

# Chemical weed management in onions (*Allium cepa* L.)<sup>1</sup>

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## ABSTRACT

Four herbicide experiments were conducted in a San Antón soil at Juana Díaz Substation from 1985 to 1988. In the first experiment, conducted in 1985-86, we found that post emergence oxyfluorfen (0.14, 0.28 and 0.56 kg ai/ha) preceded by preemergence DCPA (11.2 kg ai/ha) plus hand weeding effectively controlled broadleaf weeds (93-97%) for 9 weeks. Onion yield increased proportionately with the increasing rates of oxyfluorfen. In the second experiment, established in 1986-87, preemergence metolachlor (2.8 and 5.6 kg ai/ha) caused high phytotoxicity on onion and affected its yield. Oxyfluorfen (0.14 kg ai/ha) applied in mixture and sequentially with fluazifop-P (0.24 kg ai/ha) provided an excellent weed control with onion yields similar ( $P = 0.05$ ) to that obtained in the hand-weeded check. In two subsequent experiments established in 1987-88 we found that two or three applications of either oxyfluorfen (0.14 kg ai/ha) + fluazifop-P (0.25 kg ai/ha) or oxyfluorfen (0.14 kg ai/ha) + sethoxydim (0.25 kg ai/ha) mixtures gave excellent grass and broadleaf weed control. However, no significant differences ( $P = 0.05$ ) in onion yield were detected by increasing the number of herbicide applications in either experiment.

## RESUMEN

### Combate químico de malezas en cebolla (*Allium cepa* L.)

En un suelo San Antón de la Subestación Experimental Agrícola de Juana Díaz se hicieron cuatro experimentos de herbicidas en cebolla desde noviembre de 1985 hasta abril de 1988. En el 1<sup>er</sup> experimento, realizado en 1985-86, oxifluorfen posemergente a razón de 0.14, 0.28 y 0.56 kg. p.a./ha. combinado con el preemergente DCPA (11.2 kg. p.a./ha. con desyerbo manual, reprimieron las malezas eficazmente (93 a 97%) hasta 9 semanas después de la siembra. El rendimiento en cebollas aumentó proporcionalmente con los aumentos en la concentración del oxifluorfen. En el 2<sup>do</sup> experimento, realizado en 1986-87, el preemergente metolaclor (2.8 y 5.6 kg. p.a./ha.) fue altamente fitotóxico y afectó el rendimiento de la cebolla. Oxifluorfen (0.14 kg. p.a./ha.) aplicado en mezcla y en secuencia con el fluazifop-P (0.42 kg. p.a./ha.) reprimió las malezas excelentemente y propició rendimientos de cebolla similares ( $P = 0.05$ ) a los obtenidos en el testigo desyerbado. En dos experimentos en 1987-88 las mezclas de

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<sup>3</sup>Trade names in this publication are used only to provide specific information. Mention of a trade name does not constitute a warranty of equipment or materials by the Agricultural Experiment Station of the University of Puerto Rico, nor is this mention a statement of preference over other equipment or materials.

oxifluorfen (0.14 kg. p.a./ha.) + fluazifop-P (0.25 kg. ia/ha) y oxifluorfen (0.14 kg. p.a./ha.) + setoxidim (0.25 kg. p.a./ha.) reprimieron excelentemente las malezas gramíneas y de hoja ancha después de 2 y 3 aplicaciones, respectivamente. No hubo diferencias significativas ( $P = 0.05$ ) en el rendimiento al aumentar el número de aplicaciones de herbicidas en ninguno de los experimentos.

#### INTRODUCTION

This study was conducted to evaluate oxyfluorfen and other new potential herbicides in an attempt to develop an integrated weed management system for onions. Onion production in Puerto Rico has been increasing during recent years. Total onion production increased from 621 metric tons (mt) in 1984-85 to 1030 mt in 1985-86, with a farm value of \$0.29 million (4). Among vegetable crops grown in Puerto Rico, onions have great potential for increasing local production. 21,808 mt were imported from the United States in 1985. At a value of \$7.77 million.

Of all crops, onion is one of the most susceptible to weed interference. Williams et al. (8) reported that weed competition at any time during the growing season reduced onion yields significantly. The use of herbicides together with cultivation and handweeding appears to be the most effective practice for controlling weeds in onions. DCPA is a preemergence herbicide recommended for onions (1, 3, 5). Oxyfluorfen was registered for postemergence weed control in onions in 1983 (2). This herbicide should be applied when onion plants have 2 or 3 true leaves and weeds are in their 2- to 4-leaf stage in order to obtain crop selectivity and effective weed control (2, 3, 6). Despite the fact that oxyfluorfen was registered for weed control in onions, its efficacy under our conditions has not been evaluated. Oxyfluorfen was also found to be a potential herbicide for pre- and postemergence weed control in pigeon peas (7).

