Full Length Research Paper

Improved shield for knapsack sprayers

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Abstract

Crop production in developing countries is limited by the over dependence on inefficient tools for implementation of critical field operations such as weed control. A knapsack shield that suits the spray pattern of a drift reduction off centre nozzle (AirMix ® Nozzle) was developed and tested in the forest zone of Ghana for herbicide weed control in cassava (Manihot esculenta). Paraquat was applied through the shield at a rate of 3 l/ha. The treatments were: i) spraying half row width with each pass, ii) spraying entire row width with a pass, iii) timely hand hoeing and iv) delayed hand hoeing. Weed control with the shield was effective and it resulted in similar cassava yields as timely hand hoeing.

Key words: Knapsack, shield, paraquat, cassava, Manihot esculenta, weed control, Euphorbia

INTRODUCTION

A major constraint limiting crop production in Africa is the over dependence on primitive and inefficient implements such as hoes for critical field operations. One such operation is weed control after crop emergence. In Ghana, many farmers delay weed control due to scarcity of labor during the peak periods of demand. Crops are sensitive to weed infestation at the initial stages of growth (Onochie, 1975, Talatala et al 1980). Studies done in Nigeria show that herbicide weed control is more profitable than manual weed control (Adigun et al., 1993, Ishaya et al., 2008). There has been increased use of herbicides by small scale farmers in Ghana in recent times (Ekboir et al 2002). For crops like maize and rice, farmers can use broad-spectrum herbicides to control pre-plant weeds and selective herbicides to control in-crop weeds. However cassava and many crops have no selective herbicide on the Ghanaian market, therefore farmers have no option than to use manual labor to control in-crop weeds. Furthermore, many farmers practice intercropping system (Doku 1967, Mutsaers et al 1993) in which selective herbicide for one crop may not be suitable for the component crop(s). Tests conducted by Awadhwal et al (1991) shows that attachment of a shield to a knapsack sprayer decreased drift by 63% compared with unshielded spray. The shield used in the study consists of a conical wire frame covered with polythene material, and it uses a hollow cone nozzle. Most knapsack shields are in the form of a fan and they use flat fan nozzles. One feature with a shield that uses a hollow cone or flat fan nozzle is that the swath of the nozzle increases towards both ends of the shield. If a shield of this type is lifted up during herbicide application, the swath extends beyond the width of the shield, and directly drifts the herbicide onto the adjacent crops. Therefore this shield is not suitable for herbicide application on farms where it must be frequently lifted to avoid obstacles on the field such as stumps. The principal investigator (P. Osei Bonsu) has developed a knapsack shield that uses a drift reduction off centre nozzle (AirMix ® Nozzle, developed by Agrotop). This paper describes the shield and presents results of a study on its efficiency for paraquat application in cassava.

Description of the shield

The shield was developed locally using a thin aluminum sheet. It is a hollow body that is closed at 4 sides and opened at the bottom. When the bottom of the shield is placed on a flat surface, the back is directly perpendicular to the surface and the two sides are generally in a form of a right angle triangle as shown in figure 1 (left).

The shield is designed to suit the spray pattern of a drift reduction off centre nozzle (AirMix ® Nozzle) developed by Agrotop, Germany. The swath of the nozzle is in the form of a right angle triangle and it increases towards one
direction only as shown in figure 1 (right). The nozzle is fixed on the shield such that during spraying, the swath moves away from the back of the shield (figure 1, right). Figure 2 and 3 show how the shield is used to apply herbicide to control weeds in two crop rows R1 and R2. One method is to spray half the row width with each pass (at a go). In this method, the shield is operated at about 15 cm above the ground. The back of the shield is placed adjacent to crop row R1 and half the row width A-B is sprayed to the end. Thereafter the back of the shield is placed adjacent to crop row R2 and the other half of the row width (C-B) is sprayed. When the shield is lifted to avoid an obstacle, the swath extends towards the middle of the row (and not towards the adjacent crop row R1),
### Table 1. Plant stand, weed and yield of cassava as affected by shield spray

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Plants /ha</th>
<th>Weeding time/plot (minutes)</th>
<th>Plant Scorch (score)</th>
<th>Weed dry wt. (g/m²)</th>
<th>No of tubers/ha</th>
<th>Tuber wt. (T/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Half row width spray</td>
<td>8542</td>
<td>2.9</td>
<td>2.0</td>
<td>10.1</td>
<td>38880</td>
<td>20.9</td>
</tr>
<tr>
<td>Entire row width spray</td>
<td>8542</td>
<td>1.8</td>
<td>3.5</td>
<td>12.7</td>
<td>33420</td>
<td>21.1</td>
</tr>
<tr>
<td>Timely hoeing</td>
<td>8958</td>
<td>8.5</td>
<td>1.0</td>
<td>23.3</td>
<td>39560</td>
<td>21.9</td>
</tr>
<tr>
<td>Delayed hoeing</td>
<td>7708</td>
<td>11.1</td>
<td>1.0</td>
<td>114.0</td>
<td>32670</td>
<td>14.1</td>
</tr>
<tr>
<td>CV %</td>
<td>10.7</td>
<td>14.3</td>
<td>13.8</td>
<td>24.2</td>
<td>22.7</td>
<td>14.2</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td>ns</td>
<td>2.2</td>
<td>1.5</td>
<td>34.4</td>
<td>1650</td>
<td>5.5</td>
</tr>
</tbody>
</table>

Therefore direct drift of herbicide onto the crops is minimized.

