Designing a Better Sprayer for Pesticide Application in Strawberries

Laura McDermott[1] and Andrew Landers[2]
[1]Cornell Cooperative Extension, 415 Lower Main Street, Hudson Falls, NY 12839
[2]Cornell University, Barton Lab, NYSAES, Geneva, NY 14456

Strawberry growers using conventional boom sprayers find it difficult to obtain good disease and insect control due to poor pesticide coverage on the undersides of leaves, on the lower leaves, and on the fruit when the strawberry plant is in full canopy. Inadequate crop protectant coverage results in higher levels of disease and insect activity translating to consumer rejection of poor quality fruit and lower overall profitability of the planting.

"We evaluated a modified sprayer boom in commercial strawberry fields. The use of a modified boom gave better coverage of interior and lower leaves especially later in the season. This system may help growers perfect spray application, but more work on this prototype is necessary to better understand the importance of factors like row alignment in the field."

This project focused on spray systems for strawberries – a high value crop with a low, 3-dimensional canopy. Strawberry diseases are a big concern for growers, so adequate spray coverage is important – better coverage would allow growers to make fewer applications of fungicides during the growing season.

Drift is often identified as being the biggest source of problems with spray deposition. In fact there are other, inter-related factors that combined with drift, make designing the perfect crop protectant delivery system a challenge. These include the sprayer design, the droplet size and the size of the spray fan. The air volume, direction and velocity will also affect the amount of material that is deposited vs. the amount that is lost to drift. Application rate, nozzle orientation and the speed of the tractor, plus the skill and attitude of the tractor operator are also factors. Additionally the crop canopy will determine deposition rate and the weather also has a great deal of influence.

Materials and Methods

A prototype 'modified boom' was built at Cornell University and in 2007 the first field trials were conducted to determine appropriate volume rates, proper nozzle selection and the best pressure and nozzle positioning. In the trials we compared three sprayer systems: a traditional boom, a hoop boom with 3 nozzles and a hoop boom with 5 nozzles. Deposition onto the crop was measured by adding Pyranine fluorescent tracer into the sprayer tank. Leaves were picked from the top, middle and bottom part of the canopy. Three leaves from each area were placed into plastic bags and sealed. Ten plants per treatment were selected and there were five replicates.

The following growing season (2008), 2 more "hoops" were constructed and fitted to the sprayers belonging to berry growers John Hand of Hand Melon Farm in Greenwich, NY and Dale Ila Riggs of The Berry Patch in Stephentown, NY. The modified booms or hoops were connected to the existing plumbing system. The hoop was designed with 5 nozzles and the grower could target the canopy with the appropriate number of nozzles, most likely increasing from 3-5 targeted nozzles as the strawberry canopy developed (Figure 1).

Florescent pyranine tracer was used to reveal the coverage of spray distributed throughout plant canopy at two different dates.

Biological effectiveness was rated by noting the presence or absence of infection or insect damage on leaf and fruit tissue. These observations were made for 3 different canopy stages on 2 farms. The degree of infection on leaf and fruit tissue was also rated. Seven leaves were evaluated for each of 5 replications with

Figure 1. Modified boom attached to spray rig, above. Close up of boom design with all 5 nozzles, below.

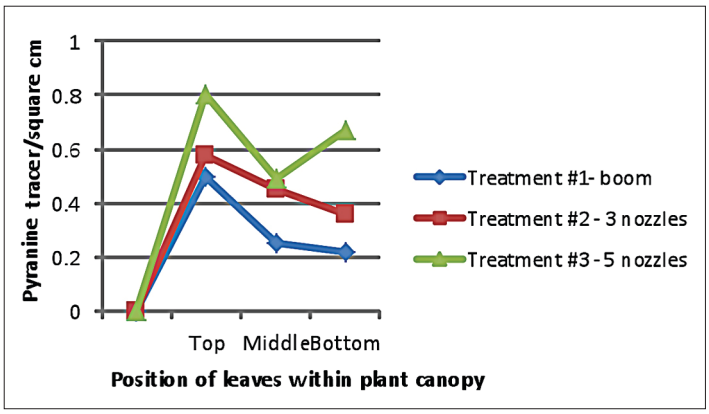

Figure 2. Amount of spray coverage measured on plant canopy of strawberries from three sprayer design treatments in 2007.

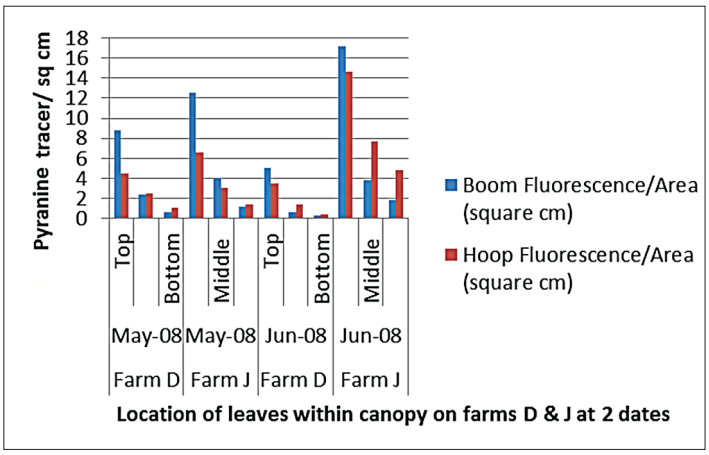

Figure 3. Spray coverage within strawberry canopy from two sprayer designs at two farms in 2008.

1 being no infection/damage and 5 being entire surface infected/damaged. Twenty-five fruit for each of 4 replications were evaluated using the same rating system. This rating protocol helped to determine if differences existed in effectiveness of spray coverage from each treatment.

