CARBARYL RESIDUES IN RICE SPRAYED WITH A SPINNING DISC ULTRA LOW VOLUME APPLICATOR

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The spinning disc ultra low volume applicator was evaluated for its possible usefulness in rice pest control. Insecticide concentrations in plant parts, insecticide drift, distribution in the plant parts at grain milking stage; and contamination of the sprayer operator were evaluated. Coverage of the stem portions of the plant is minimal for both ULV and conventional applicators and no differences in leaf coverage was observed. Wind velocity plays a very important role in the usefulness of the applicator; drift problems and low deposition could be encountered at high wind velocities.

Insect pests are major constraints to rice production in the Philippines. Studies conducted in four provinces from 1975 to 1977 indicated that insects and diseases account for about 0.5 to 1.0 t/ha yield loss (IRRI 1978). The use of insecticides is one of the major methods to control rice insect pests. Control efficiency is often not sufficiently high and a favorable benefit: cost ratio for insecticide application is not achieved (IRRI 1978).

The most common method of insecticide application in Philippine rice production is the use of the high volume knapsack sprayer. Although current insecticide recommendations suggest a minimum of 300 L spray solution/ha, most farmers use less because of the difficulty of carrying large volumes of water through the paddy field. As a result, many farmers are applying much less than the recommended rates (IRRI 1978). Thus, it is desirable to develop a more practical means of applying foliar sprays which save labor and time.

The ultra low volume (ULV) technique of insecticide application provides a possible solution to the problem of carrying large volumes of water. ULV application of pesticides is used in a number of crops. However in rice insect control there still exists a need to determine the practicality of ULV spraying. ULV has been defined as the minimum amount of liquid per unit area compatible with economic requirements of achieving control (Anonymous 1971). In this paper ULV refers to the use of less than three L spray solution/ha.

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Several commercial organizations have developed hand-held battery operated spinning disc sprayers. The spinning disc sprayer is being successfully used for control of cotton insects in Africa (Matthews 1973; Usenbo 1974; King 1976). The applicability of the ULV spinning disc sprayer in rice insect control has not been determined. This study was conducted to 1) compare the ULV spinning disc sprayer with the knapsack sprayer currently being used by Filipino farmers, 2) determine the distance of insecticide drift from the release point of the ULV sprayer, 3) determine the distribution of insecticide on the various portions of the plant, and 4) determine the extent of contamination of the ULV sprayer operator.

MATERIALS AND METHODS

Comparison of ULV and high volume knapsack sprayer. This experiment was conducted in a farmer's field near the IRRI farm. Varieties IR36 and IR42 were transplanted at a spacing of 25 x 25 cm in plots varying from 400 to 500 m^2. All other recommended cultural practices were followed. Treatments were replicated three times.

Plots were sprayed at 34 and 50 days after transplanting (DAT) with a commercial formulation Sevin 4 Oil, an oil formulation containing carbaryl (naphthelenyl methylcarbamate) at five m intervals at the rate of two L/commercial formulation/ha (0.96 kg a.i./ha). Although an anemometer was not available, wind speed averaged about one MPH. The Union Carbide ULV spinning disc sprayer was used in all experiments reported herein. Droplet size produced by this machine is 80-120 microns. A formulation of carbaryl (Sevin) wettable powder was applied at the rate of 0.75 kg a.i./ha with a knapsack sprayer at a volume of 300 L/ha and a two m swath width similar to how a farmer would apply.

One hour after spraying, five hills were selected at random from each plot, the rice stalks were cut one inch above the water line and placed in a plastic bag for transport to the laboratory. Plants were then separated into leafsheath and leaf, each tissue was cut into one to 1 1/2 in. sections respectively and prepared for analysis.

Determination of insecticide drift. One day prior to spraying, Whatman filter paper strips measuring five cm in width were cut to simulate rice leaves and stems. The strips were of same length as the leaves and stems at the time of spraying; the paper strips are hereafter called paper-stem and paper-leaves. One paper-stem and one paper-leaf were each attached to a no. 16 wire. The wires holding the paper strips were placed vertically in the row between two rice hills by forcing the wire end into the mud so that the paper-stem and paper-leaf were of the same height as the actual stems and leaves. The paper strips were placed at distances of 1, 4, 7, 10, 13, and 16 m perpendicular to the spray release. Sevin 4 Oil was sprayed at 34 and 50 DAT upward from the paper strips at the rate of two L/ha. The paper strips were removed one hour after spraying and placed in a screw cap vial and returned to the laboratory for analysis.

Distribution of residues on plants. In a separate experiment conducted with IR1917-3-17 rice on the IRRI farm, Sevin 4 Oil was applied at the rate of two L/ha at the grain milking stage to determine the relative amounts of insecticide residue on the panicles, leaves, and stems. One pass was made with the sprayer held about a meter above the canopy while walking along the levee. Entire plants were removed at three and five m from the spray release and the panicle, leaf, and stem portions were separated for analysis.

Sprayer operator contamination. During the applications in the first two experiments above, paper strips measuring 2" x 6" were taped to the upper arm, lower arm, shoulder, chest, nape, and thigh of the ULV sprayer operator. The operator sprayed six plots in each of the two experiments which required eight min to completely spray. After spraying, the strips were removed and analyzed.

Residue analysis. Samples of leaves and panicles were separately placed inside a 500 ml flask. Sufficient acetone was added to cover the sample; the flask was stoppered and the sample was allowed to soak for ten minutes. A 25 ml aliquot was transferred to a 12 ml stoppered centrifuge tube and stored in the refrigerator until analyzed.

