Boom and Broadcast Sprayers

comparative field and laboratory study of spray distribution as applied by two types of sprayers on spotted alfalfa aphid

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At approximately the same time that maximum control of the spotted alfalfa aphid—*Therioaphis maculata* (Buckton)—became of great importance, a new boomless sprayer for broadcasting insecticides became popular in some areas.

The boomless sprayer has a single nozzle—or cluster of nozzles—that replaces the boom on the conventional spray rig. Because the boomless sprayer was new in the insecticide field, studies were made to compare its effectiveness with that of the boom type sprayer. The studies were made in the field during the 1956 season, in relation to actual aphid control treatments, and also under separate laboratory conditions.

Three of the most common types of boomless cluster nozzles—broadcast applicators—were matched against a standard 30′ spray boom in each case. The booms had properly spaced, flat fan nozzles that were common for size and pump pressure. Together the boom nozzles gave the same gallonage output per acre as the boomless system. As closely as possible, the same kind of tractor, pump system, speed of spraying, and gallons used per acre were maintained with each comparison trial.

The cluster nozzles were selected on the basis of those used most commonly in the field, as well as because of their variation of one, three or five orifices, and were identified as broadcast nozzle No. *1*, No. *3*, and No. *5*. The over-all size of the largest of the applicators was no bigger than a man's fist.

Broadcast nozzle attachment was made at the rear-center of the tractor or trailer spray unit, and at the height suggested by the manufacturer.

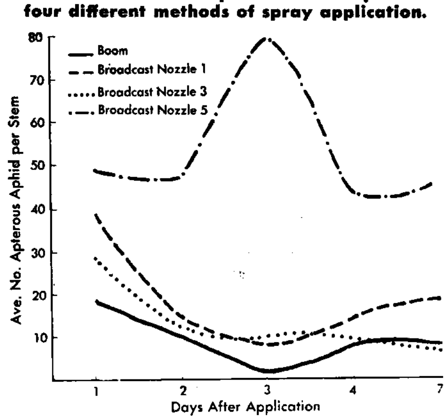
Theoretically the boomless system carries the spray through a high and solid arc out 15′–30′ to each side of the nozzle. For the trials, the boomless nozzles were regulated through pressure, gallons per acre, and speed to approximately 15′ arcs, or a total 30′ swath.

Field evaluation was made in each multi-acre replication—four replications per application system—by counting the number of spotted alfalfa aphids per stem and at each 3′ interval across the pattern of the spray swath. The count, actually made perpendicular to the line of the sprayer travel, was done at four locations in each replication.

