northwest corner of the State). There had been very little rain in that area for three weeks. Tomatoes in a garden near blighted potatoes were severely diseased. The foliage on some plants was almost all killed by late blight and approximately 60 percent of the fruits were infected. The fungus was fruiting abundantly on foliage and fruit of tomatoes.

I will answer some of the questions which you submitted by number.

1. Tomato losses due to late blight are estimated at 0.5 percent of the crop.

2. Loss occurred on the growing crop before maturity. In southern Illinois, blight became severe before the first tomatoes were ready to pick. However, I saw some late blight on tomato plants in one plant field in Pulaski and Monroe Counties.

8. In the northwest part of the State late blight spread from potatoes to tomatoes in garden.

9. In southern Illinois where late blight occurred on tomatoes and potatoes in May and June, the progress of the disease was stopped by warm, dry weather of June and July. In the northern part of the State, late blight came in late because of the warm, dry weather in July. The following table gives the average total rainfall and average mean temperature of three stations in southern Illinois (Cairo, Anna, and East St. Louis) and of two stations in northwestern Illinois (Freeport and Mt. Carroll).

	3 Southern Stations		2 Northern Stations	
Month	Average mean temperature	Average total of rainfall in inches	Average mean temperature	Average total of rainfall
April	61.7	2.86		
May	62.8	8.16		
June	76.5	2.29		
July	79.5	3.09	73.0	0.90
August			68.7	4.28

ILLINOIS STATE NATURAL HISTORY SURVEY
URBANA, OCTOBER 19

TOMATO LATE BLIGHT IN ILLINOIS

M. B. Linn

1. The losses from late blight for the State as a whole were probably less than 1 percent since only two general areas involving around 1200 acres were affected. The loss in these areas was from 5 to 7 percent.

2. Loss was mostly on vines with green or ripe fruits.

3. Dusts were used almost exclusively. These were fixed-copper dusts with around 6 percent metallic copper and applied with peach dusters and by plane. One small grower in the southern part of the State used 5-5-50 Bordeaux mixture.

4. No direct comparisons were possible between spraying and dusting.

5. Airplane dusting is believed to have checked appreciably the spread of the late blight fungus. Coverage of fruit with dusts was good under rather heavy foliage at a distance of 25 feet from path of plane. Where planes were used, two applications were made.

6. Probably around 1 percent of growers in the State attempted control measures.

7. Thus far we have made no plans for expanded control facilities for 1947. Ground equipment for use in tomato fields is limited but there would be little trouble in obtaining planes for dusting. We are somewhat dubious about the use of plane dusting in the neighbor- of the large cities, e.g. in the greater Chicago area.

8. No specific observations were made on dissemination.

9. When rains ceased in the East Central Part of the State in September, there was a cessation in development and spread of the late blight fungus. Had this not happened losses would have been nearly 75 percent instead of five percent.

10. Garden State was affected more severely than Early Baltimore and Rutgers in same field. No claims are made regarding susceptibility. We are reasonably sure that Garden State is no more resistant than the other two varieties named, however.

UNIVERSITY OF ILLINOIS
URBANA, OCTOBER 11

WISCONSIN

R. E. Vaughan

1. No estimates of loss can be made for Wisconsin. Many irrigated fields gave a very poor crop. Commercial fields in Southeastern Wisconsin were not affected.

2. Losses were noted mostly on the mature crop.

3. No control measures were taken.

6. As far as we know no growers attempted control.

7. At present we are not preparing expanded control facilities.

9. We have no observations on effect of weather. The first specimens were brought in August 30.

UNIVERSITY OF WISCONSIN
MADISON, OCTOBER 8

TOMATO LATE BLIGHT IN MINNESOTA

E. C. Stakman

The following memorandum was prepared by Dr. C. J. Eide and Mr. R. C. Rose.

1. From reports by growers, I would estimate a loss of yield of 10-20 percent of the tomato crop.

2. Loss occurred on fruit in the latter part of the season. The disease was just reported about August 15.

3. No control measures were used as this was the first year blight has been severe on tomatoes, and most growers do not find it pays to spray or dust for Septoria leaf spot or Alternaria.

