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Managing Volunteer Potato (*Solanum tuberosum*) in Field Corn with Mesotrione and Arthropod Herbivory[1]

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Abstract: Volunteer potato is becoming increasingly detrimental in potato production regions. We assessed methods to manage the weed in field corn with herbicides and arthropod herbivory. In greenhouse trials, new tuber production was reduced at least 95% in ‘Ranger Russet’, ‘Russet Burbank’, ‘Russet Norkotah’, and ‘Shepody’ potato varieties by mesotrione applied at 0.11 kg/ha. In field studies conducted near Paterson, WA, a single application of mesotrione at 0.07 or 0.11 kg/ha applied at the time of tuber initiation (mid-postemergence [MPOST]) controlled potato top growth 96 to 98% in 2002 and 2003. Mesotrione applied at earlier stages of potato growth, preemergence or early postemergence, controlled potatoes less than mesotrione applied MPOST. All herbicide treatments prevented yield loss in field corn compared with nontreated checks. Mesotrione reduced new potato tubers and tuber weight more than any other herbicide. Herbivory of volunteer potato by Colorado potato beetle reduced tuber number 21% and tuber density 23% in the absence of herbicides and appeared to further suppress the weed in combination with herbicides. Whereas treatments containing mesotrione were most effective against volunteer potato, arthropod herbivory supplemented weed suppression and may be an important component in reduced or low-input weed management systems.

Nomenclature: Mesotrione; volunteer potato, *Solanum tuberosum* L. ‘Ranger Russet’, ‘Russet Burbank’, ‘Russet Norkotah’, ‘Shepody’; field corn, *Zea mays* L.; Colorado potato beetle, *Leptinotarsa decemlineata* Say.

Additional index words: Arthropod herbivory, biological weed control, groundkeeper (volunteer potato), integrated weed management.

Abbreviations: CPB, Colorado potato beetle; EPOST, early postemergence; IWM, integrated weed management; LPOST, late postemergence; MPOST, mid-postemergence; POST, postemergence; PRE, preemergence; WAT, weeks after treatment.

INTRODUCTION

In regions with mild winter temperatures, volunteer potato is a serious weed in crop rotations. Volunteer potatoes can reduce yield of rotation crops and harbor insects, diseases, and nematodes that can infest potato crops (Ellis 1992; Thomas 1983; Wright and Bishop 1981). Volunteer potatoes are difficult to control because of large carbohydrate reserves in the tuber and the ability to resprout after various control tactics (Boydston and Seymour 2002; Williams and Boydston 2002).

Several herbicides that suppress volunteer potatoes are registered in field corn including atrazine, dicamba, and carfentrazone (Boydston 2001, 2004). In addition, fluroxypyr has recently had emergency use registrations for volunteer potato control in field and sweet corn. Herbicides often reduce the weight of new tubers produced by volunteer potatoes but are not as effective in reducing the number of new tubers produced (Boydston 2001, 2004). These new tubers can result in volunteer potato for multiple years after a single potato crop. Mesotrione, a selective broadleaf and grass herbicide, was recently registered for weed control in field corn. Mesotrione can be applied preemergence (PRE) or postemergence (POST) and inhibits chlorophyll synthesis in susceptible plants. Potato cultivars can differ in susceptibility to herbicides (Arsenault and Ivany 2001; Wilson et at. 2002). The four potato varieties comprising the majority of the potato hectarage grown in the Pacific Northwest consist of ‘Russet Burbank,’ ‘Russet Norkotah,’ ‘Ranger Russet,’ and ‘Shepody,’ (Anonymous 2003) and their susceptibility to mesotrione has not been reported.

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Integrated weed management (IWM) involves restricting weed populations through a series of mortality and fitness-reducing events. Arthropod herbivory, as one aspect of biological control, is a component of IWM. Colorado potato beetle (CPB) larvae can severely defoliate potato mid- to late season and recent work by Williams et al. (2004) indicates integrated management of volunteer potato could be more effective when the CPB defoliates volunteer potato stressed by herbicides. As an example, the biologically effective dose of fluroxypyr was reduced 13 to >85% with beetle herbivory, compared with when beetles were excluded from the weed. If defoliation by CPB proves effective in reducing volunteer potato tuber production, growers could limit insecticide applications to allow beetle populations to develop in crop rotations.

