Clomazone and oxyfluorfen for weed control in transplanted cabbage (*Brassica oleracea* L.)[1,2]

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ABSTRACT

Two field experiments were conducted in 1992-93 and 1994 at Juana Díaz, Puerto Rico, to evaluate clomazone, oxyfluorfen, and prometryn as preplant herbicides in cabbage. After three weeks, clomazone (1.12 and 2.24 kg ai/ha), oxyfluorfen (0.28 and 0.56 kg ai/ha), and prometryn (2.0 and 4.0 kg ai/ha) reduced weed density by more than 67% and 90% in 1992-93 and 1994, respectively. At the lower rate, clomazone and oxyfluorfen caused 15% to 25% injury to cabbage when evaluated after three weeks, and 2% to 10% after six weeks. Prometryn caused more than 65% injury and reduced cabbage yield by more than 84%. Cabbage treated with clomazone at both rates and oxyfluorfen at 0.56 kg ai/ha produced yields similar to that of the handweeded check (39,980 kg/ha) in 1992-93. Interference to cabbage was caused mostly by purple nutsedge (*Cyperus rotundus* L.) in 1994.

Key words: cabbage, clomazone, oxyfluorfen, prometryn, weed control

RESUMEN

Clomazone y oxyfluorfen para controlar malezas en repollo (*Brassica oleracea* L.) de trasplante

Durante 1992-93 y 1994 se realizaron dos experimentos de campo para evaluar clomazone, oxyfluorfen y prometryn como herbicidas pretrasplante en repollo. Clomazone (1.12 y 2.24 kg ia/ha), oxyfluorfen (0.28 y 0.56 kg ia/ha) y prometryn (2.0 y 4.0 kg ia/ha) redujeron la densidad total de malezas en más de 67% y 90% a las tres semanas después del trasplante del repollo en 1992-93 y 1994, respectivamente. A la dosis baja tanto el clomazone como el oxyfluorfen causaron daño al repollo; el daño varió desde moderado (15% a 25%) cuando se evaluó a las tres semanas hasta leve (2% a 10%) a las seis semanas. Prometryn causó mas de 65% de daño en las plántulas de repollo y redujo el rendimiento del repollo en más del 84%. El repollo tratado con clomazone a ambas dosis y con oxyfluorfen a 0.56 kg ia/ha produjo rendimientos similares al del desyerbo manual (39,980 kg/ha) en 1992-93. La interferencia en el repollo fue causada mayormente por el coquí (*Cyperus rotundus* L.) durante el 1994.

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INTRODUCTION

Cabbage has the potential to become a major vegetable crop in Puerto Rico. Most of the local demand is supplied from the United States (Departamento de Agricultura, 1992). Decline in local production since 1988 is attributed to insect problems, especially to damages from the diamondback moth (*Plutella xylostella* L.) (Alamo, 1992).

The results of a herbicide field trial indicate that weed interference represents a potential problem for cabbage production in Puerto Rico (Jackson, 1977). In this trial, crop yield declined by 85% when DCPA was not applied to cabbage. At present, DCPA is the only herbicide registered for cabbage in Puerto Rico, and its efficacy for weed control has been deficient under local conditions.

Cole crops have been somewhat tolerant to oxyfluorfen and clomazone in the United States (Scott et al., 1995; Scott and Weston, 1992). According to Herbst and Deer (1990), direct-seeded broccoli (*B. oleracea* var. *botrytis*) was marginally tolerant to several rates of oxyfluorfen that acceptably controlled broadleaf weeds. Oxyfluorfen was labeled for weed control in cabbage in 1989 and clomazone from 1990 to 1994 in the North Central United States (Hopen, 1995). Oxyfluorfen and prometryn were more than 90% effective for weeds in transplanted cabbage in Colombia (Nuñez-Almario, 1984).

The objective of this study was to evaluate the efficacy of clomazone, oxyfluorfen, and prometryn as pretransplant herbicides in cabbage.

MATERIALS AND METHODS

Two experiments were conducted at the Juana Díaz Agricultural Experiment Station in 1992-93 and 1994. The soil was a San Antón (Fine-loamy, mixed, isohyperthermic Cumulic Haplustolls) with pH of 7.8. Clay, silt, sand, and organic matter content was 33.9, 27.9, 38.2, and 1.2%, respectively.