4. Neither spray nor dust were used enough to tell which was better.

5. No airplane dusting was used.

6. Only a fraction of the growers used fungicides.

7. I believe the extenion pathologist (R. C. Rose) plans to recommend

fungicides next year.

8. No observations were made on methods of dissemination. Infection was widespread.

9. Because July and August were very dry, the disease was found first only in gardens or commercial fields where overhead irrigation was used.

10. No differences in varietal reaction were observed.

11. No blight was observed on hosts other than potato and tomato. There was relatively little blight on potatoes, except for fields on peat. (Blight from tomato infected potato tubers and vice versa in limited laboratory tests)

UNIVERSITY OF MINNESOTA
UNIVERSITY FARM, ST. PAUL, OCTOBER 17

TOMATO LATE BLIGHT IN IOWA

W. F. Buchholtz

1. Loss was estimated at 15 percent on tomatoes.

2. Loss was to the tomato fruit crop just as harvest season was about to begin. Afflicted fields were a total loss.

3. No control measures were used on tomatoes.

7. Our commercial tomato growers will probably spray or dust in 1947.

8. On tomatoes, P. infestans appeared first and most severely on southern-grown (Georgia) plants. Ultimately it spread to home gardens and commercial fields grown from seed. It was observed on potatoes after it had been found in abundance on tomatoes!

9. Cool, wet weather during one week in mid-August was enough to facilitate complete destruction of the tomato crop in afflicted fields.

10. No varietal differences were observed.

IOWA STATE COLLEGE
AMES, OCTOBER 21

COLORADO

W. D. Thomas, Jr.

Late blight on tomatoes appeared very late in September in Adams, Weld, and Larimer Counties. However, these infections were slight and widely scattered, apparently as a result of inoculum blown in from nearby potato fields or garden plots.

COLORADO A & M COLLEGE
FORT COLLINS, OCTOBER 17

WASHINGTON

M. R. Harris

The late blight fungus was present in the Yakima Valley on tomatoes only to a very slight degree. I did find a field of tomatoes on the coast in Whatcom County not far from Bellingham that was severely affected by late blight. In coastal areas the disease exists but growers in that part of the State are accustomed to practice control measures and I did not see any fields there that showed more than an occasional trace.

STATE COLLEGE OF WASHINGTON
PULLMAN, OCTOBER 16

SOME NEGATIVE REPORTS

MISSOURI

By C. M. Tucker

We did not encounter late blight on tomatoes in this state during the past season. Niether did we find it in 1945 when we experienced our first outbreak of the disease on potatoes. This may have been because of the fact that our potato crop is harvested early, and warmer weather later in the season was not favorable to the development of the disease on tomatoes.

Our 1946 season was very warm and dry during July, and the temperatures during August and September were not low enough to permit the development of the disease on tomatoes.

UNIVERSITY OF MISSOURI
COLUMBIA

ARKANSAS

By V. H. Young

We have no reports of late blight on either tomatoes or potatoes and the Plant Board has no record so far as I can find of diseased plants shipped in.

My feeling is that it becomes hot and dry here too early for the disease to obtain foothold.

UNIVERSITY OF ARKANSAS
FAYETTEVILLE, OCTOBER 11

NEBRASKA

By Arden F. Sherf

Late blight on either tomatoes or potatoes has not been a problem in Nebraska this year. We have had no reports of tomato late blight. Tomatoes are only a minor crop here.

UNIVERSITY OF NEBRASKA
LINCOLN, OCTOBER 16

OKLAHOMA

By K. Starr Chester

I have your request for information on late blight of tomatoes and potatoes. This disease is very rare on either host in Oklahoma. There have been no reports or findings of late blight in this State during the past season nor, indeed, do we have any authentic records of late blight in Oklahoma in past years.

A possible explanation is the fact that our potatoes and tomatoes become mature during a period of very high temperatures, often 90-100° or even higher temperatures that are quite unfavorable for late blight development. In contrast, these crops when grown in the North, mature at a time of falling temperatures, while in the deep South they are grown as winter crops under cool conditions. In both of these cases the temperatures are favorable for late blight.

