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The SWATH PATTERN of Tomato Disease Control with an Air-Blast Sprayer

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Late blight of tomato (*Phytophthora infestans* deBary) is reported from some garden or field in Ohio nearly every year, but its average ocurrence in epidemic form over the past 40 years has been only once in every 4 or 5 years. However, it is capable of causing very serious loss on tomato and potato when weather conditions (low night temperatures and extended periods of high humidity) favor its development.

The disease caused rather serious loss on both potato and tomato in the vicinity of Wooster in 1946, 1950[1], and 1957[2], and it assumed epidemic proportions over much of Ohio in 1958. Its occurrence in an experimental block of tomatoes being sprayed with air-blast equipment at the Northwest Substation near Hoytville, Ohio, afforded an opportunity to obtain some long-sought data on the swath pattern of disease control with an air-blast (mist) sprayer.

Anthracnose fruit rot (*Colletotrichum phomoides* (Sacc.) Chester), a disease of tomato which ocurrs in varying degrees every year in Ohio, and which now causes the growers and canners in the state a greater average annual loss than any other tomato disease, was also present in this experimental area. This provided an opportunity to study the swath-pattern of control (see Fig. 1) for that disease as well.

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[1]Wilson, J. D. 1951. Fungicides for controlling late blight. Ohio Agric. Exp. Sta., Farm and Home Res. 36: 6-7.

[2]Wilson, J. D. 1958. Experiments in the control of vegetable diseases in Ohio conducted in 1957. Ohio Agric. Exp. Sta., Botany and Plant Path. Mimeo. Series 26: 1-82.

On the Cover . . . . . .

Fig. 2.—Experimental air-blast sprayer used in the experiment discussed in this paper. Spray is delivered to the right side of the machine and to the row underneath.

The experimental air-blast sprayer used in this experiment is shown in Figure 2. It is capable of delivering about 21,000 cubic feet of air per minute at an outlet velocity of 90 to 100 miles per hour. It was used here to spray an effective swath of 36 feet on one side of the machine only. The row under the sprayer was sprayed by a liquid spray nozzle especially placed in a blast of air diverted from the main outlet. The use of a one-row hydraulic sprayer in the same experiment provided a comparison between the fixed boom and air-blast types of spray application in the control of both late blight and anthracnose fruit rots. Furthermore, provision was made for studying the effect on disease control of varying the volume of water (spray formulation) applied per acre with both types of equipment.

The influence of pressure on disease control was observed by introducing the spray material into the air-blast at two different pressures (300 and 60 p.s.i.) at an application rate of 40 gallone per acre at both pressures. Maneb (3 pounds per acre), which was the only fungicide used in the experiment, was formulated both as a wettable powder and as an oil suspension, as will be explained later. It was originally planned to use a 10-day spray interval but this schedule was varied (shortened) somewhat in two or three instances to provide more positive disease control during one period of extremely wet weather.

Late blight first appeared on the foliage in late July, or only about 3 weeks after the spray schedule was started. It soon became so severe on the untreated check plots that virtually all of the fruits then present on the plants were destroyed. By August 21, late blight had become so

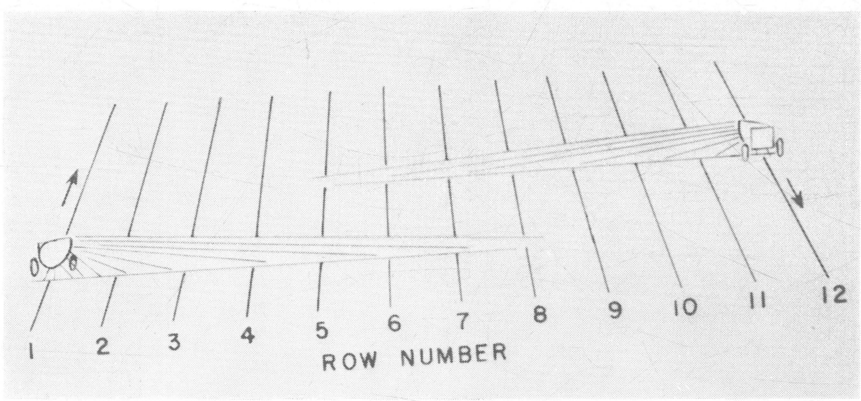

Fig. 1.—Diagram showing how applications were made with the air-blast sprayer to 12-row test plots. The sprayer traveled across on row "one" and returned on row 12, with the spray pattern overlapping in center of plot.

severe in the untreated check plots that it was decided to go over the whole area (all treatments) to pick and count the diseased fruits before they had decomposed beyond identification as individual entities. The first picking of ripe fruits was made on August 28 and at that time the count of diseased fruits (ripe or green) was repeated. The counts for the two dates are combined in the data presented in Table 1, which also identifies the different treatments included in the experimental outline.