#### MATERIALS AND METHODS

Four herbicide experiments were established at the Fortuna Substation in Juana Díaz, Puerto Rico, from 1985 to 1988. The soil belongs to the San Antón series (Mollisol, fine loamy, mixed isohyperthermic) with pH 6.9. Randomized block design with 4 replications was used for the arrangement of herbicide treatments. Sprinkler irrigation was applied as needed for experiments 1 and 2, and drip irrigation for experiments 3 and 4.

In experiment 1, seeds of onions cv. Brownsville were planted 21 November 1985. Plots were 2.7 × 4.6 m with 3 beds per plot and 2 rows per bed with 0.3 m between rows. DCPA (11.2 kg ai/ha) was applied to the whole experiment area as preemergence. All plots (except checks) were weeded by hoe 4 weeks after onion planting because of the poor weed control provided by DCPA. Oxyfluorfen at 0.14, 0.28 and 0.56 kg ai/ha was applied over the top of crop and weeds 26 December 1985.

Sethoxydim at 0.56, 1.12 and 2.24 kg ai/ha, and fluazifop-P at 0.42, 0.84 and 1.68 kg ai/ha were applied 9 January 1986. One additional weeding was performed to each half plot 10 weeks after planting. Onions were harvested 30 April 1986, dried at room temperature and weighed for yield determinations.

In experiment 2, seeds of onion cv. Ringer Grano were planted by hand 5 November 1986. This time, plot size was increased to 3.6 × 6.1 m with 4 beds per plot. Preemergence metolachlor at 2.8 and 5.6 kg ai/ha was applied one day after planting. Oxyfluorfen (0.14 kg ai/ha) alone and in mixture with fluazifop-P (0.42 kg ai/ha) was applied 3 weeks after onion planting. Fluazifop-P (0.42 kg ai/ha) and sethoxydim (0.56 kg ai/ha) were applied on 10 December 1986 to plots previously treated with oxyfluorfen alone. Onions were harvested 19 March 1987 and processed as in experiment 1.

The third and fourth experiments were to determine the number of applications of oxyfluorfen + fluazifop-P and oxyfluorfen + sethoxydim (mixtures) needed for good weed control and yield of onions. Onion cv. Texas Grano seeds were sown on 21 December 1987. Two beds 0.3 m × 9.1 m were used as individual plots, with 2 rows of onion per bed 0.3 m apart. Mixtures of oxyfluorfen (0.14 kg ai/ha) + fluazifop-P (0.25 kg ai/ha) in experiment no. 3 and oxyfluorfen (0.14 kg ai/ha) + sethoxydim (0.25 kg ai/ha) in experiment no. 4 were applied as follows: 1) treatment no. 1 at 3 weeks, 2) treatment no. 2 at 3 and 8 weeks, and 3) treatment no. 3 at 3, 8 and 12 weeks after planting. Spreader sticker (Ortho X-77)<sup>s</sup> at 0.25% v/v was added to spray solutions in both experiments. Spray volume for different applications ranged from 425 to 750 L/ha. Drip irrigation was applied three times a week from planting until 1 month before harvesting. Fertilizer 10-10-8 (N P K) at 746 kg ai/ha each application was applied three times: 1) pre-plant incorporated, 2) after complete germination, and 3) at bulb formation. Onions were harvested 28 April 1988.

## RESULTS AND DISCUSSION

### Experiment 1 (1985-86)

Table 1 shows the effect of preemergence DCPA (11.2 kg ai/ha) in sequence with handweeding and postemergence herbicides. Oxyfluorfen was the only herbicide which caused slight injury to onion (6 to 12%) but observed symptoms disappeared at 9 weeks after planting. Oxyfluorfen (all rates) in combination with DCPA plus handweeding controlled broadleaf weeds effectively (93 to 97%) for 9 weeks, but at lower rates failed to control grass weeds. DCPA in sequences with sethoxydim and fluazifop-P, both at three rates, gave effective control of grasses but did not control broadleaf weeds. A handweeding performed at 10 weeks after

TABLE 1.—Effect of preemergence DCPA (11.2kg ai/ha), hand-weedings (Hw) and post emergence herbicides on yield of onion (cv. Brownsville) and weed control - 1985-86