These studies were conducted to: (1) determine the response of four potato varieties to mesotrione, (2) evaluate volunteer potato control in field corn with PRE and POST applications of mesotrione alone and in combination with other herbicides, and (3) quantify the contribution of CPB herbivory to volunteer potato suppression.

MATERIALS AND METHODS

Field Trials. Trials were conducted in 2002 and 2003 in field corn grown under center pivot irrigation in south central Washington on a Quincy (Mixed, mesic Xeric Torripsamments) sand. Potato tubers, var. Russet Burbank averaging about 80 g/tuber were planted on April 3, 2002, and April 9, 2003, to simulate volunteer potato. Potato was planted in two rows spaced 85 cm apart to obtain a final density of 5.7 plants/m row (7.5 plants/m^2, representing a high volunteer potato density) near the two center rows of corn in each four-row plot. Corn, var. 'Pioneer 3655' was planted on April 16, 2002, and April 15, 2003, to obtain a final target density of 80,000 plants/ha in rows spaced 76 cm. Dimethenamid-*p*, which does not affect potato, was applied PRE at 0.7 kg/ha to the entire trial to control annual weeds both years. Trials were kept free of additional weeds by hand-weeding.

Plots were 6 by 9 m, and herbicide treatments were replicated three times in a randomized complete block design. Herbicides were applied with a bicycle sprayer equipped with flat-fan nozzles and operated at pressure of 186 kPa in a total spray volume of 187 L/ha. Mesotrione was applied as PRE or POST treatments or sequential treatments at various stages of potato growth. Mesotrione was also tested POST in tank mixtures with carfentrazone-ethyl. Additional treatments of dicamba, fluroxypyr, and a mix of dicamba plus diflufenzopyr[3] applied mid-postemergence (MPOST), a hand-weeded control, and nontreated control were included for comparison (Table 1). Emerged potato shoots were removed weekly in hand-weeded controls for 5 wk after corn planting and as needed the remainder of the season. All mesotrione treatments included a crop oil concentrate[4] at 1% (v/v) spray solution and 32% nitrogen solution (urea ammonium nitrate) at 2.5% (v/v) spray solution. All other treatments included nonionic[5] surfactant at 0.25% (v/v) spray solution.

PRE treatments were applied April 18, 2002, and April 21, 2003, before corn or potato emergence. In 2002, POST treatments were applied May 8 (early postemergence [EPOST]), May 15 (MPOST), and May 24 (late postemergence [LPOST]) when field corn was in the two- to three-, three- to four-, and five- to six-leaf stage, respectively. In 2003, herbicides were applied May 12, May 19, and May 30 when field corn was three- to four-, four-, and six-leaf stage, respectively. Most potato shoots were 6 to 11 cm tall at the EPOST application date both years and 12 to 20 cm tall at the time of the MPOST applications. Potato tuber initiation was just visible at the time of the MPOST application date both years with some plants having 4-mm-diam tubers. All applications made at the LPOST stage were repeat applications, so potato height varied depending on the effectiveness of the initial treatment.

Volunteer potato control was visually rated on a scale of 0 = no control to 100 = complete control in early June in both years. Corn injury was rated visually on a scale of 0 = no injury to 100 = dead in early June each year. Potato tubers were dug from 3 m of row in September of each year, and the number and biomass of tubers determined. Corn grain was machine harvested from 9 m of the two center rows in each plot, weighed, and seed moisture adjusted to 15.5%.

Tuber number and biomass data were rank transformed to equalize variance. A combined ANOVA did not indicate an effect of year or a significant year × treatment interaction for tuber number, tuber biomass, or corn yield. There was a significant year × treatment effect for potato control and corn injury, so data from each year were analyzed separately. Treatment means were

[3] Distinct herbicide, BASF Corporation, P.O. Box 13528, Research Triangle Park, NC 27709.

[4] Mor-Act, a crop oil concentrate product of Wilbur-Ellis Co., P.O. Box 16458, Fresno, CA 93755.

