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EVALUATION OF ULV SPRAYERS FOR WEED CONTROL IN VEGETABLE PRODUCTION – PART 1

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Keywords: ULV sprayers, Laboratory tests.

RINGKASAN

Sebanyak lima jenis penyembur 'ultra low volume' dan 13 saiz kepala penyembur telah diuji di makmal untuk mengumpul data awal tentang sifat-sifat semburan alat tersebut. Peraturan pengujian di makmal telah diselaraskan seberapa yang boleh.

Keputusan ujian didapati sama dengan spesifikasi yang diberi oleh pembuatnya. Berbagai-bagai kesimpulan telah didapati daripada kiraan kepadatan titisan semburan. Penyembur CP 15 MK II telah dianggap sebagai penyembur yang serba boleh kerana penyembur ini boleh digunakan untuk menyembur segala jenis racun perosak termasuk racun rumpai.

INTRODUCTION

Weed dominance has become a major problem in vegetable production. In long-cultivated fields where fertilizers had been regularly added, the dominance of weeds is menacing the vegetable crops. Weed eradication by traditional manual means using the hoe is slow and tedious. Chemical weed control method, therefore, must be resorted to.

In Peninsular Malaysia, important weeds found in vegetable holdings are *Eleusine indica, Cleome rutidosperma, Cleome ciliata, Amaranthus blitum, Borreria latifolia, Cyperus iria, Fimbristylis miliacea, Echinochloa colona, Digitaria longiflora, Asystasia intrusa, Ageratum conyzoides, etc.* (LEE and CHONG, *pers comm.*,1986). A survey of vegetable farming in Peninsular Malaysia indicated that the most widely used weedicide was paraquat (ANON., 1981). Its mode of action is essentially to kill by contact action. Plant tissues are affected very rapidly and leaf discolouration occurs within one or two hours after spraying with the chemical.

Various types of weedicide applicators are being used in vegetable farming. These include the hand-operated knapsack sprayer with a 9-litre or 18-litre metal tank, the tractor-mounted and power take-off operated boom sprayer with a 600–800-litre plastic tank, and the engine-operated high-pressure power sprayer. However, these types of sprayers have high discharge rates and thus, use a large amount of water per unit area. Much time is wasted in getting water, mixing the spray solution and refilling the tanks. The new trend is towards the use of lower volume application, particularly the ultra low volume (ULV) sprays. The ULV sprayers have the advantages of lower water requirement and higher working output. These sprayers also demand less physical effort to operate and thus, are less tiring to the operators. Taking these advantages into consideration, this experiment was proposed to evaluate the use of ULV sprayers for efficient weed control in vegetable production.

The overall evaluation plan is, firstly, to conduct laboratory tests on the sprayers with various nozzle sizes to observe their spray characteristics. Secondly, the sprayers would be tested in a fallow field spraying several weedicides to observe their effectiveness of kill. Thirdly, suitable sprayers and nozzles would be selected for applying preemergence, postemergence and selective weedicides on plots planted with

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vegetables. Finally, further studies may be carried out to adapt the sprayers for more efficient use in vegetable cultivation. This report deals only with the first stage of laboratory tests.

The main objective of the laboratory tests was to obtain reliable data on the discharge rate, spray swath width, spray distribution, and droplet density of each sprayer and nozzle size. These data provide basic information on their spray characteristics.

MATERIALS AND METHODS

Five ULV sprayers available locally were selected for the laboratory tests. Their specifications are given in *Appendix 1*. The sprayers and their nozzle sizes were as follows:

Sprayer	Nozzle size
Berthoud H2	yellow, red, green
Micron Herbi 77	blue, yellow, red
Turbair Weeder	1.2 mm, 2.0 mm
Birky Knapsack LV	yellow, red
CP 15 MK II	VLV 50, VLV 100, VLV 200

Before each test, the revolution of the spinning disc atomizer of each sprayer, when not spraying any liquid, was measured using the non-contact digital tachometer. The spinning disc was angled at 60 degrees from the horizontal and fixed at about 30 cm from the ground surface as indicated by a string tied to a weight *(Plate 1)*.

The forward walking speed of the operator was measured using a stop-watch while the wind speed was measured using the hand-held Dwyer anemometer.