Treatment <sup>1</sup>	kg ai/ha	Weed control <sup>2</sup>		Onion yield in kg/ha <sup>3</sup>	
		Broadleaf	Grasses	Hand-weeded at 10 weeks	Non-weeded at 10 weeks
DCPA + Hw + Oxyfluorfen	0.14	93	0	9,704 bcd	5,963 bc
DCPA + Hw + Oxyfluorfen	0.28	97	50	12,088 bc	7,806 b
DCPA + Hw + Oxyfluorfen	0.56	97	81	18,539 a	15,558 a
DCPA + Hw + Sethoxydim	0.56	32	100	5,096 de	867 d
DCPA + Hw + Sethoxydim	1.12	38	100	10,137 bcd	1,951 d
DCPA + Hw + Sethoxydim	2.24	26	100	6,125 de	488 d
DCPA + Hw + Fluzafop-P	0.42	34	100	6,614 cde	1,030 d
DCPA + Hw + Fluzafop-P	0.84	13	100	5,583 de	1,518 d
DCPA + Hw + Fluzafop-P	1.68	43	100	7,860 cd	1,300 d
DCPA + Hw at 7 weeks	—	55	44	13,823 ab	3,470 cd
DCPA + Hw at 4 weeks	—	13	0	2,060 ef	759 d
DCPA	—	0	0	0 f	0 d

<sup>1</sup>Hand weeding also performed at 4 weeks after planting onion.

<sup>2</sup>Mean of 4 replications based on a scale of 0 to 100, where less than 70% = poor, 70-79 fair, 80-89 good and 90-100 = excellent weed control.

<sup>3</sup>Yields in columns followed by the same letter in each column do not differ significantly at the P = .05 level, Duncan's multiple range test.

planting increased onion yield in all cases, except in the DCPA-only treatment. Onion yield increased proportionately with increasing rates of oxyfluorfen. The highest onion yield (18,539 kg/ha) was obtained with DCPA + handweedings followed by oxyfluorfen at 0.56 kg ai/ha rate. Sethoxydim and fluzafop-P, applied sequentially after DCPA and weedings, were effective against grass weeds only; onion yield was reduced by the interference of broadleaf weeds. The results of this experiment suggested that a combination of oxyfluorfen with either sethoxydim or fluzafop-P should be applied for improving over-all weed control in onions.

#### Experiment 2 (1986-87)

Table 2 shows that preemergence metholachlor (2.8 and 5.6 kg ai/ha) was highly phytotoxic to onions and thus affected final bulb yield. Excellent weed control was obtained with all treatments, except with oxyfluorfen in sequence with sethoxydim, which failed to control grasses effectively. Herbicide treatments controlled effectively pigweed (*Amaranthus dubius* Mart.), horse purslane (*Trianthema portulacastrum* L.), spider flower (*Cleome gynandra* L.), junglerice [*Echinochloa colonum* L. Link] and crabgrass (*Digitaria sanguinalis* L.). The highest onion yield (15,095 kg/ha) was obtained in the hand-weeded check, followed by that with the mixture of oxyfluorfen (0.14 kg ai/ha) + fluzafop-P (0.42

TABLE 2.—Effect of herbicides on weed number (10 weeks) and yield of onion (cv. Ringer Grano) 1986-87

Treatment	kg ai/ha	Phytotoxicity <sup>1</sup>	No. weeds/0.5 m <sup>2</sup>		Onion yield in kg/ha <sup>2</sup>
			Broadleaf <sup>2</sup>	Grasses <sup>2</sup>	
Metolachlor	2.8	7.8	5.62 a	0.00 b	200 b
Metolachlor	5.6	9.9	2.50 b	0.00 b	169 b
Oxyfluorfen	0.14 <sup>3</sup>	0.0	0.75 d	0.00 b	10,309 a
Oxyfluorfen	0.14				
Fluazifop-P	0.42	0.0	1.50 c	1.75 b	13,667 a
Oxyfluorfen	0.14 <sup>4</sup>	0.0	0.25 d	18.75 a	4,314 b
Hand-weeded	—	0.0	0.12 d	1.25 b	15,095 a

<sup>1</sup>Mean ratings of 4 replications with 0 representing no effect and 10 complete stand kill at 5 weeks after planting onion.

<sup>2</sup>Means followed by the same letter do not differ significantly at  $P = 0.05$ , Duncan's multiple range test.

<sup>3</sup>Treated with fluazifop-P (0.42 kg ai/ha) 5 weeks after planting of onion.