[5] R-11 nonionic surfactant containing octyl phenoxy polyethoxy ethanol, isopropanol, and compounded silicone, Wilber-Ellis Co., P.O. Box 16458, Fresno, CA 93755.

Table 1. Visual assessments of volunteer potato control and number and weight of tubers produced after ten herbicide treatments in field corn in 2002 and 2003 at Paterson, WA.[a,b]

Treatment	Timing[c]	Rate	Potato control[d]		Number of tubers[e]	Weight of tubers[e]
			2002	2003	2002–2003	2002–2003
		kg/ha	%		no./m²	g/m²
Mesotrione	PRE	0.21	73 e	50 e	6.4 cd	244 ef
Mesotrione	PRE + MPOST	0.21 + 0.07	96 a	86 cd	2.8 ef	44 efg
Mesotrione	EPOST	0.11	74 de	84 d	3.9 de	54 e
Mesotrione	MPOST	0.07	96 a	97 a	3.9 cd	29 de
Mesotrione	MPOST	0.11	97 a	98 a	0.5 fg	6 gh
Mesotrione	EPOST + LPOST	0.11 + 0.11	93 ab	99 a	0.0 g	0 h
Mesotrione + carfentrazone-ethyl	MPOST	0.07 + 0.01	88 bc	89 bc	6.7 c	142 cd
Fluroxypyr	MPOST	0.27	89 b	92 b	17.6 b	297 bc
Dicamba + diflufenzopyr	MPOST	0.21 + 0.08	88 bc	97 a	22.6 b	463 c
Dicamba	MPOST	0.28	81 cd	85 d	41.3 a	1,097 ab
Nontreated			0 f	0 f	47.5 a	3,804 a
Hand-weeded			100 a	100 a	0.3 efg	1 fgh

[a] Treatment means within a column followed by the same letter are not significantly different according to Fisher's protected LSD at a P = 0.05 level.

[b] Abbreviations: PRE, preemergence; MPOST, mid-postemergence; EPOST, early postemergence; LPOST, late postemergence.

[c] PRE applied April 18, 2002, and April 21, 2003; EPOST applied May 8, 2002, and May 12, 2003; MPOST applied May 15, 2002, and May 19, 2003; and LPOST applied May 24, 2002, and May 30, 2003. Mesotrione treatments included crop oil concentrate at 1% (v/v) and a 32% nitrogen solution at 2.5% (v/v) spray solution. Fluroxypyr and dicamba treatments included nonionic surfactant at 0.25% (v/v) spray solution.

[d] Volunteer potato control was visually estimated June 2, 2002, and June 6, 2003. Data from 2002 and 2003 are presented separately because of a significant treatment by year interaction.

[e] Nontransformed treatment means are presented whereas mean separation is based on rank transformed data using Fisher's protected LSD at a P = 0.05 level.

separated by Fisher's protected LSD procedure at $\alpha = 0.05$.

Tuber Sprouting in Greenhouse. Potato tubers harvested from selected treatments each year were stored at 3 C for 4 mo at which time six tubers from each field plot were selected and weighed. Tubers were planted in two, 7.5-L plastic pots (three tubers per pot) filled with potting soil and placed in a greenhouse. Greenhouse temperatures ranged from 20 to 28 C with a 16-h photoperiod over the course of the experiment. Potato injury on a scale of 0 = no injury to 100 = dead, shoot length, number of emerged shoots, and oven-dry shoot biomass were determined after 31 d.

Effect of CPB. To quantify the contribution of CPB herbivory to volunteer potato suppression, a study was conducted using a split-plot design. Treatments were replicated three times in 2002 and five times in 2003. Potato and corn planting and herbicide application methods were identical to the previously described studies. Main plots measured 12 by 9 m, and subplots measured 6 by 9 m. The main plot factor was ''herbicide'' treatment. Levels of herbicide were 0.28 kg/ha fluroxypyr, 0.1 kg/ha mesotrione, 0.21 kg/ha dicamba plus 0.08 kg/ha diflufenzopyr, and a nontreated check. Herbicides were applied MPOST on May 15, 2002 and May 12, 2003 when corn was at the three- to four-leaf stage and potatoes were 15 to 18 cm tall and just beginning to initiate tubers. Fluroxypyr and dicamba plus diflufenzopyr treatments included a nonionic surfactant at 0.5% (v/v) spray solution. Mesotrione included crop oil concentrate at 1.0% (v/v) and a 32% nitrogen solution (urea ammonium nitrate) at 2.5% (v/v) spray solution. The subplot factor was ''herbivory'', which had two levels, including beetle presence and absence.