These preliminary results obtained in the control of late-blight fruit rot show that the control was good with all combinations of gallonage and pressure with both types of application, and that the wettable-powder formulations gave somewhat better control than did the oil suspensions. The superiority of the former was most noticeable in the central portion of the air-blast swaths, as will be shown later.

In a comparison of pressures of introduction of the spray material into the air-blast (Treatments 1 and 2 in Table 1) 60 p.s.i. was as good, and in fact slightly better, than 300 p.s.i. (Figure 3.) Also, there was little to choose between the applications of 40, 20 and 10 gallons per acre (Treatments 2, 3, and 4); with 40 gallons of water per acre giving only slightly better late-blight control than did 20 and 10 (Figure 4).

TABLE 1.—Comparative control of late-blight fruit rot on Hoytville tomatoes by different formulations of maneb when applied with an air-blast and a hydraulic sprayer. Harvests of Aug. 21 and 28 only.

Treatment Specifications					Average number of diseased fruits per 70′ of row	Percent control on basis of count in check plots
Number	Type of application*	Type formulation†	Gallons per acre	Pressure (P.S.I.)		
1	Air-blast	W.P.	40	300	3.6	98.6
2	Air-blast	W.P.	40	60	2.5	99.2
3	Air-blast	W.P.	20	60	3.5	98.7
4	Air-blast	W.P.	10	60	3.1	98.8
5	Air-blast	O.S.	10	60	15.3	94.4
6	Air-blast	O.S.	5	60	10.8	96.0
7	Hydraulic	W.P.	160	300	3.6	98.7
8	Hydraulic	O.S.	20	40	4.2	98.5
9	Hydraulic	O.S.	10	40	6.1	97.7
10	No treatment	----	--	--	270.0	----

*The air-blast swath was 12 rows spaced 6′ apart. The hydraulic plots were 3 rows wide and they were treated with a 1-row tractor-mounted sprayer.

†W.P. = Wettable-powder and O.S. = Oil-suspension formulations.

The treatments in which maneb formulated in oil were applied at only 10 and 5 gallons per acre of the mixture of fungicide + oil + water (formulated in such a way that 1.5 gallons of oil was applied per acre with each application) failed to give as good control as the wettable-powder formulations. This is shown in a comparison of Treatments 4 and 5 (Table 1), in each of which the application rate was 10 gallons of the spray mixture per acre.

Treatment 7 represents the standard specifications with respect to gallonage and pressure that are used in most of the tomato spraying experiments conducted at the Ohio Station. It is evident here that the hydraulic application at 300 p.s.i. and 160 gallons of spray mixture per acre gave little, if any, better late blight control than did the use of lower pressures and gallonages with an air-blast applicator. The 20-gallon hydraulic application of an oil-emulsion formulation gave slightly better control of late-blight fruit rot than did 10-gallons, as indicated in Treatments 8 and 9, respectively.

