I. & M. Smith (Pty) Ltd.

P.O. Box 5687
Johannesburg
2000
South Africa

Telephone: +27 11 337 8740 to 45
Fax: +27 11 333 6897
Email: imsmith@iafrica.com
Telex: 48 7143 SMITH SA

Agents for Electrostatic Spraying Systems Inc. U.S.A., in Africa

1993 Research Report to the
New York State Cabbage Advisory Committee

TITLE: Evaluating spraying systems for reducing the environmental impact of cabbage pest control

PRINCIPAL INVESTIGATOR: Richard C. Derksen
Agricultural and Biological Engineering
Riley-Robb Hall
Cornell University
Ithaca, NY 14853-5701

MATERIALS AND METHODS:

The 1993 study evaluated three different commercially available application techniques that could be used to apply cabbage insecticides. Overall in the study there were four different treatments: 1) a conventional, hydraulic, broadcast boom sprayer, 2) a Hardi TWIN, air assist, hydraulic, broadcast boom sprayer, 3) an ESS, low volume, air assist, electrostatic sprayer applying full-rate recommendations of active ingredient and 4) an ESS, low volume, air assist, electrostatic sprayer applying half-rate recommendations of active ingredient. The Hardi TWIN boom sprayer was used to simulate a conventional spraying system by turning the air system off. The conventional application was made using Hardi 1553-20, grey swirl, hollow cone nozzles operating at 98 psi to apply 35 gpa while traveling at 5 mph. The Hardi TWIN was used to represent lower volume applications made with air assistance. The TWIN applications were made with Hardi 4110-12, flat fan nozzles operating at 72 psi to apply 13.5 gpa while traveling at 5 mph. Both applications with the ESS sprayer were made with the charging activated and with nozzles oriented in broadcast configurations applying 4.5 gpa of spray solution while traveling at 5 mph.

The cabbage variety used in the study was Superior which is thrips resistant. Javelin, *Bacillus thuringiensis* variety kurstaki, was the control for imported cabbage worm, cabbage looper, and diamondback moth. Full-rate treatment of Javelin for controlling imported cabbage worm and diamondback moth was 0.5 lb/acre. Full-rate treatment of Javelin for controlling cabbage looper was 0.75 lb/acre. No surfactants were added to any of the spray treatments. Cabbage plots (12, 3-ft rows x 55-ft) were scouted weekly. A threshold level of 30% infested plants for processing cabbage was used to determine when spray applications were necessary. The first applications were made to all treatments on July 22.

RESULTS:

Table 1 illustrates the number of sprays applied by each treatment during the season and the total rate of application of Javelin applied during the season. In general, both hydraulic boom sprayer treatments required the most frequent applications. However, even though the ESS, half-rate application required the same number of treatments during the season as the Hardi TWIN, it used less than half as much material to provide the same level of control. During the season, no ESS treatments required applications to specifically control cabbage looper.

Table 1. Seasonal total number of applications and rate of application of Javelin.

Treatment	Application Rate (gpa)	Total Number of Treatments	Total Rate of Javelin (lb/acre)
ESS, half rate A.I.	4.5	6	1.50
ESS, full-rate A.I.	4.5	5	2.00
Hardi TWIN, full-rate A.I.	13.5	6	3.25
Conventional, full-rate A.I.	35.0	8	4.00

The reduction in number of infested plants following each spray treatment are shown in Table 2. These values represent the change in percent of pre- and post-spray infested plants observed in each treatment. The full-rate applications made with the ESS sprayer were the most effective in reducing the total number of infested plants. The increased effectiveness of the ESS sprayer corresponds with the ESS sprayer requiring the fewest number of applications during the season shown in Table 1.

Table 2. Average reduction in infested plants by pest and total plants following each spray application.

Treatment	Reduction in Infested Plants			
	Diamondback	Imported Cabbage Worm	Cabbage Looper	Total Infested Plants
ESS, half rate A.I.	13.9	14.4	-1.7	28.9
ESS, full-rate A.I.	21.3	24.0	1.3	34.0
Hardi TWIN, full-rate A.I.	13.3	22.2	-0.6	27.2
Conventional, full-rate A.I.	4.2	8.3	-0.8	10.0

Spray coverage characteristics produced by the ESS sprayer on cabbage leaves were evaluated by using the sprayer to apply a fluorescent dye. Spray deposition was greatest along the edges of the leaves. Spray coverage was greatest on the upperside of leaves. The average diameter of the spots on the leaves was approximately 24 micrometers (µm). Underside leaf surface coverage was greatest when the charging system on the ESS sprayer was activated. It is believe that the waxy surface of the cabbage leaves contributed to the small spots observed. Similar evaluations on potato leaves found the average diameter of spots to be 48 µm or roughly double the size of spots on cabbage leaves. Average ESS, charging on, spray coverage was 3.5% of the leaf surface.