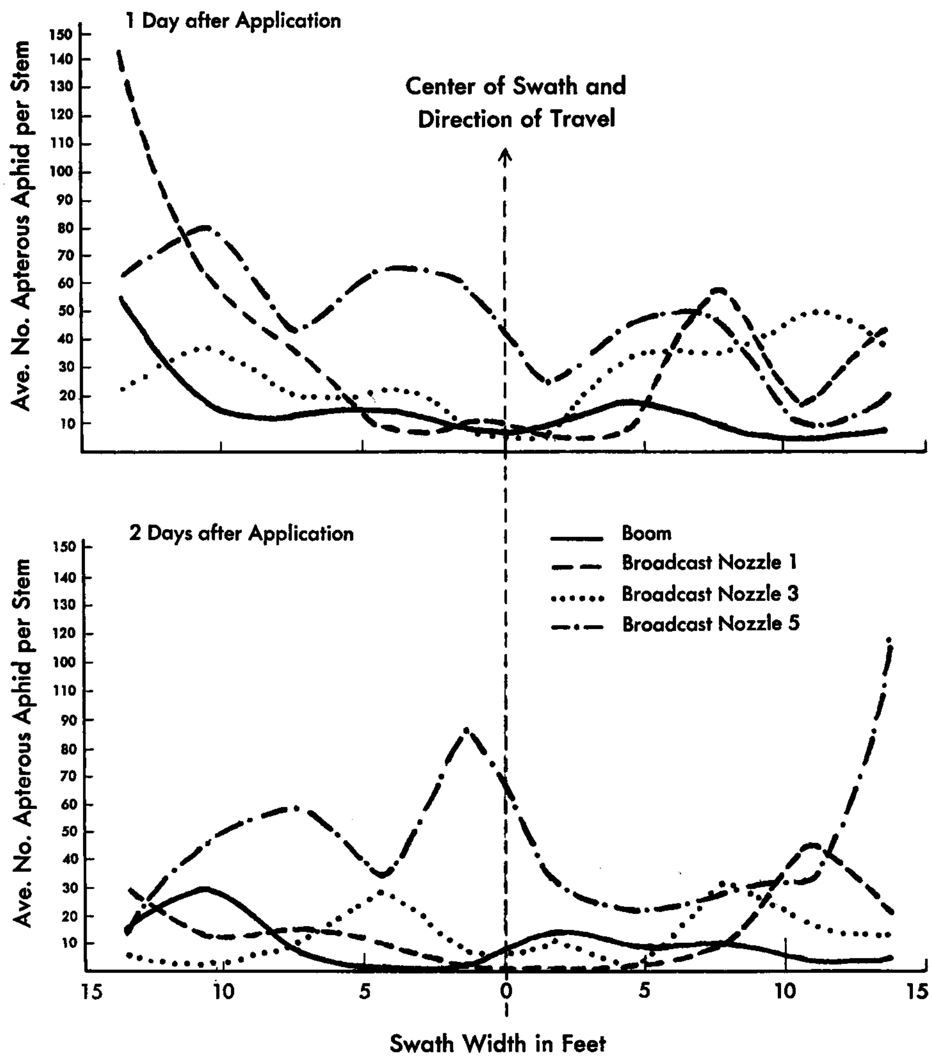
Malathion—at the rate of eight ounces actual per 10 gallons of water per acre—was used as the plot insecticide, so that direct contact kill and not fuming action would be involved. The aphid kill was satisfactory where good coverage was attained.

The small graph on this page shows the consolidated average counts for the various field trials, in relation to the average number of living aphids per stem in the spray swath. The lower and more horiontal the graph line, the better the nozzle performance.

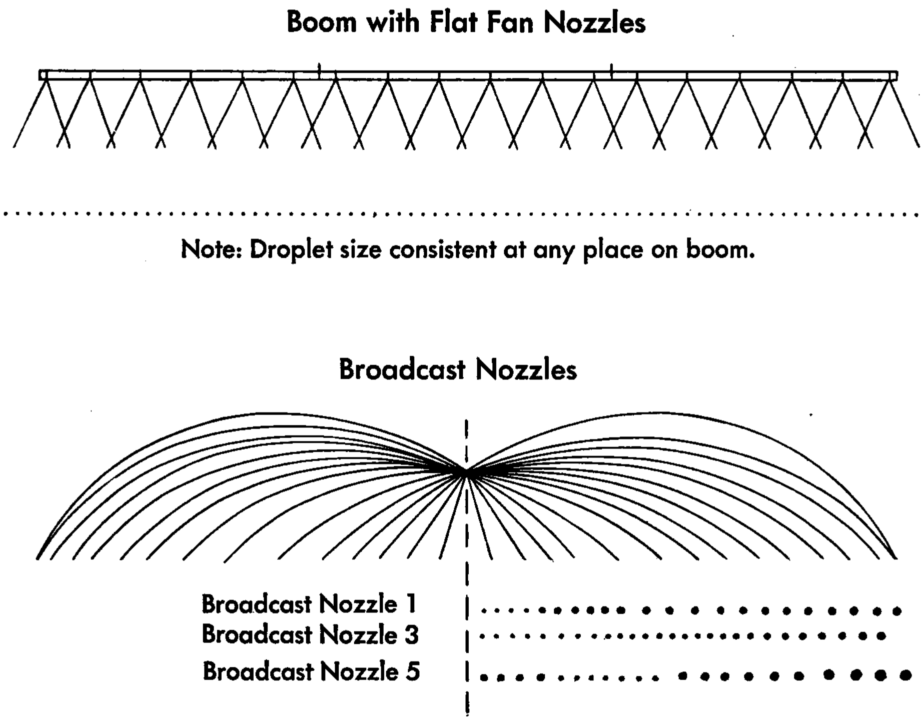
Relative control of the spotted alfalfa aphid with four different methods of spray application.



Variation of swath uniformity in relation to apterous spotted alfalfa aphid control.