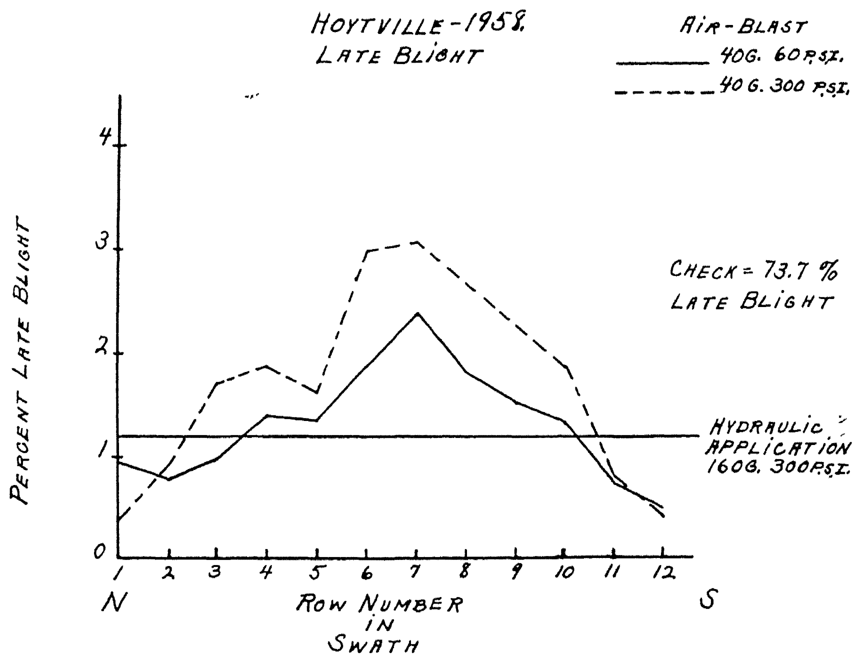

Fig. 3.—Comparative control of late blight fruit rot of tomato on each row of a 12-row air-blast swath by spraying applications made at 40 gallons per acre with pump pressures of 300 and 60 pounds per square inch.

The application of 10 gallons per acre with the hydraulic sprayer (Treatment 9) gave somewhat better disease control than did the same quantity of spray mixture applied with the air-blast machine (Treatment 5). However, one must remember that the spray material was applied with a 1-row hydraulic machine in Treatment 9 and with a 12-row air-blast sprayer in Treatment 5 and the data given for the air-blast treatments are an average of all 12 rows of the swath. Actually, in a row-by-row study of the disease occurrence in the air-blast swath of Treatment 5, the disease control in the rows under the sprayer and on the first ones adjacent to them, was better than with the hydraulic sprayer, and it was only toward the center of the 12-row swath that the control dropped off somewhat, as will be shown later.

These data on the comparative control of late blight by the different treatments in the experiment, as indicated from the first two harvests, are representative of those obtained in the next five pickings, although the incidence of the disease in the sprayed plots dropped off steadily toward the end of the harvest period.

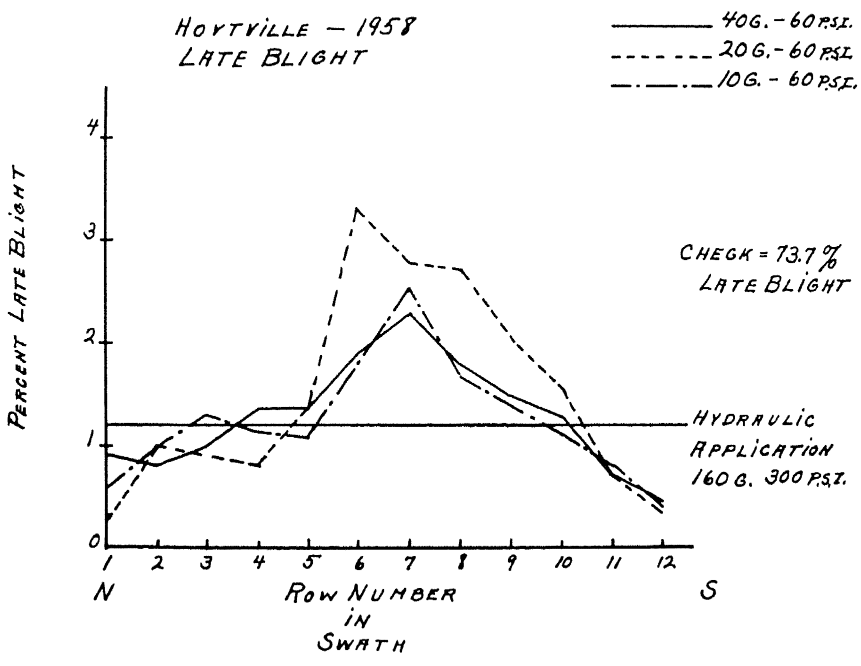

Fig. 4.—Comparative control of late blight fruit rot on each row of a 12-row air-blast swath by spray formulations applied at different rates of water use.

