Application timing for clomazone and oxyfluorfen in transplanted cabbage[1]

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ABSTRACT

Field experiments with cabbage cv. Blue Vantage were conducted at Corozal and Juana Díaz Substations (UPR-AES) from 2 November 1994 to 9 February 1995 to evaluate the efficacy of three preplant applications of clomazone (1.12 kg ai/ha) and oxyfluorfen (0.28 kg ai/ha). Both herbicides were applied to the soil surface 5, 10, and 15 days before transplanting (DBT). Visual injury three weeks after transplanting at Corozal was greater for clomazone applied at 5 DBT (10%) than at 10 and 15 DBT (0 and 1%, respectively). Weed density at Corozal ranged from 2 to 10 plants/m² and did not interfere with cabbage yield. After six weeks, at Juana Díaz, there were no significant visual injuries in cabbage from the clomazone and oxyfluorfen applications. Also at Juana Diaz, clomazone applied 10 and 15 DBT resulted in lower weed densities (8 and 22 weeds/m², respectively) than the non-treated control (178 weeds/m²) after six weeks. At Juana Díaz, clomazone at the three application times and oxyfluorfen applied at 5 and 10 DBT increased cabbage yield beyond that of the non-treated control.

Key words: cabbage, clomazone, oxyfluorfen, preplant herbicides

RESUMEN

Tiempos de aplicación para clomazone y oxyfluorfen en repollo de trasplante

Se establecieron dos experimentos de campo con repollo cv. Blue Vantage, en las Subestaciones de Corozal y Juana Díaz (UPR-EEA), desde el 2 de noviembre de 1994 hasta el 9 de febrero de 1995, para evaluar la eficacia de tres aplicaciones de clomazone (1.12 kg ia/ha) y oxyfluorfen (0.28 kg ia/ha). Ambos herbicidas se aplicaron a los 5, 10 y 15 días antes del trasplante (DAT) del repollo. En Corozal el daño visual estimado después de tres semanas fue mayor con clomazone aplicado a los 5 DAT (10%) que a los 10 y 15 DAT (0 y 1%, respectivamente). La densidad de malezas fluctuó desde 2 a 10 malezas/m², y éstas no interfirieron con el rendimiento del repollo. En Juana Díaz, no se observaron daños visuales en el repollo con las aplicaciones de clomazone y oxyfluorfen después de seis semanas. Cuando se aplicó clomazone a los 10 y 15 DAT se obtuvieron densidades de 8 a 22 malezas/m², siendo éstas menores que las observadas en el tratamiento sin desyerbo (178 malezas/m²), a las seis semanas después del trasplante. En Juana Díaz,

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todas las aplicaciones de clomazone y oxyfluorfen a los 5 y 10 DAT aumentaron el rendimiento del repollo comparado con el del control no desyerbado.

INTRODUCTION

Timing and method of herbicide application are important considerations when developing weed management strategies. Field studies conducted in Illinois demonstrated that herbicides such as clomazone, imazethapyr, and imazaquin preplant incorporated dissipated more slowly than in preemergence treatments (Curran et al., 1992). Slow dissipation of chemicals may cause carryover injury in subsequent crops. Field studies conducted by Kirksey et al. (1992) suggested a potential for clomazone injury to rotational crops such as wheat. Clomazone applied to soybean [*Glycine max* (L.) Merr.] caused injury in wheat planted 11 to 12 months after application (Ahrens and Fuerts, 1990).

Relatively few herbicides are labeled for use in cabbage in the United States (Smeda and Weston, 1995). Oxyfluorfen and clomazone are among the few registered (Hopen, 1995). However, these herbicides alone cannot always reduce weed interference in field seeded cabbage since a weed free period from two to four weeks after planting is needed to avoid yield loss (Miller and Hopen, 1991). For this reason, growers depend upon mechanical cultivation and hand labor to complement chemical weed control.

Use of herbicides in cabbage has been limited by crop tolerance. Clomazone inhibited chlorophyll and carotenoids in cabbage seedlings under laboratory conditions (Scott and Weston, 1992). Likewise, a preemergence application of clomazone reduced cabbage yield under field conditions (Scott et al., 1995). However, selectivity among cabbage cultivars to clomazone was demonstrated under field conditions for cultivars Bravo, Cheers, Genesis, Krautman, and Mavelon (Hopen et al., 1993). Therefore, tolerant cabbage cultivars must be planted when clomazone is to be applied.