Naturally occurring populations of CPB were used to defoliate potatoes. For subplots assigned the beetle absence treatment, imidacloprid was applied at 0.02 kg/ha on May 1 and July 17, 2002 and May 14 and July 1, 2003 to arrest CPB defoliation.

Volunteer potato shoot biomass and leaf area was assessed July 13, 2002, and July 18, 2003. Along 4.6 m of a single potato row, leaf area was determined within three replicates of each treatment. For all replicates, oven-dry shoot biomass was determined along 4.6 m of a single row. CPB densities were assessed at 3 and 8 wk after treatment (WAT). At each sampling time, three classes of CPB were counted on three plants per plot, including (1) total number of first, second, and third instar larvae, (2) total number of fourth instar larvae, and (3) total number of adults. Potato tubers were dug from 3 m of the adjacent row in October of each year, after corn harvest along 9 m of the same row.

Volunteer potato and corn data from both years were combined and subjected to ANOVA. A combined ANOVA did not indicate an effect of year or a significant year × treatment interaction. Treatment means were separated by Fisher's protected LSD procedure at $\alpha = 0.10$.

Potato Variety Response to Mesotrione. The response of four potato varieties, Ranger Russet, Russet Burbank, Russet Norkotah, and Shepody, to mesotrione applied POST was tested on greenhouse-grown plants. Plastic pots (7.5 L) were filled with potting mix (soil–peat–sand), pH 6.5, and one potato seed piece weighing approximately 60 g was planted 7 cm deep. Greenhouse temperatures ranged from 20 to 30 C with a 16-h photoperiod. When average potato shoot height reached 15 cm, 10 plants of each variety were treated with mesotrione at 0.1 kg/ha using a bench sprayer equipped with an even flat spray nozzle delivering 235 L/ha at 220 kPa pressure. Treatments included crop oil concentrate at 1% (v/v) and a 32% urea ammonium nitrate solution at 2.5% (v/v) spray solution. Ten plants of each variety received no mesotrione and served as nontreated controls.

Potato shoots were harvested at 6 WAT and dried at 60 C for 48 h to determine dry weight. Visual injury ratings (0 = no control to 100 = dead) and number and weight of tubers produced per plant were measured at 6 wk after mesotrione application. The entire experiment was repeated and data combined for ANOVA. Treatment means were separated using Fisher's protected LSD test at the 5% level.

RESULTS AND DISCUSSION

Field Trials. Mesotrione applied PRE caused most potato shoots to emerge white and chlorotic whereas occasional shoots emerged without apparent injury. Mesotrione applied POST caused death of all potato foliage exposed at the time of herbicide application.

A single application of mesotrione applied at the time of tuber initiation (MPOST) or split applications of mesotrione EPOST plus LPOST controlled potatoes 93 to 99% both years (Table 1). Mesotrione applied PRE or EPOST controlled potatoes less than mesotrione applied MPOST (Table 1). The combination of carfentrazone at 0.01 kg/ha and mesotrione at 0.07 kg/ha MPOST rapidly killed exposed potato foliage, but by early June, potato control was less than mesotrione applied alone MPOST (Table 1). The rapid death of exposed foliage may have ultimately limited the translocation of mesotrione to underground shoots.

Fluroxypyr applied at 0.27 kg/ha or dicamba applied at 0.28 kg/ha MPOST controlled potatoes less than mesotrione at 0.07 or 0.11 kg/ha MPOST in both years (Table 1). Dicamba at 0.21 kg/ha plus diflufenzopyr at 0.08 kg/ha applied MPOST controlled potatoes similar to fluroxypyr or dicamba in 2002, but in 2003 controlled potatoes greater than fluroxypyr or dicamba and similar to mesotrione applied MPOST.