One of the most significant results connected with this experiment deals with variations in disease control (late blight and anthracnose fruit rots) as the distance from the air outlet of the sprayer increases; in other words, the swath-pattern of disease control. Various studies have been made of the swath-pattern of spray deposition [3, 4, 5], but this experiment marked the first good opportunity for observing the row-by-row pattern of actual disease control.

Some of the spray deposit studies have been made with the air-blast directed down the row rather than across them, and it is of interest to note that some tomato growers are now becoming interested in the possibility of spraying their fields by the former method. The decrease in the quantity of spray material deposited on the foliage as the distance from the air outlet increases is apparently quite similar in the two methods. The fact that the two halves of the spray swath overlap in the center (see Figure 1) tends to equalize the amount of fungicide deposited on each row of the swath if its width (the distance between driveways) is not too great.

The data of Table 2 show how the pattern of late blight control differed for the six variations in gallonage, pressure, and fungicide formulation. The average percentages of fruits affected with late blight lesions, as shown at the bottom of Table 2, indicate that the control was better with wettable powder formulations of maneb than with the oil-suspension mixtures (Treatments 1, 2, 3, and 4 versus numbers 5 and 6). Then when Treatments 1 and 2 are compared it is evident that, in this experiment at least, the larger spray droplets formed at a pressure of 60 p.s.i. were giving better control across the whole swath, and especially in the rows farthest from the sprayer, than were the smaller drops formed at 300 p.s.i., possibly because their greater mass was enabling them to travel a more definitive path to make contact with the foliage.

The average percentage of fruits showing late blight lesions on the standard hydraulic application of 160 gallons per acre at 300 p.s.i. (Treatment 7) was 1.2 percent. In checking this value against the

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[3]Wilson, J. D. 1958. Vegetable disease control experiments in Ohio in 1953. Ohio Agric. Exp. Sta., Botany and Plant Path. Series 16: 35-41.

[4]Wilson, J. D. 1954. Summary of vegetable disease control experiments in Ohio in 1954. Ohio Agric. Exp. Sta., Botany and Plant Path. Mimeo. Series 17: 49-56.

[5]Wilson, J. D. 1956. Summary of experiments in vegetable disease control in 1955. Ohio Agric. Exp. Sta., Botany and Plant Path Mimeo. Series 18: 31-38.

individual rows of Treatment 4 (10 gallons per acre at 60 p.s.i. into the air-blast) it is evident (Figure 3) that 7 of the 12 rows had a percentage of late blight lower than 1.2, which in itself speaks very well for the ability of the air-blast sprayer to cover the tomato foliage with the fungicidal agent, even with only 10 gallons of water per acre.

Just how effective the 10-gallon per acre air-blast application was in the control of the two fruit rots of tomato present in this experiment (anthracnose and late blight) is well demonstrated in Table 3 where anthracnose control was the best of any of the treatments used, and late blight control was as good as with higher air-blast gallonages. As a result, the percentage of cull fruits was lower even than that for the single-row hydraulic application of 160 gallons per acre at 300 p.s.i. (Treatment 4 versus 7). In terms of net yield the 20-gallon per acre air-blast application (Treatment 3) ranked highest, but comparatively little significance can be attached to these yield data (with the exception of that of the untreated check plots where virtually all of the fruit was ruined by late blight) because of the unevenly distributed areas of early water damage in the experimental block.

TABLE 2.—Percentages* of fruits affected with late blight on rows 1 to 12 of the differently treated air-blast swaths on tomatoes at Hoytville in 1958

Row† number in swath	Treatments (See Table 3)						Averages‡ of treatments
	1	2	3	4	5	6	1, 2, 3, & 4
1	0.40	0.94	0.20	0.60	0.32	0.42	0.54
2	0.90	0.80	1.00	1.00	1.33	0.67	0.92
3	1.68	0.96	0.91	1.32	5.93	2.03	1.22
4	1.87	1.38	0.80	1.13	4.32	3.10	1.30
5	1.60	1.32	1.32	1.10	5.00	3.00	1.34
6	2.97	1.87	3.30	1.80	8.10	3.67	2.49
7	3.01	2.31	2.75	2.53	7.42	5.98	2.65
8	2.63	1.83	2.71	1.70	7.70	6.35	2.22
9	2.29	1.51	2.03	1.44	4.50	3.06	1.82
10	1.83	1.30	1.57	1.13	4.00	2.00	1.46
11	0.74	0.71	0.72	0.80	0.66	0.55	0.74
12	0.42	0.48	0.37	0.40	0.25	0.20	0.42
Averages	1.83	1.27	1.36	1.26	4.00	2.54	

*73.7 percent of the fruits showed late blight lesions in the untreated check plots.