For the discharge test, a measuring cylinder was used to measure between 200 ml and 400 ml of water which was then poured into the solution tank. The time taken to completely discharge the whole volume of water was measured using a stop-watch. An average of five readings was taken to indicate the discharge rate for each nozzle.

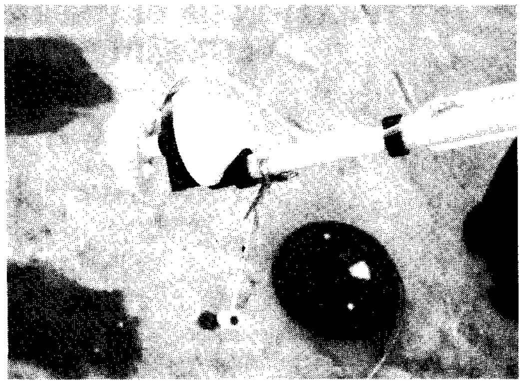

Plate 1. Spinning disc atomizer of Birky sprayer positioned at 30 cm above ground surface as indicated by a string tied to a weight.

The spray distribution of each nozzle was monitored using the water-sensitive paper. The paper could also be used for checking the droplet density. Each strip is 2.5 cm wide and 50 cm long. A total of six strips of the paper were laid out in a continuous line and a single pass of each nozzle was made across them at the centre *(Plate 2)*. The density of droplets per square centimetre was then counted with the aid of a piece of paper with a one-centimetre square window. An average of three counts, one at the centre and the other two at each end, was taken to indicate the droplet number.

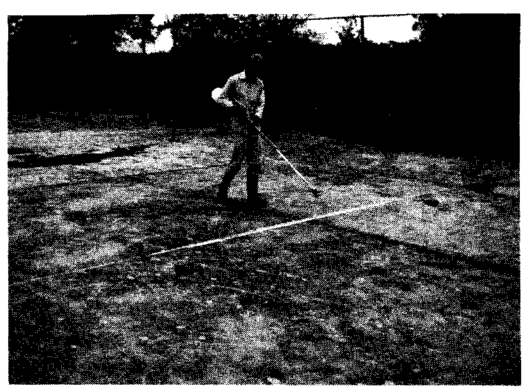

Plate 2. Single pass made at the centre of the water-sensitive paper for monitoring the spray distribution and droplet density.

The effective spray swath width was measured from the distribution of spray droplets on the water-sensitive paper. After studying the concentration of the droplets on the paper, arbitrary demarcation lines were drawn to indicate the boundaries of the swath and the width measured.

RESULTS AND DISCUSSION

The results obtained from the laboratory tests are summarized in *Table 1.* The average forward walking speed of the operator was 0.5–0.7 m/second. This speed was slower than that (1.0 m/s) normally quoted by the manufacturers in calculating the spray volume. However, a walking speed of 0.5–0.7 m/s is considered more normal for the Asians.

The discharge rates obtained from the sprayers with different nozzle sizes were generally slightly higher than those given by the manufacturers. Water was used in the tests. The discharge rate would decrease slightly if the spray solution had a higher viscosity.

Knowing the walking speed, spray swath width and the discharge rate, the spray volume could be calculated in terms of litres per hectare. In the application of weedicides, the spray volumes are normally classified as follows (MATTHEWS, 1979):

Ultra low volume (ULV) = < 50 litres/ha
Very low volume (VLV) = 50–200 litres/ha
Low volume (LV) = 200–500 litres/ha

As can be seen from the figures obtained, the Berthoud H2, Micron Herbi 77 with blue and yellow nozzles, Turbair Weeder and Birky Knapsack LV fell under the ULV classification. The Micron Herbi 77 with the red nozzle and the CP 15 MK II with its three nozzle sizes were classified under VLV while the conventional knapsack was not even under the LV sprays.