The spray coverage characteristics produced by the Hardi TWIN and Conventional sprayer treatments were not evaluated in cabbage. However, in potatoes there were no differences in overall spray coverage produced by any of the three treatments but the ESS sprayer produced significantly greater lower leaf surface coverage than either the TWIN or Conventional treatments.

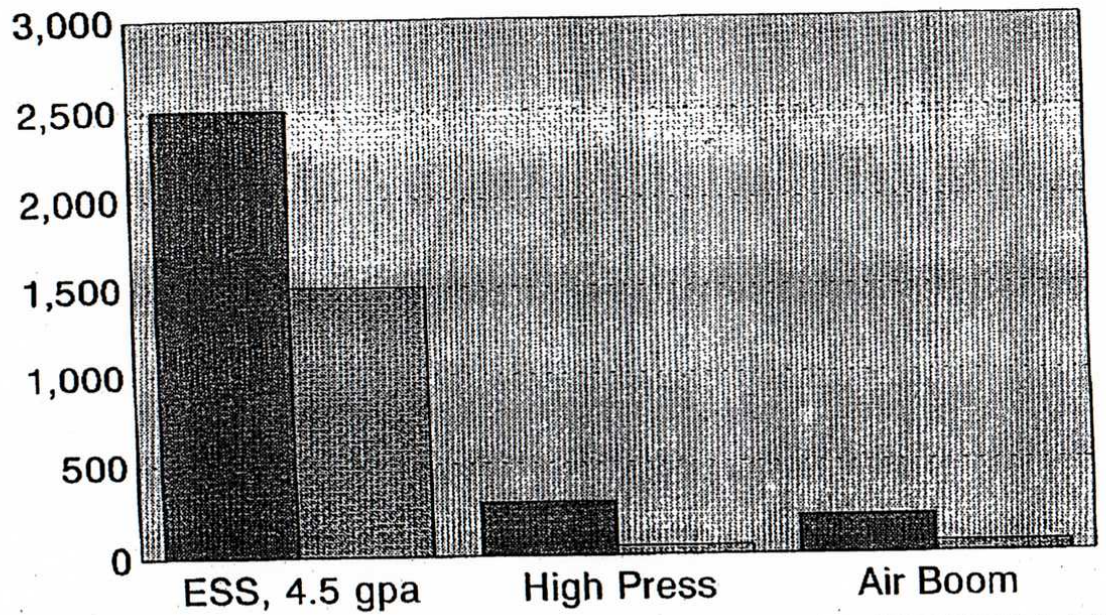
SUMMARY:

The application technique can significantly influence the effectiveness of applications of materials for managing cabbage pests. For the second year, broadcast applications of *Bacillus thuringiensis* were the least effective of the application techniques studied. In 1992 the broadcast applications were made at 30 gpa and in 1993 they were made at 35 gpa. Fewer treatments were required with non-conventional but commercially available application techniques. The half-rate application of Javelin was also very effective when it was applied with the ESS sprayer. The total quantity of Javelin required during the season was lowest for the ESS, half-rate treatment. Again, for the second year, full-rate applications of Javelin made with the ESS sprayer were the most effective in reducing pest infestations. The ESS sprayer demonstrated that it can provide effective control of cabbage pests using lower levels of active ingredient and lower volumes of water carrier than a conventional broadcast application with hollow cone nozzles.

Cabbage growers should be aware that they can make more efficient use of *Bt*'s such as Javelin by improving application techniques. The result could be reduced operating costs and less contamination to the environment. Commercial technology currently exists that will provide effective application of *Bt*'s and thus reduce overall application requirements compared to conventional treatments with hollow cone nozzles. Without using additional air assistance, growers can most easily adapt the concepts of the ESS and TWIN sprayers to their own sprayers by better directing sprays at the plants and by using nozzles the produce smaller droplets.

Spray Deposition Comparison on Potatoes

Number of Spray Deposits per square cm of leaf area



	ESS, 4.5 gpa	High Press	Air Boom
Leaf Topside	2,502	285	201
Leaf Undside	1,505	48	55

Cornell University, 1993