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# THE USE OF ULTRA-LOW VOLUME ATOMISERS FOR WEED CONTROL IN FRUIT PRODUCTION

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## A B S T R A C T

The aim of this study was to evaluate the weeding efficiency of controlled droplet application (CDA) with low doses of glyphosate applied with ultra-low volume atomisers. The influence of spray volume, herbicide dose, and droplet size was tested in an apple orchard. The efficiency of weed control by CDA was compared to of a conventional reference method (standard boom with flat fan nozzles with a spray volume 250 l $ha^{-1}$ and a glyphosate dose of 1.8 kg $ha^{-1}$ of glyphosate). CDA was a highly satisfactory technique for controlling weeds, although low spray volumes and low herbicide doses were not as effective as conventional spraying. The influence of herbicide dose and droplet size was not statistically significant, although better results were achieved when 2.5 l/ha of Roundup™ was used. According to European Weed Research Society (EWRS) guidelines, CDA was not as effective as conventional spraying at controlling dandelions (*Taraxacum officinale* Web.), but statistical differences are significant in only a few cases.

**Key words:** weeds, chemical weeding, ULV, glyphosate, apple growing, CDA

## INTRODUCTION

Glyphosate is one of the most effective and environment-friendly weed control agents, and it has been approved for use in Integrated Fruit Production. The weeding efficiency of glyphosate is comparable to that of mechanical weed control, which is still very common in fruit production.

One major drawback of applying glyphosate with conventional flat fan nozzles is the cost of the herbicide itself. Applying half the standard dose (0.9 kg

$ha^{-1}$) with hydraulic flat fan nozzles does not provide effective weed control.

Glyphosate doses can be significantly reduced by using CDA with a rotary atomiser disc (Jollands et al., 1983). In some cases, CDA can effectively control

weeds with doses of glyphosate as low as 0.18-0.27 kg $ha^{-1}$ (Turner and Southcombe, 1985).

The aim of the present study was to compare the weeding efficiency of CDA with low doses of glyphosate to that of conventional spraying with standard doses of glyphosate.

## MATERIAL AND METHODS

The influence of spray volume, herbicide dose, and droplet size on weeding efficiency was tested in an eight-year-old apple orchard in which the trees were spaced 4 x 2 m apart.

Herbicide was applied by either tractor-mounted atomisers (Micromax III and Micromax 120, Micron, U.K.) or a tractor-mounted boom fitted with conventional flat fan nozzles.

**Figure 1.** Tractor-mounted Micron atomisers

With CDA, the spray volumes used were 15, 25 and 40 l $ha^{-1}$, the glyphosate doses used were 0.54 and 0.9 kg $ha^{-1}$, and the droplet volume median diameters (VMD's) used were 150 and 250 µm; (Tab. 1).

With conventional spraying, the spray volume was 250 l $ha^{-1}$, the glyphosate dose was 1.8 kg $ha^{-1}$, and the VMD was 173 µm.

Eight treatments were applied in three replicates, with each replication consisting of a 100 m long row of trees (Tab. 1).

The dominant annual weeds were Cockspur Grass (*Echinochloa crus-galli* L. Pal.B.), Common Chickweed *(Stellaria media* L. Vill.), and Groundset (*Senecio vulgaris* L.). The dominant perennial weeds were Common Dandelion (*Taraxacum officinale* Web.), Field Horsetail *(Equisetum arvense* L.), and Field

Bindweed (*Convolvulus arvensis* L.).

T a b l e 1. Treatment dates and doses

| Treatment date | Spray volume [l ha$^{-1}$] | | Herbicide dose [kg ha$^{-1}$] | | | |
|---|---|---|---|---|---|---|
| | | | glyphosate | | MCPA | |
| | CDA | conven-tional spraying | CDA | conven-tional spraying | CDA | conven-tional spraying |
| 30 July 1998 | 15 25 | 250 | 0.54 0.90 | 1.8 | - | - |
| 20 May 1999 | 15 25 | 250 | 0.54 0.90 | 1.8 | - | - |
| 12 July 1999 | 15 25 | 250 | 0.54 0.90 | 1.8 | 0.24 | 0.6 |
| 01 August 1999 | 15 25 | 250 | 0.54 0.90 | 1.8 | 0.24 | 0.6 |
| 06 April 2000 | 15 25 | 250 | 0.54 0.90 | 1.8 | 0.24 | 0.6 |
| 21 May 2000 | 15 25 | 250 | 0.54 0.90 | 1.8 | 0.24 | 0.6 |

T a b l e 2. European Weed Research Society (EWRS) weeding efficiency scale

| EWRS score | % efficiency |
|---|---|
| 1 | 100 |
| 2 | 95-99.9 |
| 3 | 90-94.9 |
| 4 | 82-89.9 |
| 5 | 70-81.9 |
| 6 | 55-69.9 |
| 7 | 30-54.9 |
| 8 | 10-29.9 |
| 9 | 0-9.9 |

Weeding efficiency was evaluated visually by three persons 9-14 days after treatment on three selected plots (8 m$^2$) in each tree row. Annuals and perennials were evaluated separately. Data were elaborated by ANOVA, followed by Duncan's multiple range t-test (P = 0.05). Weeding efficiency was also classified according to the EWRS scale (Tab. 2).