†Sprayer driven over rows 1 and 12 blowing toward 12 and 1, respectively, with rows 6 and 7 farthest from the air outlet.

‡The average percentage of fruits with late blight with the standard hydraulic application was 1.2 percent for the season.

Treatments 5 and 6 consisted of maneb suspended in oil plus an emulsifying agent with water added and were applied at 10 and 5 gallons per acre of spray mixture at such a rate of water use that 1.5 galons of the oil-maneb mixture were applied per acre. This formulation, or one very similar to it, gave excellent control of late blight in 1957[2] and for that reason was tested further in this experiment. However, at these low gallonages the control was not equal to that obtained with the wettable powder-water formulations of Treatments 1 to 4, inclusive, and there was some oil injury. This was also true for treatments 8 and 9 where the oil-emulsion formulations were applied with the 1-row hydraulic sprayer used in Treatment 7. The wettable-powder versus oil-emulsion comparison can be made between Treatments 4 and 5, respectively, where number 4 was definitely superior to number 5.

Most of the discussion up to this point has dealt with late blight and the control of the fruit rot which it causes, but some of the data on the control of anthracnose fruit rot on the different rows of the air-blast

TABLE 3.—Comparative control of anthracnose and late blight fruit rots by different formulations of maneb applied at different gallonages and different pressures with air-blast and hydraulic equipment

Treatments	Net yield* in tons per acre	Percentages of fruits as,—		
		Culls (all harvests)	Anthracnose (all harvests)	Late blight (first two harvests)
1. AB – 40g – 300 p.s.i. – WP†	17.9	5.7	2.18	1.82
2. AB – 40g – 60 p.s.i. – WP	19.7	5.2	2.37	1.27
3. AB – 20g – 60 p.s.i. – WP	20.4	6.2	2.70	1.36
4. AB – 10g – 60 p.s.i. – WP	16.8	4.8	2.16	1.26
5. AB – 10g – 60 p.s.i. – OS	14.2	8.1	3.32	4.00
6. AB – 5g – 60 p.s.i. – OS	12.0	6.6	3.00	2.54
7. Hyd. – 160g – 300 p.s.i. – WP	15.6	5.1	2.44	1.20
8. Hyd. – 20g – 40 p.s.i. – OS	13.8	6.0	3.26	1.38
9. Hyd. – 10g – 40 p.s.i. – OS	14.0	7.5	3.72	1.80
10. No treatment	1.9	38.5	12.3	73.7

*The yield data in connection with this experiment are of little significance due to an unequal amount of water damage in the different replicates of the differently treated plots.

† AB=Air-blast equipment.
HYD.=Hydraulic equipment.
g=Gallons per acre.
p.s.i.=Pressure in pounds per square inch.
WP=Wettable-powder formulation.
OS=Oil-suspension formulation.

swath should also be examined. The percentages of the fruits showing anthracnose lesions for all harvests from the differently treated plots are given in Table 3. The percentage of diseased fruits on each of the 12 rows of the air-blast swath for treatments 1 to 4, inclusive, in Table 3 are shown in Figure 5.

The percentage of fruits affected by anthracnose for each of the first four air-blast treatments varied but little (from 73 to 82 percent less than that present on the untreated check plots), and the difference in control by the best and the poorest treatment was somewhat less than the spread in late blight control (see the last two columns of Table 3). The average degree of control of anthracnose for all 12 rows of the four air-blast treatments in which the wettable powder formulations was used (Treatments 1 to 4, inclusive) was better in three instances than that provided by the 1-row hydraulic sprayer which applied a much larger gallonage of water (Treatment 7). Ten gallons per acre of the oil-emulsion formulation gave better control when applied with the air-blast (Treatment 5) than with the hydraulic machine (Treatment 9).