Cabbage had acceptable tolerance to oxyfluorfen at 0.43 and 0.56 kg ai/ha as a pretransplant treatment either alone or followed by grass herbicides (Bhowmik and McGlew, 1986). At four weeks after transplanting, at the rates of 0.3 kg ai/ha and 0.2 kg ai/ha, oxyfluorfen plus napropamide (1.1 kg ai/ha) provided acceptable control of weeds with no injury to cabbage (Hoyt et al., 1996).

The efficacy of clomazone and oxyfluorfen was evaluated under field conditions at Juana Díaz, Puerto Rico, in 1992-93 and 1994 (Semidey, 1997). In these studies, clomazone (1.12 and 2.24 kg ai/ha) and oxyfluorfen (0.56 kg ai/ha) applied to soil surface five days before transplanting cabbage injured 18 to 37% of the cabbage for the first three weeks. The injury symptoms were not evident at nine weeks after

the cabbage transplanting, and the herbicide treated plots yielded similarly to the handweeded plots. These results suggest that delaying cabbage planting after the clomazone and oxyfluorfen applications may result in improved yields and less injury.

The objective of this study was to evaluate cabbage injury and yield and weed control in cabbage transplanted 5, 10, and 15 days after application of clomazone and oxyfluorfen in two different soils of Puerto Rico.

MATERIALS AND METHODS

Field experiments were established at Corozal and Juana Díaz Substations (UPR-AES) in early November 1994. At Corozal, the soil was a Corozal clay (clayey, mixed isohyperthermic Aquic Haplohumults) with 2.3% organic matter and pH 6.4. Plots at Corozal consisted of four beds 0.9 m wide and 4.6 m long. At this site, a single row of cabbage per bed was transplanted 2 November 1994.

At Juana Díaz, the soil was a San Antón clay loam (fine-loamy, mixed, isohyperthermic Cumulic Haplustolls) with 1.2% organic matter and pH 7.8. Plots consisted of two beds 1.83 m wide and 6.0 m long; double rows per bed were transplanted 17 November 1994. At both locations, cabbage (cv. Blue Vantage) seedlings were spaced 30 cm apart in the rows.

Treatments at both locations consisted of clomazone and oxyfluorfen applied 5, 10, and 15 days before transplanting (DBT) cabbage. Herbicides were applied with a CO_2-pressurized backpack sprayer calibrated to deliver 165 L/ha aqueous solution. Overhead irrigation was applied for 0.5 h immediately after each soil incorporation of herbicide. To maximize cabbage yield, drip irrigation was applied during the initial two days after planting and then twice a week until harvesting.

A complete randomized block design with four replications was used. Counts of weed density (number of plants/m^2) and visible crop injury (%)[5] were made three and six weeks after transplanting (WAT). At Juana Díaz, grass density (30 plants/m^2) was considered high and was controlled with fluazifop-P at 0.20 kg ai/ha applied 26 November 1994. Cabbage heads were harvested 80 to 90 days after transplanting. Data were subjected to analysis of variance and means separated by Fisher protected LSD test at $P = 0.05$.

[5]Injury rating scale from 0 to 100, with 0 = no visible injury and 100 = complete cabbage death.

RESULTS AND DISCUSSION

The predominant weed species at Corozal were pigweed (*Amaranthus dubius* Mart. ex Thell.), wild poinsettia (*Euphorbia heterophylla* L.), guineagrass (*Pannicum maximum* Jacq.), and goosegrass [*Eleusine indica* (L.) Gaertn.]. Densities of these weeds in the non-treated plots were 4, 2, 2, and 2 plants/m^2, respectively. No differences in weed density were found among application times and the non-treated plots 3 WAT at Corozal (Table 1). Although weed densities were generally low at 6 WAT, clomazone and oxyfluorfen further reduced weed density compared to that of non-treated plots, irrespective of application timing. Visual injury to cabbage foliage was greater for the clomazone application made 5 DBT than for that at 10 and 15 DBT. The results at Corozal indicate that delaying cabbage planting after the clomazone applications reduced phytotoxicity to cabbage. At 6 WAT, cabbage injury was not significant for the application timing of either clomazone or oxyfluorfen at Corozal. Cabbage yield (from 48,740 to 54,605 kg/ha) was high, and no significant differences were detected among herbicide treatments or the checks.