Potatoes in nontreated plots produced 48 tubers/m^2 with a total weight of 3,804 g (Table 1). All herbicide treatments except dicamba reduced the number and weight of new tubers produced. A split application of mesotrione applied EPOST plus LPOST completely eliminated tuber production both years whereas a single MPOST mesotrione application reduced the number and weight of tubers produced by 99% (Table 1). All treatments containing mesotrione, regardless of rate or time of application, reduced the number of new tubers produced more than fluroxypyr, dicamba, or dicamba plus diflufenzopyr applied MPOST (Table 1).

Similar to results of previous studies (Boydston 2001, 2004), fluroxypyr, dicamba, and dicamba plus diflufenzopyr reduced potato tuber weight more than tuber number. Mesotrione appears unique in the ability to greatly reduce the number of new tubers produced (<14% of nontreated checks) when applied at or before tuber initiation as in this study. Reducing the number of tubers and tuber weight could greatly reduce potato populations and improve effectiveness of control measures in subsequent years.

In nontreated plots, volunteer potato stunted field corn growth (data not shown) and reduced corn yield by approximately 50%, compared with hand-weeded checks, which yielded 12,700 kg/ha (Table 2). In both years, fluroxypyr caused the greatest visual injury to corn but injury with all treatments was relatively minor and transient (Table 2). All herbicide-treated plots yielded similarly to hand-weeded checks, and there were no significant differences in corn yield among herbicide treatments.

Tuber Sprouting in Greenhouse. Shoot emergence was delayed in tubers collected from plots that received mesotrione compared with tubers collected from nontreated plots (data not shown). Herbicide injury symptoms were greatest on shoots emerging from tubers produced by mesotrione EPOST or MPOST or dicamba or dicamba plus diflufenzopyr MPOST treated plants (Table 3). Shoots from tubers collected in mesotrione EPOST or MPOST treated plots often emerged chlorotic. Symptoms tended to decrease with time and green shoots eventually emerged. Shoots emerging from tubers col-

Table 2. Field corn injury and yield after herbicide treatments for volunteer potato control in 2002 and 2003 at Paterson, WA.[a,b]

Treatment	Timing[c]	Rate	Corn injury[d]		Corn yield
			2002	2003	2002–2003
		kg/ha	%		kg/ha
Mesotrione	PRE	0.21	0 c	0 c	13,020 a
Mesotrione	PRE + MPOST	0.21 + 0.07	1 bc	0 c	13,520 a
Mesotrione	EPOST	0.11	0 c	0 c	12,210 a
Mesotrione	MPOST	0.07	0 c	0 c	13,110 a
Mesotrione	MPOST	0.11	0 c	0 c	12,940 a
Mesotrione	EPOST + LPOST	0.11 + 0.11	2 bc	0 c	13,070 a
Mesotrione + carfentrazone-ethyl	MPOST	0.07 + 0.01	4 b	0 c	13,220 a
Fluroxypyr	MPOST	0.27	14 a	3 a	11,950 a
Dicamba + diflufenzopyr	MPOST	0.21 + 0.08	3 bc	0 c	13,070 a
Dicamba	MPOST	0.28	0 c	1 b	11,950 a
Nontreated			—	—	6,480 b
Hand-weeded			—	—	12,700 a

[a] Means within a column followed by the same letter are not significantly different according to Fisher's protected least significance difference test at P = 0.05 level.

[b] Abbreviations: PRE, preemergence; MPOST, mid-postemergence; EPOST, early postemergence; LPOST, late postemergence.

[c] PRE applied April 18, 2002, and April 21, 2003; EPOST applied May 8, 2002, and May 12, 2003; MPOST applied May 15, 2002, and May 19, 2003; and LPOST applied May 24, 2002, and May 30, 2003. Mesotrione treatments included crop oil concentrate at 1% (v/v) and a 32% nitrogen solution at 2.5% (v/v) spray solution. Fluroxypyr and dicamba treatments included nonionic surfactant at 0.25% (v/v) spray solution.

