Evaluating New Nozzles and an Air Assist Sprayer for Improving Spray Coverage and Powdery Mildew Control on Underleaf Surfaces

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ABSTRACT

The goals of this project were to identify equipment that maximizes spray coverage on the underside of leaves of cucurbits and to determine if powdery mildew can be controlled effectively with nonsystemic fungicides when coverage is maximized. Conventional nozzles and sprayers deliver little spray material to the underside of leaves. Therefore, growers presently rely on systemic fungicides to control powdery mildew in cucurbits. Fungicide resistance is a major concern because systemic fungicides are at-risk for resistance development due to their single-site mode of action and because the powdery mildew fungus has demonstrated high potential for developing resistance. For this project, unfortunately, it was only possible to examine spray coverage because of technical problems with the sprayer. Greater coverage on both leaf surfaces was achieved with the air induction and twin jet nozzles, two novel types for a conventional hydraulic spray boom, than with the traditional flat fan, hollow cone, and cone jet nozzles. Better coverage was obtained on upper leaf surfaces with these novel nozzles than with the air assist boom; similar coverage was obtained on the underside of leaves. The differences between the novel and traditional nozzle types were not great, however, this was a limited study because it could not be started until late in the growing season. Additional research is needed to further these preliminary results and to obtain a true measure of spray coverage by examining disease control.

BACKGROUND AND JUSTIFICATION

Effective control of powdery mildew in a cucurbit crop necessitates controlling the disease on the underside of leaves. Conditions are more favorable for development of powdery mildew on the under compared to upper surface. A protectant fungicide applied with conventional nozzles is deposited almost exclusively on the upper surface of leaves. Leaves die prematurely when powdery mildew is not controlled effectively on the underside. Thus systemic fungicides have been critically important for powdery mildew control. Unfortunately, systemic fungicides are at-risk for resistance development. The powdery mildew fungus has demonstrated high potential for developing resistance.

A means to improve spray deposition on the leaf underside would reduce grower dependence on systemic fungicides. This would be even more valuable for organic growers because there are no systemic fungicides that are approved for organic production. Several novel nozzles have come into the market place for conventional boom sprayers that reportedly improve coverage by delivering more spray to the leaf underside and also by reducing drift. Another approach to improving coverage is to use an air assist sprayer. Air assist sprayers use air as a carrier for the pesticide. A fan is used that moves air at a fast speed thereby pushing the spray into the canopy and also generating turbulence that moves spray to undersides of leaves. Nozzle velocity can be up to 180 mph. This is an expensive means to improving coverage because it entails purchasing a new sprayer rather than just new nozzles. Another benefit of improved deposition is the potential to maintain good control but with lower pesticide rates.

The goals of this project were to identify spray equipment that maximizes spray coverage on the underside of leaves and to determine if powdery mildew can be controlled effectively with nonsystemic fungicides when coverage is maximized. Disease control is the ultimate measure of coverage because it includes the entire canopy, in contrast with water sensitive paper that can only measure a small percentage of the canopy. The sprayer selected for this project is a tractor-drawn air assist sprayer with a second conventional boom that parallels the air assist boom.

Two novel nozzles (air induction and twin jet) and three traditional nozzles (flat fan, hollow cone, and cone jet) were selected for comparison on the conventional boom. All are considered ideal for applying fungicides. Twin-jet flat fan nozzles use forward and rearward pointing flat fans, which in effect gives two opportunities to hit the plant. They apply the same amount of liquid as a conventional flat fan but halve the quantity for each hole, resulting in a small hole producing smaller droplets for a given output. Smaller droplets stick to leaves, therefore the potential for better deposition maybe acceptable. These nozzles were used at 85 psi and 71 gpa. Air induction, air inclusion or venturi nozzles are flat fan nozzles where an internal venturi creates negative pressure inside the nozzle body. Air is drawn into the nozzle through two holes in the nozzle side, mixing with the spray liquid. The emitted spray contains large (300 micron) droplets filled with air bubbles (similar to a candy malt ball) and virtually no fine, drift-prone droplets. Normally these droplets would be large enough to bounce off their target. However, because of the air they explode on impact and spread over the leaf as the air absorbs the impact load. Coverage is similar to conventional, finer sprays. Drift is reduced even at pressures of $\geq$80 psi. These nozzles were used at 92 psi and 74 gpa. Flat fan 110 degree nozzles were chosen for their finer droplet characteristics compared to 80 degree nozzles. They were used at 85 psi and 54 gpa. The hollow cone is a very traditional design comprising a core that creates the swirl (also called a swirl plate) and a ceramic disc that contains the hole. These nozzles were used at 85 psi and 81 gpa. Cone jet nozzles create small droplets in an 80 degree cone. They were used at 100 psi and 42 gpa. In addition, the air assist boom was operated at 63 psi and 23 gpa with the fan at maximum speed.

MATERIALS AND METHODS

Unfortunately, it was not possible to evaluate disease control because the sprayer was not working correctly and required extensive modifications to the design that could not be completed before powdery mildew was well-established. However, spray coverage on pumpkin and muskmelon leaves was examined using water sensitive paper. These two cucurbit crops were selected because they have different canopies. Muskmelon leaves are much smaller and shorter than pumpkin leaves. Also, most leaves in the muskmelon canopy are at the same level whereas the pumpkin canopy consists of a few layers of leaves. Coverage was examined twice on both crops (28 Aug and 7 Sept) and a third time on pumpkin (14 Sept). Water sensitive paper cards were attached in pairs to both leaf surfaces using a staple or paper clip. The proportion of each card that changed color due to spray deposit was determined using a computer scanning program specifically designed for this purpose (Droplet Scan by WRK of Arkansas).

RESULTS AND DISCUSSION

All spray equipment provided much better coverage on upper than on under leaf surfaces with both crops. The air induction and twin jet nozzles provided the greatest coverage on both leaf surfaces. For cards on upper leaf surfaces, percent spray coverage averaged over both crops and all 3 dates was 59% for the air assist boom, 84-90% for the traditional nozzles, and 91% for the novel nozzles. Percent spray coverage for cards on the underside of leaves was 5% for the air assist boom, 1-4% for the traditional nozzles, and 5% for the novel nozzles. The difference between the novel and traditional nozzle types, however, is not great. It remains to be seen whether this is sufficient to affect disease control.

CONCLUSIONS

Additional research is needed to further these preliminary results in a more comprehensive study with more coverage evaluations and to obtain a true measure of spray coverage by examining disease control. Implementing the necessary changes to achieve better spray coverage will not be very costly if the novel nozzle types for a conventional boom prove to provide better coverage than traditional nozzle types and at least as good coverage as an air assist boom. Switching from a conventional to an air assist boom would be substantially more expensive. If coverage is improved sufficiently, growers will be able to reduce the quantity of pesticides used because they will not need to apply systemic fungicides as much as they now need to.