The droplet density is critical in pesticide application. The following provides a guide on the minimum droplet density requirement in the target area for the various types of sprays to be effective (CIBA-GEIGY, 1981):

Droplet density (min. no./cm^2)	Type of spray
20 – 30	Insecticides
20 – 30	Preemergence weedicides
30 – 40	Postemergence, contact weedicides
50 – 70	Fungicides

In this study, the droplets as shown on the water-sensitive papers indicated the uniformity of the distribution of the sprays over the whole swath. From the data obtained, the droplet densities for the three nozzle sizes of Berthoud H2 and the blue nozzle of Micron Herbi 77 were below the minimum requirement of 20 droplets per square centimetre. The effectiveness of these sprayers, even for applying preemergence weedicides, is thus suspected. In addition, the droplet densities for the yellow and red nozzles of Birky Knapsack LV and the yellow nozzle of Micron Herbi 77 hovered around the lower limit of the droplet number requirement. Field tests would have to be carried out to gauge the effectiveness of their sprays. The red nozzle of Micron Herbi 77 could be used for applying preemergence weedicides while the two nozzle sizes of Turbair Weeder could be used for applying insecticides, preemergence and postemergence weedicides. The CP 15 MK II, with the improved hydraulic nozzles, could be used for applying all the pesticides including fungicides. In addition, its spray volumes of 57.1–165.5 litres/ha, when compared with the spray volume of 694.7 litres/ha of the conventional knapsack, gave a saving of 4.2–12.2 times in water requirement.

The spray distributions and droplet densities for VLV 50, VLV 100 and VLV 200 nozzles are shown in *Plates 3–5.*

The droplet size was not measured due to lack of facilities. However, some infor-

Table 1. Laboratory tests of various ULV sprayers with different nozzle sizes

Sprayer & nozzle size	Walking speed (m/s)	Spray swath width (m)	Discharge rate (water, ml/s)	Spray volume (litre/ha)	Droplet density (av. no./cm^2)	Revolution of atomizer disc (rpm)
Berthoud H2						
Yellow	0.6	1.1 (1–1.2)	1.3 (1.2)	19.7	9.4	2 446 (2 240–2 500)
Red	0.6	1.2 (1–1.2)	1.8 (1.4)	25.0	18.2	2 446 (2 240–2 500)
Green	0.6	1.2 (1–1.2)	2.2 (2.5)	30.6	18.4	2 446 (2 240–2 500)
Micron Herbi 77						
Blue	0.5	1.1 (1.2)	1.4 (1.1)	25.5	14.8	1 979
Yellow	0.5	1.2 (1.2)	2.6 (2.0)	43.3	20.5	1 979
Red	0.5	1.2 (1.2)	5.2 (5.0)	86.6	28.5	1 979
Turbair Weeder						
1.2 mm	0.5	1.1 (1–1.3)	1.3 (2.0)	23.6	37.8	2 323 (2 000–2 500)
2.0 mm	0.5	1.3 (1–1.3)	3.4 (5.0)	52.3	39.5	2 323 (2 000–2 500)
Birky Knapsack LV						
Yellow	0.7	1.4 (1.2–1.6)	3.7 (3.2)	37.8	19.3	1 452 (1 200–1 600)
Red	0.7	1.4 (1.2–1.6)	4.4 (4.8)	44.9	21.0	1 452 (1 200–1 600)
CP 15 MK II						
VLV 50	0.7	1.2 (1.2)	4.8 (3.7)	57.1	95.5	Pressure setting 3 kgf/cm^2
VLV 100	0.7	1.2 (1.2)	8.3 (7.6)	98.8	154.5	3 kgf/cm^2
VLV 200	0.7	1.2 (1.2)	13.9 (16.6)	165.5	Partially blotched	3 kgf/cm^2
Conventional Knapsack						
Twin-hollow cone (2.0 mm)	0.6	0.9 (1.0)	39.6	694.7	Blotched	Pressure not regulated

Note: (i) Values in ( ) are provided by the manufacturers.
(ii) Wind speed : 0–2 m/s
(iii) Position of spinning disc atomizer : 60° from horizontal
(iv) Height of nozzle above ground surface : 30 cm

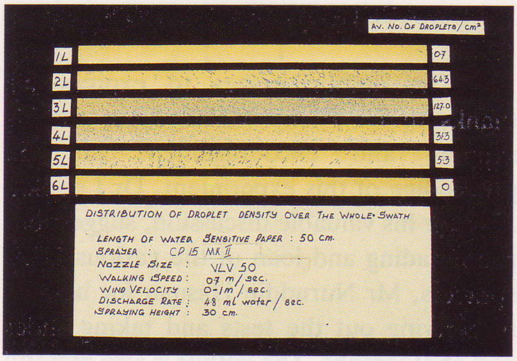

Plate 3. Spray distribution and droplet density for VLV 50 nozzle.