Under these conditions control measures for late blight are not recommended in this State.

UNIVERSITY OF OKLAHOMA
STILLWATER, OCTOBER 5

TEXAS

By P. A. Young

My answer must be "No" to all of the questions, because I did not see (or hear of any) late blight on tomatoes or potatoes in East Texas this year. More plants were brought here from the Lower Rio Grande Valley again last March, but there was enough dry, warm, windy weather last spring to control late blight. I had warned them to get plants only from healthy fields.

TOMATO DISEASE LABORATORY
JACKSONVILLE, OCTOBER 9

ARIZONA

By J. G. Brown

Late blight was not observed nor have any complaints come in. It is usually unimportant in this State.

UNIVERSITY OF ARIZONA
TUCSON, ARIZONA

IDAHO

By C. W. Hungerford

No late blight in Idaho.

UNIVERSITY OF IDAHO
MOSCOW, IDAHO

ACCOUNTING FOR THE BEHAVIOR OF TOMATO LATE BLIGHT IN MASSACHUSETTS IN 1946

Oran C. Boyd
(Reprinted from: "The Commercial Vegetable Grower", October, 1946)

Twice before in Massachusetts, in 1905 and 1932-33, the late blight disease of tomatoes assumed epidemic form and caused heavy losses in home gardens and commercial fields. In 1932, it even spread to and greatly damaged a great many fall greenhouse crops of tomatoes in eastern Massachusetts before the heating season started. This year, scarcely a garden or field in Massachusetts escaped damage. Losses varied from light to complete, depending mostly upon the time of setting the plants, whether or not they were trained to stakes, trellis, etc., and the amount of protection with fungicides.

In 1932-33, the tomato late blight outbreak occurred in New England, with the most pronounced damage being in Connecticut, Massachusetts, and Rhode Island. This year, the outbreak in New England merely represented an aftermath or continuation of a similar situation that covered all the Eastern States from Florida to New York State and as far inland as Tennessee, Kentucky, Indiana and Illinois. In general, however, the greatest damage occurred in States along the Atlantic coastline together with the adjoining States and the New England States.

Relation to Potato Late Blight. Late blight of tomatoes is caused by the same fungus, *Phytophthora infestans*, that causes the common late blight and tuber rot disease of Irish potatoes. The question then arises, why does the disease behave so differently on tomatoes than it does on potatoes? Practically every year late blight is present on potatoes in Massachusetts, causing moderate to heavy damage in unsprayed gardens and fields, particularly in the late maturing varieties. Yet, under the same growing conditions, late blight ordinarily attacks tomatoes either very lightly or not at all, even when no fungicidal treatments are given; or when the disease is severe it is very spotty in distribution and develops late in the season usually after the first of September.

A few years ago plant pathologists in New York State demonstrated beyond doubt that although the tomato blight fungus is the same species as the one causing potato blight, two different strains of the species are involved on the two crops. The ordinary potato blight fungus is not capable of spreading from potatoes to tomato plants and causing anything but very light infection with only slight or no damage. In other words, tomatoes are quite resistant to potato late blight and will not become damaged by that disease organism except after certain conditions have prevailed. It was found, for example, that when the potato blight organism was permitted or compelled to develop seven or more successive "broods" or generations on tomato plants, it gradually became adapted to the tomato plant and was then capable of causing typical severe damage to tomatoes. Furthermore, this resulting tomato strain of the late blight fungus retained its virulence for attacking potatoes; and it would remain the tomato strain even after growing continuously on potato foliage for three months or on potato tubers for six months.

In other words, it is possible for the potato late blight fungus to assume additional parasitic properties for the naturally resistant tomato plant provided weather conditions are favorable for seven or more successive passages of the fungus through the tomato plant. The minimum time that will permit one complete passage, that is, the infection of the tomato leaf or fruit, the formation of the lesion, and finally the production of spores on that lesion, is about three days. Hence, even when the most favorable weather conditions prevail continuously, that is, cool wet nights, and warm, dry or wet days, the shortest period of time required for building up a tomato strain of the fungus from potatoes would be around three weeks. But since it is likely that unfavorable weather would occur at one or more places in the series of seven successive "broods", the formation of the tomato strain may never be completed or it would be delayed well beyond the minimum 3-week period, probably not before an early-planted tomato crop matured or a late crop is killed by frost.