Relative consistency* of spray droplet size of boom and broadcast nozzles as recorded on paper.



* Not actual droplet size.

The graph also indicates that all four types of test applications lessened the pretreatment aphid population average of 235.5 per stem. Apparently coverage or spray distribution was the principal cause of the variation. There were no constant winds during the spray application period, but there were occasional gusts of wind that were impossible to measure. The boom sprayer and the broadcast nozzles No. *1* and No. *3* appear to follow fairly close to a control pattern. Slight aphid build-up at approximately the fourth day was normal for malathion. Near parallel activity for the boom and broadcast nozzle No. *3* appeared consistent in most trials, with broadcast nozzles No. *1* and No. *5* exhibiting a sporadic pattern. Even though the graph shows broadcast nozzle No. *1* to be almost as good as No. *3* and the boom, it usually fell short of their performances, but was superior to No. *5*. No explanation of the high peak for No. *5* could be found. However, even at best the control obtained with No. *5* did not appear generally as effective as the boom and Nos. *1* and *3*, throughout the field trials.

The larger graph on page 6 represents an elevation diagram—much like an architectural drawing—and shows the variation of control attained. The level of aphid control across the average replicated spray swath is represented for each form of application. Here again the lower and more horizontal the graph line, the better the nozzle performance. However, because spotted alfalfa aphid populations are not consistent across any alfalfa field, a variation—even after spray application—might exist.

The diagram at the top of this page shows relative spray droplet size of the boom and broadcast nozzles, as recorded by a method improvised to give a relative field evaluation as the sprayer passed over recording paper.

Though from slightly more to severely more sporadic than the more positive spray distribution by boom rig application, broadcast nozzles offer an application method initially lower in cost, plus ease in maintenance and convenience factors. The field disadvantage of the broadcast method appears to be a less positive spray distribution that is further lessened when there is a wind.

Effect of Wind

Other trials—also during 1956—were conducted to determine the effect of varying crosswind conditions on the spray pattern and swath width. The same types of nozzles were used in this second group of trials but the sprayer units were different.

Several field runs were made with each sprayer while wind velocities ranged from 1.7–5.4 miles per hour. The direction of travel was varied with the wind direction to produce crosswinds or components of crosswinds.

The swath width and spray distribution were determined for each of the runs by collecting the spray on a set of 3″ × 6″ stainless steel plates laid on the ground 1′ apart. The spray material contained one pound of red dye—safranine—per 100 gallons of water. The plates were washed with a 50% solution of ethanol and the washings analyzed for dye content on a colorimeter. Wind velocity was measured at 1′ and 3′ levels with an anemometer and wind direction was observed from a weather vane at the point of the runs.

The sprayers tested were all in the 10 gallons per acre delivery range for the conditions used. They were also adjusted and operated according to the manufacturer's instructions. Ground speeds for all tests were approximately 4 mph.

The larger graph on page 10 shows the effect of wind on the spray swath. The ends of the swath were determined as the points on the spray distribution graph where the concentration of material dropped below one half the average. The arrows at the left of each bar indicate the wind velocity and its direction with respect to the direction of travel for that run. The lettered bars designate the test runs and are representative of the results obtained. Tests *A* and *B* were with the boom sprayer with nozzles; tests *C* and *D* with broadcast nozzle No. *3; E* and *F*, broadcast nozzle No. *1*; and tests *G* and *H* with broadcast nozzle No. *5*.

A distribution graph was plotted for each run to determine the variation in the distribution of spray material over the swath width. The average distribution line indicates the average for the entire swath. The arrows indicate direction of travel and wind direction. There was a shift of the pattern downwind and a pileup of material on the windward side. On the broadcast sprayer trials, the peak on the graph or maximum point on the