A split-plot design with four replications was used for the arrangement of treatments in the field. Plots consisted of six 6.1-m rows spaced 0.91 m apart. The main plots were herbicide treatments and subplots were cabbage cultivars (Blue Vantage and Tenacity). Herbicide treatments (in kg ai/ha) were clomazone (1.12 and 2.24), oxyfluorfen (0.28 and 0.56), and prometryn (2.0 and 4.0). Handweeded and nonweeded treatments were also included in the experiments.

Herbicides were surface applied at the rate of 165 L/ha 10 December 1992 and 19 January 1994 with a CO_2-pressurized backpack sprayer. Overhead irrigation was applied for 0.5 h immediately after herbicide application to promote herbicide activity. Cabbage seedlings were

transplanted 30 cm apart five days after herbicide application each year.

Drip irrigation was applied for the first two days after cabbage planting and then twice a week until harvesting. Plots were evaluated for weed emergence and visible crop injury at three and six weeks after planting (WAP). Insects were controlled with Guthion 2 L[a], Lannate 90 WSP, Ambush, and Diazinon AG500.

Cabbage heads were collected at 10 and 12 WAP for yield determination. Data from each experiment were subjected to Analysis of Variance and means separated by LSD (0.05).

RESULTS AND DISCUSSION

Data were not combined over years since rainy conditions delayed cabbage planting and promoted more weed growth in 1994 than in 1992-93. Results presented are the main effects of herbicides compared either to handweeded or nonweeded treatments.

Both rates of clomazone, oxyfluorfen, and prometryn reduced total weed density by more than 67% at three WAP in 1992-93 (Table 1). At six WAP, clomazone reduced weed density by 52% to 74%, oxyfluorfen by 48% to 62%; and prometryn by only 25% and 34%. Clomazone and oxyfluorfen each at the lower rate caused moderate (18% to 22%) to low injury (5% to 7%) to cabbage at three and six WAP, respectively. Visible injuries were similar in the two cultivars (data not shown).

Injury symptoms observed in cabbage foliage were chlorosis and bleaching for clomazone treatments. Leaf crinkling was observed after oxyfluorfen treatments. These injury symptoms were not evident at nine WAP (data not shown). The two rates of prometryn caused over 73% stand mortality at six WAP and cabbage yields were reduced by more than 84% as compared with yields of the handweeded treatment. Cabbage treated with clomazone (1.12 and 2.24 kg ai/ha) and oxyfluorfen (0.56 kg ai/ha) produced yields similar to that of the handweeded treatment.

Data on total weed density and visible crop injury in response to herbicides in 1994 were similar to data recorded in 1992-93 (Table 2). For 1994, all herbicide treatments reduced weed density by 91% or more at three WAP as compared to the nonweeded treatment. Clomazone (1.12 kg ai/ha) and oxyfluorfen (0.28 kg ai/ha) reduced weed density by 83% and 84%, respectively, at six WAP.

[a]Trade names in this publication are used only to provide specific information. Mention of trade names does not constitute a warranty of materials by the UPR-AES, nor is this mention a statement of preference over other materials.

TABLE 1.—*Effect of pre-transplant treatments on total weed density, visible injury, and cabbage yield in 1992-93 at Juana Díaz, Puerto Rico.*

Treatment	Rate	Total weed density		Visible injury[1]		Cabbage yield
		3 WAP[2]	6 WAP	3 WAP	6 WAP	
	kg ai/ha	Plants/0.5 m² (%)[3]		%		kg/ha
Clomazone	1.12	27 (67)	29 (52)	22	7	33,450
Clomazone	2.24	15 (82)	16 (74)	37	14	37,160
Oxyfluorfen	0.28	13 (84)	32 (48)	18	5	24,630
Oxyfluorfen	0.56	9 (89)	23 (62)	28	29	30,200
Prometryn	2.00	6 (93)	46 (25)	77	73	6,460
Prometryn	4.00	6 (93)	40 (34)	98	98	280
Handweeded	—	0 (100)	11 (82)	0	0	39,980
Nonweeded	—	83 (0)	61 (0)	0	0	880
LSD (0.05)		21	22	14	20	10,140

[1]Visual rating scale from 0 to 100, with 0 = no injury and 100 = complete mortality.
[2]WAP = weeks after planting.
[3]Percentage weed reduction as calculated from the nonweeded treatment.