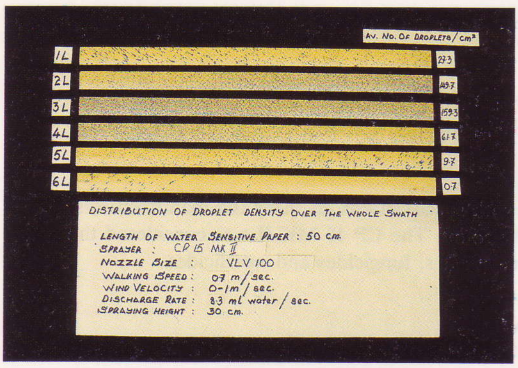

Plate 4. Spray distribution and droplet density for VLV 100 nozzle.

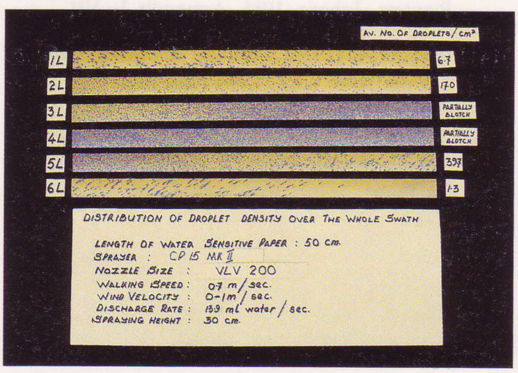

Plate 5. Spray distribution and droplet density for VLV 200 nozzle.

mation on droplet size for Micron Herbi 77, CP 15 MK II and the conventional knapsack sprayers could be obtained from NG (1985). His data showed that more than 60% of droplet size from the three sprayers fell in the range of 100–300 microns. Droplet size is highly important if pesticides are to be applied efficiently with the minimum contamination of the environment. When drift must be minimized, a medium (201–400 microns) or coarse (> 400 microns) spray is required, irrespective of spray volume applied.

The Berthoud H2, Micron Herbi 77 and the Turbair Weeder are controlled droplet application (CDA) sprayers. Controlled droplet application refers to the application of spray solution at correct size of droplets for a given target, *e.g.*, insect = 70–100 microns and weed = 200–300 microns. As a result of the uniformity of droplet size produced, there is optimization in the use of minimum spray volume to achieve effective control.

The revolutions of the spinning disc atomizer measured, when no spray was discharged, were within the range given by the manufacturers. When spray solution is applied, the number of revolutions of this disc would drop slightly. As an example, the disc revolution of red nozzle of Berthoud H2 was 2 500 rpm when not spraying. It dropped to 2 240 rpm when spraying (manufacturer's information).

CONCLUSIONS

The results of laboratory tests were in accordance with the specifications given by the manufacturers.

The actual walking speed of the operator was between 0.5 m/s and 0.7 m/s as compared with 1.0 m/s frequently quoted by manufacturers. As a result, the spray volumes applied were higher than those stated by them. The discharge rates obtained were also generally slightly higher than those given by the manufacturers.

From the droplet densities obtained, the red nozzle of the Micron Herbi 77 could be used for applying preemergence weedicides while the 1.2 mm and 2.0 mm nozzle sizes of Turbair Weeder could be used for applying insecticides, preemergence and postemergence weedicides. The CP 15 MK II, with the improved hydraulic nozzles was the most versatile as it could be used for applying insecticides, weedicides and fungicides. In addition, the CP 15 MK II gave a saving of 4.2–12.2 times in spray volume requirement as compared with the conventional knapsack sprayer.

Generally, the soundness of construction, ease of handling, operation and maintenance of the sprayers were satisfactory.

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ABSTRACT

A total of five ultra low volume sprayers with a total of 13 nozzle sizes were tested in the laboratory to gather background data on their spray characteristics. Laboratory test procedures were standardized as far as possible.

The results obtained from the tests correspond with specifications given by the manufacturers. Various inferences were made from the droplet density count. The CP 15 MK II was considered the most versatile sprayer as it can be used for spraying insecticides, fungicides and weedicides.

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