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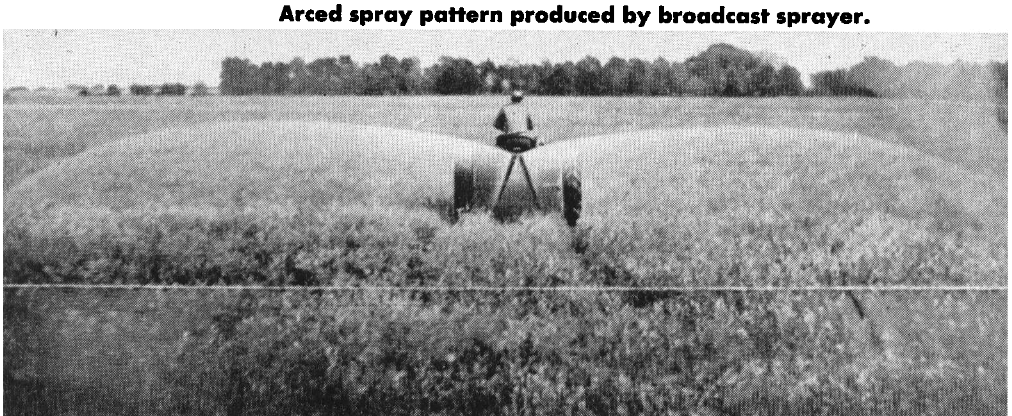
Arced spray pattern produced by broadcast sprayer.



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distribution pattern ranged from 1.2–2.0 times the average spray distribution level. The range on the boom sprayer was from 1.3–1.4 times the average. The smaller graph on this page represents the spray distribution for test run *F* as shown on the larger graph.

Over the range of wind velocities in the trials the effect of crosswind on the swath width was very pronounced for the broadcast sprayers. Crosswinds lengthened the downwind side and shortened the upwind side of the spray swath by as much as 3′ per mile per hour of perpendicular wind component. This factor would make swath matching difficult under variable wind conditions in the field but the problem could be minimized by spraying downwind only in a crosswind. Driving parallel to the wind direction would also help, but tend to be of some hazard to the operator when traveling downwind. The effect of wind on the width of spray swath was negligible for the boom type sprayer.

Variations in Distribution

The distribution of spray material in the swath varied considerably for the different types of broadcast sprayers. It was not uncommon for the pileup of spray material to exceed the average distribution by 100%. The wind tends to separate the spray droplets by size, the larger drops carrying further against the wind. Since spray drop size can be shown to affect the control of pests, variation in control can be expected because of this factor. The single nozzle broadcast sprayers produced over-all larger spray droplets, and consequently their distribution was less affected by the wind than the multiple nozzle types. There was a certain amount of pileup of spray material at the nozzle on the upwind end of the boom, although the over-all spray swath of the boom sprayer was not affected. As much as 30% variation was found in coverage between different makes of flat fan nozzles on the boom type sprayer.

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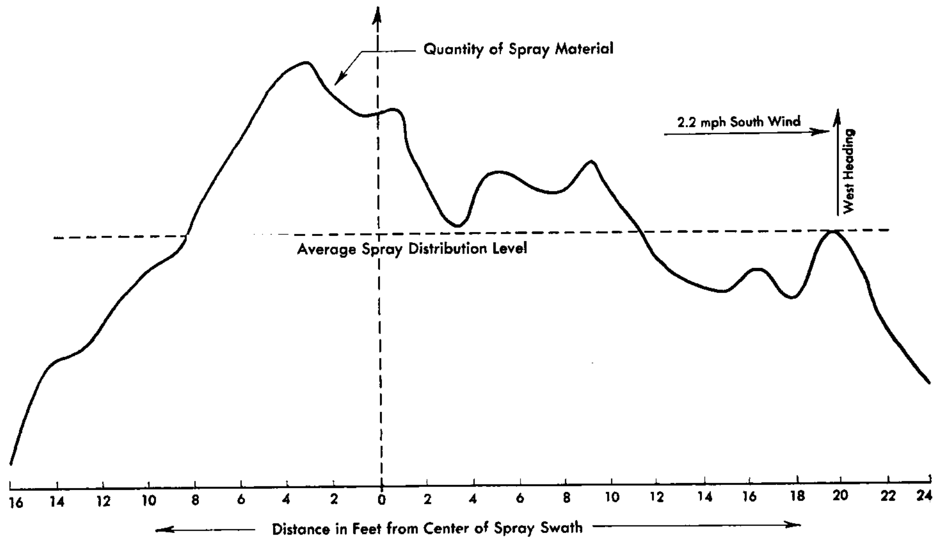
Wind effect on spray distribution of a broadcast nozzle.



Effect of wind on spray swaths.