The other method involves spraying the entire row width (A-C) with each pass. In this method, the knapsack operator places the perpendicular side of the shield adjacent to crop row R1 and increases the swath to reach the base of crop row R2. The swath is increased by lifting the shield up (spray height of about 20 cm) or tilting the back towards crop row R1. In order to prevent the herbicide from directly drifting onto crop row R2, another person uses a light rectangular board (1 m x 1 m) as guard to shield that row (Figure 3).

### Testing of the shield

On farm experiments were conducted at Ejisu in the forest zone of Ghana in 2011 to evaluate the efficiency of the shield for herbicide weed control in cassava. The experimental design was a randomized complete block with 3 replications. The treatment studied were i) Half row width sprayed with each pass; ii) Entire row width sprayed with each pass; iii) Timely hand hoeing; and iv) Delayed hand hoeing. The predominant weed at the experimental site was Euphorbia (*Euphorbia heterophylla*). Land preparation was by slashing and burning as generally practised by farmers. Cassava stems (variety Dente) were cut into 25 cm sets and planted by burying at inter-row spacing of 1 m x 1 m. Thus the target population was 10,000 plants/ha. Plot size was 6 rows of cassava, 10 m long and the two central rows were used for data collection. In the herbicide treatment plots, paraquat was applied through the shield at 3 and 6 weeks after planting at a rate of 3 l/ha. The herbicide was applied using a Jacto knapsack sprayer. Half row width spray was done using a low volume nozzle calibrated to deliver a spray volume of 150 l product per hectare. Entire row width spray was done using a medium volume nozzle calibrated to deliver 300 l product per hectare. Herbicide application was done in the morning, when wind was calm (wind was not moving leaves of surrounding trees). Timely hand hoeing involved hoeing at 3 and 6 weeks after planting and delayed hand hoeing was hoeing at 6 weeks after planting. A week after herbicide application, 5 plants were randomly uprooted from each plot from the 4 external rows and assessed for herbicide injury on a scale of 1-10; were 1 is no plant injury and 10 is total scorching of plant. Weed biomass was estimated at 6 weeks after planting (before weed control) within quadrates randomly taken from 5 points/plot. The samples were dried in an oven at 70°C for 48 hours and the weight determined. Time of weed control per plot was recorded using a stop watch.

### RESULTS AND DISCUSSIONS

There was no significant difference in plant stand of cassava due to treatments (Table 1). Time used for weed control was highest (11.2 minutes/plot) on the delayed weed control plot, followed by timely hand hoeing plot (8.5 minutes), and least (1.8 minutes) for the entire row width spray. Although weed control was fastest for the entire row width spray (this included labor for holding the guard), this method was cumbersome and labour intensive since two people were involved. It also required extreme care in that the knapsack operator and the person holding the guard move at the same pace to prevent herbicide from drifting onto the crops in row R2 (Figure 3).

The half row width spray resulted in significantly lower (P < 5%) scorching (2.0) of plants than the entire row width spray (3.5). Drift of herbicide onto crops was higher in the entire row width spray probably because the shield was operated at a higher level above the ground compared with the half row width spray. This observation agrees with findings of Jong et al (2000) that drift from a boom sprayer at 70 cm above the ground was 80% higher than at 30 cm.

Weed dry weight ranged from 10.1 g/m² for the half row
width spray to 114.0 g/m² for the delayed hand hoeing plot. Weed biomass on the delayed hand hoeing plot was about 5-10 times higher than the other weed control options. There was no significant difference in weed biomass between the herbicide treated plots and the timely hand hoeing plots. The least number of cassava tubers (32670 tubers/ha) was obtained from the delayed hand hoeing plot, and the highest (39560 tubers/ha) was obtained from the timely hand hoeing plot. Tuber yield was highest (21.9 t/ha) on the timely hand hoeing plot and lowest (14.1 t/ha) on the delayed hand hoeing plot. Thus delayed weed control resulted in about 50% yield reduction compared with shielded weed control. Harper (1973) recorded 46% reduction in cassava yields due to weed competition. Herbicide did not affect cassava yields, probably because the crop quickly recovered from the minor herbicide injury.

CONCLUSION

Application of paraquat through the shield designed to suit the spray pattern of off-centre nozzle was effective in controlling weeds in cassava, and resulted in similar yields as timely hand hoeing. Further studies are required to determine the effectiveness of the shield for application of other broad spectrum herbicides such as glyphosate. Studies are also required to determine the optimum time and rates of herbicide application in different crops.

References

Talatala RI, Bacusmo JL, Villanueva MR (1980). Response of cassava to different durations of weeds control and weed competition, Philippine J. Weed Sci. 7: 11-16