TABLE 2. — *Effect of pre-transplant treatments on weed density, visible injury, and cabbage yield in 1994 at Juana Diaz, Puerto Rico.*

Treatment	Rate	Total weed density		Visible injury[1]		Cabbage yield
		3 WAP[2]	6 WAP	3 WAP	6 WAP	
	kg ai/ha	Plants/0.5m² (%)[3]		%		kg/ha
Clomazone	1.12	20 (91)	42 (83)	25	10	15,680
Clomazone	2.24	18 (92)	69 (71)	27	10	16,750
Oxyfluorfen	0.28	17 (92)	38 (84)	15	2	13,980
Oxyfluorfen	0.56	13 (94)	71 (71)	31	22	9,790
Prometryn	2.00	11 (95)	54 (78)	78	65	410
Prometryn	4.00	5 (98)	65 (73)	98	93	1,160
Handweeded	—	0 (100)	6 (98)	0	0	25,390
Nonweeded	—	212 (0)	241 (0)	0	0	280
LSD (0.05)		41	40	10	11	8,790

[1]Visual rating scale from 0 to 100, with 0 = no injury and 100 = complete crop kill.

[2]WAP = weeks after planting.

[3]Percentage weed reduction as calculated from the nonweeded treatment.

TABLE 3.—*Plant density of three major weed species in cabbage treated with pre-transplant herbicides in 1992-93 and 1994 at Juana Díaz, Puerto Rico.*[1]

Treatment	Rate	Jimsonweed		Junglerice		Purple nutsedge	
		1992-93	1994	1992-93	1994	1992-93	1994
	kg ai/ha	Plants/0.5m² (%)[2]					
Clomazone	1.12	4 (83)	6 (54)	1 (94)	2 (99)	12 (+300)	24 (+380)
Clomazone	2.24	1 (96)	3 (77)	1 (94)	2 (99)	9 (+200)	53 (+960)
Oxyfluorfen	0.28	5 (78)	8 (38)	6 (63)	3 (99)	20 (+567)	24 (+380)
Oxyfluorfen	0.56	3 (87)	12 (8)	2 (88)	2 (99)	18 (+500)	56 (+1020)
Prometryn	2.00	5 (78)	7 (46)	19 (+19)	13 (94)	14 (+367)	31 (+520)
Prometryn	4.00	1 (96)	1 (92)	19 (+19)	8 (96)	16 (+433)	54 (+980)
Handweeded	—	0 (100)	0 (100)	7 (56)	1 (99)	1 (67)	5 (0)
Nonweeded	—	23 (0)	13 (0)	16 (0)	215 (0)	3 (0)	5 (0)
LSD (0.05)		11	9	11	17	NS	39

[1]This evaluation was made six weeks after cabbage planting.

[2]Percentage weed reduction as calculated from the nonweeded treatment. Numbers preceded by + symbol indicate increase in weed density as calculated from the nonweeded treatment.

Clomazone and oxyfluorfen caused moderate injuries (15% to 31%) to cabbage at three WAP in 1994 (Table 2). Symptoms caused by clomazone decreased to 10% or less at six WAP. Injury symptoms for clomazone and oxyfluorfen treatments were not detected after nine weeks (data not shown). For the second year, prometryn caused over 65% stand mortality and reduced cabbage yield by more than 95%. Cabbage treated with clomazone (2.24 kg ai/ha) produced yields not significantly different from those of the handweeded treatment in 1994. Other yields were significantly lower than in the handweeded treatment.

Jimsonweed (*Datura stramonium* L.), junglerice [*Echinochloa colona* (L.) Link] and purple nutsedge were the predominant weed species in the experimental area for both years (Table 3). All herbicide treatments reduced jimsonweed density by 78% or more in 1992-93; however, only the highest rates of clomazone and prometryn reduced jimsonweed density by 77% or more in 1994. Junglerice density was reduced by more than 93% with both rates of clomazone, and by 88% with oxyfluorfen (0.56 kg ai/ha) in 1992-93. Junglerice was reduced by 94% or more by all herbicide treatments in 1994 when compared to nonweeded plots.

Purple nutsedge density was not significantly different among herbicide treatments in 1992-93 (Table 3). Plots treated with high rates of the three herbicides had higher purple nutsedge density than the nonweeded treatment in 1994. This weed generally invaded cabbage plots after other weed species were controlled with herbicides.

Clomazone and oxyfluorfen showed good potential for weed control in cabbage. In our experiments, clomazone and oxyfluorfen were effective for grass and broadleaf weed control, and cabbage transplants recovered from the initial injuries. However, prometryn was highly phytotoxic and reduced cabbage yield. The yield reduction recorded in clomazone and oxyfluorfen treatments in 1994 can be attributed to weed interference, mostly from purple nutsedge.

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