For analysis of the paper strips, 30 ml of acetone was added to the screw cap vial containing the strips and the paper was allowed to soak for one hour prior to analysis.

Samples were analyzed using a Hewlett Packard HP5711 gas chromatograph equipped with a N-P FID detector and with the following parameters:

Column		4' x 2 mm (i.d.) glass packed with 3% Apiezon L on 80/100 Chromosorb W-HP	
Temperatures (°C)	:	Injector	250
		Detector	300
Flow rates (ml/min)	:	Nitrogen	20
		Hydrogen	3
		Oxygen	7
Recoveries	:	Leaf tissues	87%
		Paper strips	100%

After extraction the leaves and leafsheaths were dried to remove the acetone and the surface areas were determined. Concentration was expressed in ug/cm² in all experiments except for the experiment on distribution of residues on plants which were expressed in mg/kg.

RESULTS AND DISCUSSION

Comparison of ULV and high volume knapsack sprayer. Results from the two varieties IR36 and IR42 were similar so the data was pooled. The ULV sprayed plants had higher leaf concentrations of carbaryl than the plants sprayed with the high volume sprayer at both 34 and 50 DAT (Table 1). Leaf concentrations were much lower at 50 DAT, possibly because the wind speed was higher and there was more foliage than 34 DAT. Low concentrations were found on the stem portion with both spraying techniques indicating that few droplets reached this area.

TABLE 1. **Distribution of carbaryl in ULV-and backpack-sprayed rice plants. IRRI, 1978.**

Type of sample	Carbaryl content (ug/cm²) 34 DAT		50 DAT[d]	
	Leaves[a]	Stems	Leaves	Stems
ULV-sprayed	4.71	0.01[b]	0.31	0.02
Knapsack-sprayed	1.6	0.19[c]	0.17	0.24

[a] Average of 6 replicates
[b] Average of 5 replicates
[c] One replicate
[d] Average of 3 replicates

Determination of insecticide drift. The deposit of carbaryl on the leaves was distinctly higher at 33 than 50 DAT (Table 2). On both spray dates, carbaryl concentration on the simulated leaves was highest at one m from the sprayer, dropping rapidly at four m. Low concentrations were detected even at 16 m from the applicator. There was a distinct difference in the leaf and stem concentrations at 34 DAT at one m but no differences at four m and beyond.

TABLE 2. **Drift of ULV-sprayed pesticide. IRRI, 1978.**

Distance	Carbaryl deposit (ug/cm²) 34 DAT[a]		50 DAT[b]	
	Paper-leaves	Paper-stem	Paper-leaves	Paper-stem
1 meter	4.67	0.47	0.35	nd
4 meters	0.26	0.30	0.03	0.06
7 meters	0.07	0.06	0.05	0.01
10 meters	0.05	0.02	0.02	0.02
13 meters	0.04	0.02	0.01	0.01
16 meters	0.06	0.06	0.01	0.01

[a] Average of 5 replicates
[b] Average of 3 replicates

Distribution of residues on plants. Highest levels of carbaryl residues were detected on the panicles with lower amounts on the leaves and very low amounts on the stem portions (Table 3). Residue levels on the panicles were similar at three and five m but leaf levels were much lower at five than at three m.

TABLE 3. **Distribution of carbaryl residues on the plant when insecticide was applied with a battery-operated ultra low volume (ULV) applicator.[a] IRRI, 1977**

Plant part	Carbaryl residue (mg/kg) 3 m[b]	5 m[b]
Panicles	690	750
Leaves	90	20
Stems	2	1

[a] About 2 L of Sevin carbaryl 80% oil formulation/ha was applied with a Union Carbide ULV applicator.
[b] Distance from applicator.

Contamination of the sprayer operator. Analysis of the paper strips placed at various locations on the body of the ULV sprayer operator indicated levels of about two ug/cm^2 at most locations (Table 4). Even though wind direction during spraying was not determined, it was observed that direction shifted several times. Thus it was difficult to avoid contamination. The toxicity hazard to the spray operator of the residue levels detected is not known.

CONCLUSION

There was no distinct difference in the level of residues on the simulated leaves and stems between the ULV and knapsack sprayers. The ULV applicator was much less laborious to operate and allowed much more rapid treatment. Wind speed is quite important when using the ULV machine as the small droplets drift for a considerable distance under the influence of a strong wind. This study indicated the necessity for using an anemometer so that similar wind speeds can be used when making comparisons between spraying dates.

High levels of carbaryl residues were deposited on the panicles and the leaves but low levels were detected on the stem portion. Provided an effective insecticide is used, it can be speculated that application of insecticide with the ULV spinning disc sprayer would provide good control of insects feeding on the panicles such as the rice bug, *Leptocorisa* spp. and on leaf feeders such as the green leafhopper, *Nephotettix virescens* and the leaf folder, *Cnaphalocrosis medinalis.* However, control of insects feeding on the stem at the base of the plants, such as the brown planthopper, *Nilaparvata lugens* may not be adequate because of the low amounts of insecticide which reach this area.

This is a preliminary study and further research will include the testing of various droplet sizes and wind speeds to determine their effect on the penetration of the droplets through the canopy to the base of the stem for brown planthopper control. If altering droplet size does not allow for greater penetration, insecticides which have a fumigant action or systemic movement down the leaf to the leafsheath will be sought for the control of the brown planthopper using the ULV spinning disc sprayer.

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