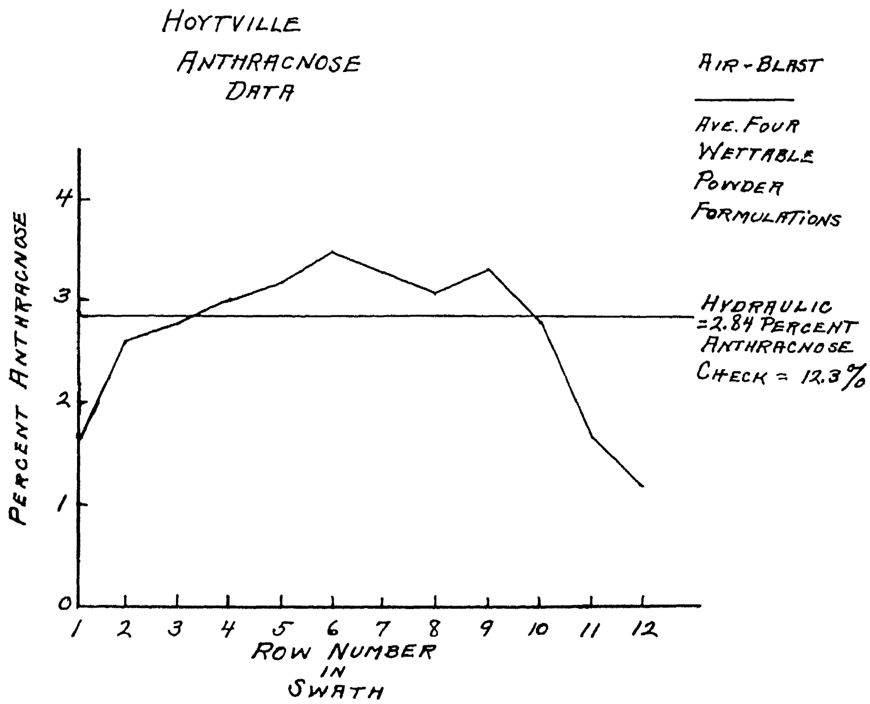

Fig. 5.—Comparative control of anthracnose fruit rot of tomato on the different rows of 12-row air-blast swath.

In terms of percentage of total culls only one of the air-blast treatments (No. 4) gave better results than the 1-row hydraulic sprayer (No. 7). However, when the gallonage used was the same with both types of application the percentages of culls were not very different (No. 3 versus 8 and No. 5 versus 9).

The data of Figure 5 indicate that, when the percentage of anthracnose-infected fruits on the different rows of the 12-row swath for all four of the air-blast treatments in which the wettable-powder formulation of maneb was used were averaged, five of the 12 rows had fewer diseased fruits than were present in the rows sprayed with the standard hydraulic application of 160 gallons of spray mixture applied at 300 p.s.i.

CONCLUSIONS

The occurrence of late blight in epidemic form in an experimental block of tomatoes in Western Ohio in 1958 afforded an excellent opportunity to study the control pattern across the swath of an air-blast sprayer being used to apply a fungicide with different rates of water use. Also, the inclusion in the experiment of a hydraulic sprayer of the fixed-boom type made it possible to compare the performance of these two types of equipment.

When the pressure at which the spray material was introduced into the blast of air was varied, while the volume was held constant at 40 gallons per acre, the control was better at the lower pressure.

There was little to choose between applications made at 40, 20, and 10 gallons per acre when the same amount of fungicide was applied to the same unit of area, with the 10-gallon rate giving as good disease control as the use of 20 and/or 40 gallons.

When wettable powder and oil-suspension formulations were compared the former gave the better disease control and were less injurious to the tomato foliage.

The average percentage of late blight infection on the tomato fruits was as low for the 12-row air-blast swath as it was with the 1-row hydraulic type of sprayer, when wettable powder formulations were used.

The degree of control of late-blight fruit rot dropped off slightly toward the center of the 12-row swath (72 feet), which was thus 36 feet from the air outlet of the sprayer, but even on the center rows the degree of control was 96 percent in terms of the percentage of disease in the unsprayed check plots.

The swath pattern of the control of anthracnose fruit rot was slightly different from that of late blight control, since there was less variation in the percentage of disease throughout the center portion of the swath with the former than with the latter.

Finally, the data obtained in this experiment indicate that an air-blast sprayer can be effectively utilized to control late blight and anthracnose fruit rots of tomato, provided, of course, that the spray applications are made at the proper time intervals, when the air is comparatively quiet, and at swath widths (distances between driveways) that are not too great for the capacity of the machine being used.