Hence it is not surprising why in some seasons tomatoes growing along side blighted potatoes remain uninfected or at least undamaged. It is also thus explainable why the same weather conditions that may contribute to rapid and complete blighting of potato vines may not "cause" adjacent-growing tomatoes to blight down.

In most years, scattered cases of late blight may be found on tomatoes in Massachusetts, most likely near the coastline in Bristol and Plymouth Counties and in the Connecticut Valley. But in those instances it shows up late in the growing season, usually a month or more after the appearance of late blight on potatoes in the same sections. The delayed appearance of the disease on tomatoes might well be explained by the time required for the fungus to convert itself from the potato strain to the tomato strain of the blight organism.

<u>Source of the Outbreak in 1946</u>: This year late blight "struck" tomato gardens and fields in Massachusetts at the same time the disease appeared in widespread form on potatoes. It is true that a very few isolated potato infections were observed in Plymouth and Bristol Counties before mid-August. However, not until August 15-20 did the disease become widespread in any part of the State on potatoes in unsprayed and poorly protected fields. The first observations of late blight on potatoes and tomatoes in the extensive Connecticut Valley

were made on August 20. All cases represented early stages of infection, and those in tomato gardens and fields were in most instances independent of infected potato plantings. In addition, it was apparent from the heavy localized infections on tomato plants with profuse sporulation on the diseased leaves, that the virulent tomato strain of the fungus was present at the very outset of those infections.

This situation suggests that the tomato strain of the late blight fungus was introduced into the State from some outside source and then developed rapidly on tomatoes simultaneously with the development of the potato strain on potatoes. Or, it could be that much of the blight on potatoes was due to the tomato-strain organism. The "outside source" for the fungus on tomatoes might readily have been air-borne spores from the heavily infected tomato fields in States located southwest of New England. There was little or no opportunity for the organism to be introduced here on southern grown plants since it is the practice in Massachusetts to use only home-grown plants.

It doesn't seem far fetched to assume the air-borne mode of entry, particularly this year, since downy mildew of cucumbers and melons is believed to reach this area each year only by way of spores blown during wet periods from States farther south and southwest of us. The weather during August in most or all of the Eastern States area was marked by cool, wet periods of sufficient duration and wind direction to favor dissemination of fungus spores over long distances. It is assumed that the tomato blight fungus was introduced in that manner and then found ideal conditions afterwards for rapid spread within the State.

<u>August Weather</u>: One reason for the rapid progress of late blight in tomato gardens and fields was the unusually cool damp weather during August. Another reason is the general failure to spray or dust tomatoes during August and September to the extent that potatoes are protected. In Bristol County, more than 12 inches of rain fell during August, about four times the normal amount. At Amherst, the total precipitation for August was hardly normal, yet there were 15 days when rain fell, as compared with a normal of 11 days; a mean cloudiness of 67% compared with the normal of 49.7%; and a mean daily temperature almost 2° below normal. The mean minimum and maximum temperatures for the last seven days of August were 50.0° and 76.3° F., respectively--conditions highly favorable for the late blight disease.

<u>Control</u>: The only instances of satisfactory control of late blight of tomatoes this year in either home gardens or commercial plantings involved copper dust or spray applications at 7 to 10 day intervals from late July or early August right through August and September. In general, spraying was more effective than dusting; and the most effective jobs of spraying involved the use of homemade Bordeaux mixture. Growers along the eastern shore of Plymouth County who spray their

tomatoes regularly every year for this disease, obtained almost perfect control where applications of Bordeaux mixtures were made at weekly intervals throughout August and into September.

MASSACHUSETTS STATE COLLEGE
AMHERST, OCTOBER

CUSTOM SPRAY RINGS USED TO CONTROL LATE BLIGHT ON TOMATO

L. O. Weaver and O. D. Burke

An attack of late blight in August and September 1945 caused tomato growers in Northern Luzerne County, Pennsylvania, to plan a spray program for the 1946 season. Tomato spraying was not the custom, machinery was non-available and spraying methods and materials not well established.