Predominant weed species at Juana Díaz were junglerice [*Echinochloa colona* (L.) Link], purple nutsedge (*Cyperus rotundus* L.),

TABLE 1.—*Weed density, visual injury and yield of cabbage in response to clomazone and oxyfluorfen with three application times at Corozal in 1994-95.*

Treatment[1]	Application timing	Weed density		Visual injury[3]		Cabbage yield
		3 WAT	6 WAT	3 WAT	6 WAT	
	DBT[2]	plants/m^2		%		kg/ha
Clomazone	15	2	2	1	0	51,130
Clomazone	10	2	2	0	0	51,200
Clomazone	5	4	2	10	1	50,720
Oxyfluorfen	15	4	4	0	2	51,060
Oxyfluorfen	10	2	2	0	0	51,810
Oxyfluorfen	5	4	2	2	0	54,605
Handweeded	—	10	2	0	0	50,240
Non-treated[4]	—	10	8	0	0	48,740
LSD (0.05)		NS	4	3	NS	NS

[1]Clomazone at 1.12 kg ai/ha and oxyfluorfen at 0.28 kg ai/ha.

[2]Days before transplanting of cabbage.

[3]Crop injury rating from 0 to 100, with 0 = no visible injury and 100 = crop completely killed.

[4]Densities at 3 WAT were 4, 2, 2, and 2 plants/m^2 for pigweed, wild poinsettia, guineagrass, and goosegrass, respectively.

jimsonweed (*Datura stramonium* L.), and pigweed. Densities of these weeds in the non-treated plots were 142, 26, 6, and 2 plants/m², respectively. Clomazone applied 10 or 15 DBT resulted in lower weed densities than in the non-treated plots at the respective evaluations made at 3 and 6 WAT (Table 2). Weed density in plots with clomazone applied 5 DBT was not-significantly lower than that of the non-treated plots at 3 and 6 WAT. Weed densities were lower when oxyfluorfen was applied 5 and 15 DBT than in non-treated plots. Significant injury (11%) was recorded 3 WAT with clomazone applied 5 and 10 DBT. However, clomazone injury was transient and none was observed at 6 WAT. No visual injury was observed with oxyfluorfen at either evaluation, irrespective of application timing. Cabbage yield in the non-treated plots was much lower than in the treated plots, except in the plots with oxyfluorfen applied 15 DBT. Compared to yield in non-treated plots at Juana Díaz, clomazone at the three application times and oxyfluorfen applied at 5 and 10 DBT increased cabbage yield from 82 to 99% and from 60 to 73%, respectively. As in a previous studies (Semidey, 1997), early crop injury by clomazone and oxyfluorfen did not limit cabbage yield or represent a problem for cabbage production in these soils. Delay of cabbage transplanting after clomazone and oxyfluorfen

TABLE 2.—*Weed density, visual injury, and yield of cabbage in response to clomazone and oxyfluorfen applied with three application times at Juana Díaz in 1994-95.*

Treatment[1]	Application timing	Weed density		Visual injury[3]		Cabbage yield
		3 WAT	6 WAT	3 WBT	6 WBT	
	DBT[2]	plants/m²		%		kg/ha
Clomazone	15	8	12	6	0	30,760
Clomazone	10	22	8	11	0	34,330
Clomazone	5	44	26	11	0	31,420
Oxyfluorfen	15	30	22	0	0	26,790
Oxyfluorfen	10	54	40	0	0	27,655
Oxyfluorfen	5	28	20	0	0	29,950
Handweeded	—	84	6	0	0	33,720
Non-treated[4]	—	178	62	0	0	17,265
LSD (0.05)		148	40	8	NS	10,080

[1]Clomazone at 1.12 kg ai/ha and oxyfluorfen at 0.28 kg ai/ha.

[2]Days before transplanting of cabbage.

[3]Crop injury rating from 0 to 100, with 0 = no visible symptoms and 100 = crop completely killed.

[4]Densities at 3 WAT were 142, 26, 6, and 2 plants/m² for junglerice, purple nutsedge, jimsonweed, and pigweed, respectively.

applications resulted in good control of weeds, and yields were comparable to that of handweeding. However, handweeding alone is more costly than herbicide applications. For example, as determined by Liu et al. (1987), tomato yields after metribuzin and handweeding were statistically similar. They reported that the cost of metribuzin application was $125/ha and for handweeding, $2,672/ha.

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