## RESULTS AND DISCUSSION

Conventional spraying was not as efficient at controlling weeds in our study than it was in the study published by Lisek (1996), who achieved 100% efficiency with doses of glyphosate of 3 and 5 kg ha$^{-1}$. Overall conditions in our study were probably worse. Our results for annual and perennial weeds are presented in

Tables 3 and 4.

Table 3. Weeding efficiency of CDA on annual weeds. Results are shown as a mean percent weed effect and converted to EWRS scores

| Volume [l ha$^{-1}$]/ dose [kg ha$^{-1}$]/ VMD [μm] | Date of treatment | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 30.07.98 | | 20.05.99 | | 12.07.99 | | 01.08.99 | | 06.04.00 | | 21.05.00 | |
| | [%] | EWRS | [%] | EWRS | [%] | EWRS | [%] | EWRS | [%] | EWRS | [%] | EWRS |
| 15/0.54/150 | 84.3 a* | 4 | 94.1 a | 3 | 99.1 a | 2 | 91.9 a | 3 | 83.1 a | 4 | 90.1 a | 3 |
| 15/0.54/250 | 82.2 a | 4 | 95.1 a | 2 | 98.9 a | 2 | 92.0 a | 3 | 83.4 a | 4 | 93.6 a | 3 |
| 15/0.90/150 | 89.4 a | 4 | 97.7 a | 2 | 99.1 a | 2 | 97.0 a | 2 | 85.8 a | 4 | 91.2 a | 3 |
| 15/0.90/250 | 84.3 a | 4 | 96.8 a | 2 | 98.9 a | 2 | 96.3 a | 2 | 83.9 a | 4 | 90.5 a | 3 |
| 25/0.54/150 | 86.2 a | 4 | 97.7 a | 2 | 99.1 a | 2 | 97.4 a | 2 | 90.1 a | 3 | 94.1 ab | 3 |
| 25/0.54/250 | 86.2 a | 4 | 95.8 a | 2 | 99.4 a | 2 | 95.6 a | 2 | 85.8 a | 4 | 92.3 a | 3 |
| 25/0.90/150 | 82.2 a | 4 | 96.3 a | 2 | 99.8 a | 2 | 97.4 a | 2 | 87.4 a | 4 | 96.4 ab | 3 |
| 25/0.90/250 | 81.8 a | 5 | 97.1 a | 2 | 100.0 a | 1 | 95.5 a | 2 | 86.5 a | 4 | 95.6 ab | 2 |
| Conventional spraying | 99.0 b | 2 | 97.7 a | 2 | 98.9 a | 2 | 92.0 a | 3 | 98.4 b | 2 | 98.7 b | 2 |

***** Means in columns followed by the same letter are not significantly different (Duncan's multiple range t-test, P= 0.05**)**

Table 4. Weeding efficiency of CDA on the Common Dandelion. Results are shown as a mean percent weed effect and converted to EWRS scores

| Volume [l ha$^{-1}$]/ dose [kg ha$^{-1}$]/ VMD [μm] | Date of treatment | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 30.07.98 | | 20.05.99 | | 12.07.99 | | 01.08.99 | | 06.04.00 | | 21.05.00 | |
| | [%] | EWRS | [%] | EWRS | [%] | EWRS | [%] | EWRS | [%] | EWRS | [%] | EWRS |
| 15/0.54/150 | 64.8 a* | 6 | 86.6 ab | 4 | 95.8 a | 2 | 63.4 a | 6 | 73.2 a | 4 | 93.3 a | 3 |
| 15/0.54/250 | 66.7 a | 6 | 85.7 a | 4 | 98.0 a | 2 | 63.4 a | 6 | 69.1 a | 4 | 94.8 a | 3 |
| 15/0.90/150 | 70.0 a | 5 | 93.4 abc | 3 | 97.7 a | 2 | 64.3 a | 6 | 73.9 a | 4 | 92.9 a | 3 |
| 15/0.90/250 | 65.7 a | 6 | 90.5 abc | 3 | 98.0 a | 2 | 64.0 a | 6 | 74.5 a | 4 | 95.3 a | 2 |
| 25/0.54/150 | 71.3 a | 5 | 95.1 c | 2 | 97.7 a | 2 | 66.0 a | 6 | 77.4 a | 4 | 97.0 a | 2 |
| 25/0.54/250 | 69.7 a | 6 | 90.1 abc | 3 | 96.3 a | 2 | 62.7 a | 6 | 72.0 a | 4 | 95.1 a | 2 |
| 25/0.90/150 | 69.1 a | 6 | 93.7 bc | 3 | 98.9 a | 2 | 64.4 a | 6 | 76.5 a | 3 | 97.7 a | 2 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 25/0.90/250 | 69.0 a | 6 | 92.9 abc | 3 | 98.9 a | 2 | 65.0 a | 6 | 72.1 a | 3 | 96.5 a | 2 |
| Conventional spraying | 79.2 b | 5 | 95.6 c | 2 | 95.8 a | 2 | 62.0 a | 6 | 84.7 b | 2 | 96.4 a | 2 |

*For explanation, see Table 3

**Efficiency of controlling annual weeds**

CDA was more than 90% efficient at controlling low-growing annual weeds, comparable to conventional spraying in all but a few cases. CDA was less effective in controlling tall and dense weed growth. CDA was also significantly less effective than the control methods after the treatments applied on 30 July 1998 and 6 April 2000. Sieckert (1983) also found no difference between CDA and conventional spraying when weed density was low.