However, the following decisions were made and carried out:

(1). The planting distances were changed so that spraying could be done effectively and with a minimum of injury by equipment. Six feet between rows was the new standard planting distance with 2 1/2 to 3 feet in the rows.

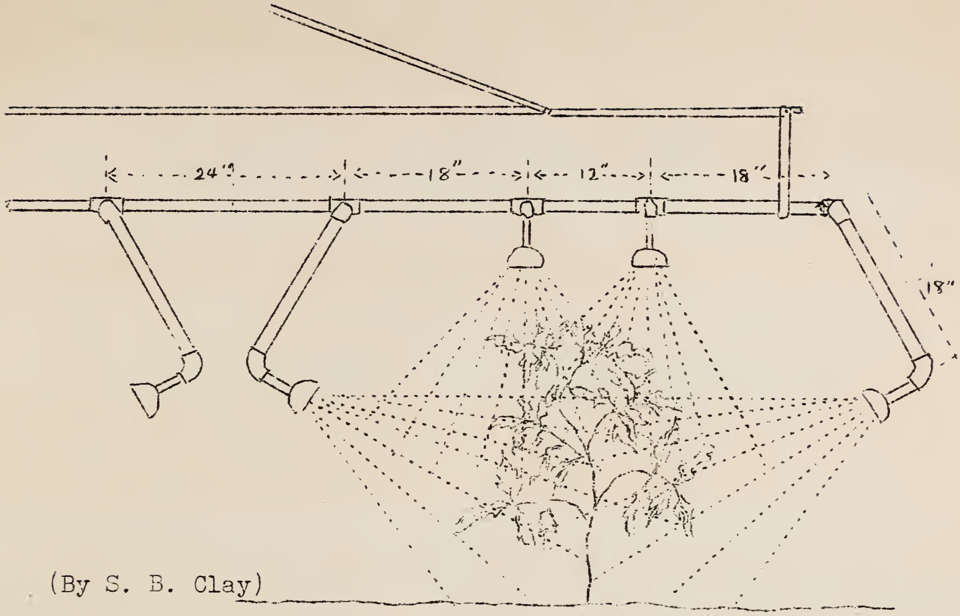
(2). Tractor mounted sprayers were used. The sprayer straddled one row and sprayed two additional rows on each side of the machine. A boom arrangement was developed similar to the conventional type of potato spray boom but with nozzles according to diagram. (Figure 1).

(3). Bordeaux mixture 6-3-100 was used in spite of reports that this fungicide injured blossoms and reduced yields.

(4). The fields were to be sprayed by custom spray ring. The price for spraying varied from $2.85 to $3.00 per acre per application.

Growers who experienced no trouble with late blight in 1946 started spraying two to three weeks after the plants were set and continued applications at 7-day intervals during the entire season. In some cases, 12 or more sprays were applied. Weather conditions were very favorable for Phytophthora infestans. The yields this year have been the largest ever produced. Many growers have reported ten tons per acre of green-wrap tomatoes where Bordeaux 6-3-100 was applied all season at weekly intervals. Fields not sprayed were severely blighted on August 8, 1946.

Luzerne County Agent Mr. J. D. Hutchison, hopes that the spray ring operators may be able to purchase additional equipment as the



(By S. B. Clay)

Figure 1. Boom arrangement used for tomato spraying in Pennsylvania

growers feel the spraying of tomatoes to be a very efficient farm operation. The growers who planted rows six feet apart are unanimous that they will not plant closer in the future since this distance provided good spraying conditions and also aided considerably in providing more room for pickers to walk and place baskets.

PENNSYLVANIA STATE COLLEGE
OCTOBER 1946

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THE PLANT DISEASE SURVEY

Division of Mycology and Disease Survey

BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING

AGRICULTURAL RESEARCH ADMINISTRATION

UNITED STATES DEPARTMENT OF AGRICULTURE

SUPPLEMENT 160

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