<sup>4</sup>Treated with sethoxydim (0.56 kg ai/ha) 5 weeks after planting of onion.

kg ai/ha) (13,667 kg/ha) and oxyfluorfen 0.14 kg ai/ha/fluazifop-P 0.42 kg ai/ha sequence (10,309 kg/ha). Although the oxyfluorfen + fluazifop-P combinations gave effective weed control for 10 weeks, more than one application was needed to control late germinating weeds in onions. As reported by Williams et al. (8), weed interference resulted in detrimental effect for onion yield in late growth stages. Our results suggested that multiple application of oxyfluorfen in combination with fluazifop-P or sethoxydim is needed to protect onion from late weed interference.

#### Experiments 3 and 4 (1987-88)

Table 3 presents data on the efficacy and yield of onions with 1, 2 and 3 applications of oxyfluorfen (0.14 kg ai/ha) + fluazifop-P (0.25 kg ai/ha) and oxyfluorfen (0.14 kg ai/ha) + sethoxydim (0.25 kg ai/ha) mixtures. The two herbicide mixtures controlled grass weeds more effectively than broadleaf weeds for 14 weeks. Two applications of either combination were needed for excellent grass control, whereas three applications were needed for broadleaf weeds. No significant differences in onion yield were detected among treatments in either experiment. No significant differences in weight of bulbs were detected among different treatments in the experiments. Mean weight of onion bulbs ranged from 154 g with two applications to 165 g with one application in experiment 3. In the fourth experiment, mean weight of onion bulbs ranged from 133 g with one application to 193 g with two applications of oxyfluorfen + sethoxydim mixture. A single application of both herbicide mixtures gave adequate weed control and good onion yield. Therefore, higher onion

TABLE 3.—Weed control and yield of onion treated with oxyfluorfen + fluazifop-P and oxyfluorfen + sethoxydim mixtures - 1987-88

Number of applications	Broadleaf weeds <sup>a</sup>			Grassy weeds <sup>a</sup>			Onion yield in kg/ha <sup>a</sup>
	5 weeks	10 weeks	14 weeks	5 weeks	10 weeks	14 weeks	
Oxyfluorfen (0.14 kg ai/ha) + Fluazifop-P (0.25 kg ai/ha) each application							
1 (3 weeks)	86	63	70	97	92	49	17,626 a
2 (3 and 8 weeks)	89	93	76	96	99	91	17,345 a
3 (3, 8 and 12 weeks)	89	95	90	99	99	99	19,730 a
Hand-weeded <sup>b</sup>	90	96	94	99	96	97	20,837 a
Oxyfluorfen (0.14 kg ai/ha) + Sethoxydim (0.25 kg ai/ha) each application							
1 (3 weeks)	94	76	61	99	85	56	14,110 a
2 (3 and 8 weeks)	97	98	78	99	99	95	22,846 a
3 (3, 8 and 12 weeks)	93	96	88	99	99	96	19,725 a
Hand-weeded <sup>c</sup>	96	99	99	99	98	99	18,814 a

<sup>a</sup>Mean of 4 replications based on a scale of 0 to 100, where less than 70% = poor, 70-79 = fair, 80-89 = good and 90-100 = excellent weed control.

<sup>b</sup>No significant differences in yield between treatments means were detected using ANOVA.

<sup>c</sup>Treated with fluazifop-P (0.25 kg ai/ha) at 3 weeks after planting onion, then weeded by hand and hoe 4, 9, 11 and 13 weeks.

<sup>d</sup>Treated with sethoxydim (0.25 kg ai/ha) 3 weeks after seeding onion, then weeded by hand and hoe 4, 9, 11 and 13 weeks.

yield (almost double) can be obtained if 4 rows per bed are planted. In our experiments only 2 rows per 1.5 m bed were planted instead of the 4-row system used in commercial plantings.

Although two or three applications of these herbicide mixtures were needed to achieve excellent weed control, we found no significant differences in onion yield among treatments. The only difference will be the higher cost of harvesting for those plots having more weed interference with accompanying lower net income. On the basis of our study, a weed management system for onions should include the following practices: 1) 1-2 applications of oxyfluorfen in combination with fluazifop-P or sethoxydim; 2) first application should be made within 3 weeks after planting; 3) weeds should be in their 2- to 4-leaf stage or 5.0 to 7.5 cm in height; 4) shallow cultivation in the bottom of ridges should be used; and 5) a second herbicide mixture should be applied 8 weeks after planting when regrowth of weed seedlings is evident.

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