With CDA, low glyphosate doses were just as effective as high doses. Adding MCPA to the spray increased the efficiency of CDA, sometimes to the point that CDA was even better than conventional spraying.

Spray volume, dose, and droplet size had no statistically significant effect on weeding efficiency, which confirms findings by other researchers cited by Knoche (1994). Out of 110 experiments, 24% showed that reducing the spray volume increased weeding efficiency, 44% showed that it decreased efficiency, and 32% showed that it had no effect. However, we found that the lowest spray volume (15 l $ha^{-1}$, with 1.5 l $ha^{-1}$ of glyphosate) had the lowest weeding efficiency.

**Efficiency of controlling the Common Dandelion**

All CDA treatments and conventional spraying were less effective at controlling dandelions than they were in controlling annual weeds. Applying lower doses of glyphosate killed 63-98% of the dandelions, which corresponds to a score of 2-6 on the EWRS scale. After the treatments applied on 30 July 1998 and 6 April 2000, CDA was less effective than conventional spraying at controlling dandelions because of high weed density. After the treatment applied on 20 May 1999, CDA with a low spray volume and low glyphosate dose was significantly less effective than conventional spraying at controlling dandelions. When MCPA was added to the glyphosate, spray volume and dose did not significantly affect the weeding efficiency of CDA.

The following observations were also made, but were not statistically evaluated**:**

- American Willowherb (*Epilobium adenocaulon* Hausskn.) survived all treatments, including conventional spraying.
- In 1998 and 2000, CDA was not effective against Field Horsetail *(Equisetum arvense* L.), whereas conventional spraying provided good weed control.
- CDA was effective against Field Horsetail when 0.24 kg $ha^{-1}$ MCPA was added.

## CONCLUSIONS

1. With annual weeds, the weeding efficiency of CDA with low doses of glyphosate was similar to that of conventional spraying with standard doses.
2. With annual weeds, spray volume, glyphosate dose, and droplet size had no effect on the weeding efficiency of CDA.
3. CDA was significantly less effective at controlling tall and dense weeds than conventional spraying.
4. CDA with a spray volume of 15 l/ha and a glyphosate dose of 0.54 kg $ha^{-1}$ was significantly less effective than conventional spraying at controlling dandelions.

5. When MCPA (0.24 kg ha$^{-1)}$ was added to the glyphosate, CDA was just as efficient a controlling weeds as conventional spraying with standard doses.
6. Even though CDA with low doses of glyphosate was slightly less effective at controlling weeds than conventional spraying, it should be recommended for use in orchards because of the significantly lower herbicide doses.

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# ZASTOSOWANIE ROZPYLACZY ROTACYJNYCH I ULTRA NISKICH DAWEK CIECZY DO ZWALCZANIA CHWASTÓW W SADACH

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## STRESZCZENIE

Celem badań była ocena efektywności niszczenia chwastów zredukowanymi dawkami glifosatu nanoszonymi rozpylaczami rotacyjnymi. Rozpylacze rotacyjne umożliwiają uzyskiwanie stosunkowo wyrównanego spektrum kropli różnych wielkości, a technika oprysku z ich wykorzystaniem (CDA) pozwala na kilkukrotne obniżenie dawek cieczy. Wpływ wielkości dawek cieczy i glifosatu oraz wielkości kropli na efekt niszczenia chwastów oceniano w sadzie jabłoniowym, porównanie stanowiła standardowa technika nanoszenia herbicydów ciśnieniowymi rozpylaczami płaskostrumieniowymi w dawkach: 250 l ha$^{-1}$ cieczy oraz 1,8 kg h$^{-1}$ glifosatu. Uzyskane techniką CDA efektywności odchwaszczania były wysokie i tylko nieznacznie gorsze od uzyskanych rozpylaczami płaskostrumieniowymi. Słabszym efektem charakteryzowały się szczególnie zabiegi wykonywane na chwastach bardziej wyrośniętych. Nie obserwowano istotnego wpływu dawki herbicydu oraz wielkości kropli, aczkolwiek wyższe efektywności uzyskiwano dla dawki glifosatu 0,9 kg h$^{-1}$ w porównaniu do dawki 0,54 kg h$^{-1}$. Sklasyfikowanie uzyskanych wyników w skali EWRS (European Weed Research Socjety) wykazało niższą skuteczność metody CDA podczas niszczenia mniszka pospolitego (*Taraxacum officinale* Web.), ale

istotne różnice udowodniono tylko w pojedynczych kombinacjach.

**Słowa kluczowe:** chwasty, chemiczne zwalczanie chwastów, ULV, glifosat, sadownictwo, CDA