Results

In 2007, we found that adjusting the volume rate from 6 L/100 m of row length to 9.5 L then finally to 12.5 L per 100 meters row length as the season progressed and as the crop canopy grew resulted in the best spray deposition over the season (Table 1).

The most appropriate nozzles were 02 and 03 nozzles because 015 nozzles were too small and the resulting small droplet size increased the risk of drift and lowered the capacity (rows per hour (Table 2). Best coverage results were at 75 psi with the nozzles 4-8 inches above the target (Figure 2).

In 2008, with the on-farm trials using modified grower sprayers, the traditional boom sprayer delivered the best coverage to the outer leaves at both farms on both dates, but this was not the case for the mid and lower canopy leaves as the season progressed. Farm D with the smaller boom sprayer and lower pressure application got better coverage from the modified hoop sprayer in the mid and lower canopy leaves and the improved coverage continued throughout the season. The larger boom that uses higher pressure during spray application did not see an advantage to the hoop until later in the season. Then, the inner and lower leaves were covered more thoroughly by the modified boom than they were with the traditional boom (Figure 3).

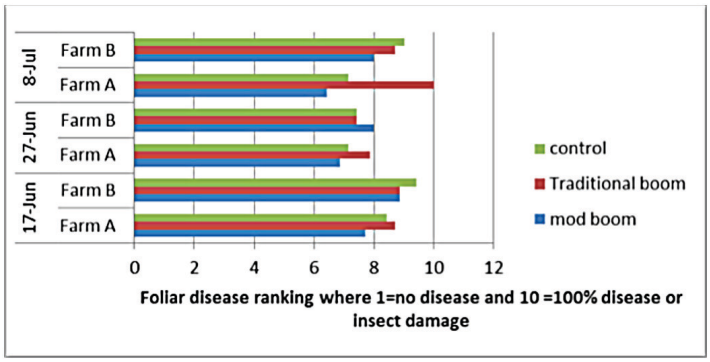

Figure 4. Severity of foliar damage following sprays with modified vs. traditional boom at two farms in 2008.

The biological effectiveness data did not show significant statistical differences between treatments, however, clear and consistent trends were apparent (Figure 3 and 4). For 4 of the 6 comparisons, the use of the modified boom (hoop) appeared to give an advantage over the traditional boom in the control of foliar disease. For all 6 comparisons, the use of the modified boom (hoop) appeared to result in a lower incidence of disease infection and/or insect damage on the fruit than did the use of the traditional boom.

Table 1. Application volume treatments used on strawberries in 2007.

Treatment	Liters/100 meter	Gallons/A
1	6	40
2	9.5	79
3	12	105.2

Table 2. Application parameters for 3 sprayer designs treatments used on strawberries in 2007.

Treatment	Nozzle Type	Nozzle Number	Flow rate/ nozzle	Pressure	Speed
1	Flat fan – yellow 80 02	Horizontal boom	0.98 l/m (0.26 gpm)	5bar (75psi)	3.2 km/h 2 mph
2	Flat fan – blue 80 03	3 nozzle hoop	1.52 l/m (0.4 gpm)	5 bar (75 psi)	3.2 km/h 2 mph
3	Flat fan – blue 80 03	5 nozzle hoop	1.52 l/m (0.4 gpm)	5bar (75 psi)	4.0 km/h 2.5 mph

Summary

Applying crop protectants to strawberries can be improved with attention to variables like drift reduction, appropriate nozzle selection, increasing spray volume as the canopy grows and applicator skill and attention. The use of a modified boom may help growers perfect spray application, but more work on this prototype is necessary to better understand the importance of factors like row alignment

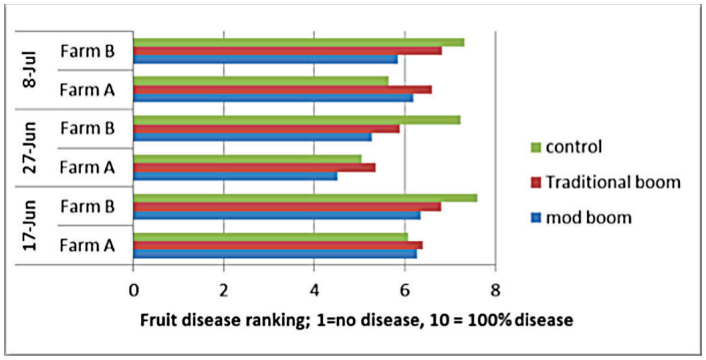

Figure 5. Severity of fruit diseases following sprays with modified boom vs. traditional boom at two farms in 2008.

in the field. The two farmer participants observed that straight rows and level fields would positively affect the spray application from a modified boom even more than those field attributes affect the performance of a traditional boom. Conversely, sloping fields and crooked rows will make it very challenging to use the more exacting modified boom successfully.

Acknowledgements

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Laura McDermott is an extension specialist located in Eastern NY that specializes in berry crops. **Andrew Landers** is pesticide application technology specialist in the Department of Entomology Cornell University, located at the Geneva Experiment Station. He leads a team studying methods of improving deposition and reducing drift.

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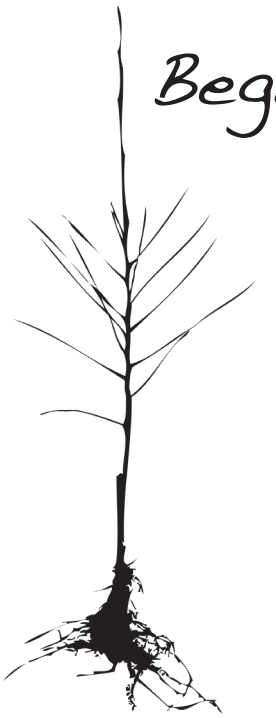

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