[d] Corn injury was visually estimated June 2, 2002, and June 6, 2003. Injury data from each year are presented separately due to a significant treatment by year interaction.

lected in dicamba or dicamba plus diflufenzopyr treated plots often exhibited epinasty. Although shoots emerging from tubers produced by mesotrione PRE or fluroxypyr MPOST treated plants had few or no injury symptoms, those treatments resulted in a low number of emerged shoots (Table 3).

The number of emerged shoots was lowest from tubers collected from plots treated with mesotrione or fluroxypyr (Table 3). Tubers from dicamba or dicamba plus diflufenzopyr treated plots produced 3.3 to 3.6 emerged shoots per tuber, similar to tubers from nontreated plots, which produced 3.8 shoots per plant. Shoot length and shoot dry weight per tuber were reduced by all treatments compared with nontreated checks (Table 3).

Effect of CPB. Adults of CPB were observed at the time of herbicide application, and within 2 wk, larvae were observed feeding on some potato plants. Imidacloprid appeared highly effective at deterring CPB feeding on potato because no larvae were observed on imidacloprid-treated plants. When potato shoots began to senesce (mid-July), forage was largely unavailable within the study area. Therefore, few CPB were observed for the remainder of the study. Similar observations were reported by Xu and Long (1997).

CPB density was low throughout the trial area. For instance, fourth instar larvae mean density was only 0.2 larvae/plant in beetle present plots at 3 WAT (data not shown), which account for the majority of defoliation

Table 3. Visual assessments of volunteer potato injury, and number, length, and dry weight of shoots emerging from tubers produced by herbicide treated volunteer potato plants.[a,b]

Treatment	Timing[c]	Rate	Visual injury	Shoot no.	Shoot length	Shoot dry weight
		kg/ha	%	no./tuber	cm	g/tuber
Mesotrione	PRE	0.21	3 b	1.2 b	8 bc	0.4 c
Mesotrione	EPOST	0.11	30 a	1.4 b	5 c	0.3 c
Mesotrione	MPOST	0.11	35 a	1.0 b	5 c	0.1 c
Fluroxypyr	MPOST	0.27	3 b	1.8 b	6 c	0.8 c
Dicamba + diflufenzopyr	MPOST	0.21 + 0.08	20 a	3.3 a	9 bc	1.0 bc
Dicamba	MPOST	0.28	28 a	3.6 a	12 b	2.0 b
Nontreated			0 b	3.8 a	19 a	4.9 a

[a] Means within a column followed by the same letter do not differ at the 5% level according to Fisher's protected LSD at a P = 0.05 level.

[b] Abbreviations: PRE, preemergence; EPOST, early postemergence; MPOST, mid-postemergence.

[c] Mesotrione treatments included crop oil concentrate at 1% (v/v) and a 32% nitrogen solution at 2.5% (v/v) spray solution. Fluroxypyr and dicamba treatments included nonionic surfactant at 0.25% (v/v) spray solution.

Table 4. Significance (P) of Colorado potato beetle herbivory, herbicides, and the interaction in determining potato shoot biomass and leaf area approximately 9 WAT and at-harvest tuber number and biomass.

	P			
Factor	Shoot biomass	Leaf area	Tuber number	Tuber biomass
Herbivory	0.867	0.077	0.0416	0.222
Herbicides	<0.001	<0.001	<0.001	<0.001
Herbivory × herbicides	0.930	0.029	0.100	0.023

(Bechinski et al. 1996). Fourth instar larvae increased to 1.0 larvae/plant by 8 WAT in the same treatments. Total number of larvae and adults was highest at 8 WAT, yet never exceeded an average of 3.8 beetles/plant. Xu and Long (1997) reported that CPB densities peaked at 2.5 larvae/plant on volunteer potatoes in mid-June.

Differences in potato response were detected among treatments by 9 WAT. A significant interaction was observed between herbivory and herbicide treatments for volunteer potato leaf area (Table 4). The nontreated, herbivory-absent treatment had the highest leaf area, whereas mesotrione with herbivory and dicamba plus diflufenzopyr treatments had less leaf area than the weedy checks (Table 5). There was a trend for herbivory to reduce leaf area 51 to 67% for all herbicide treatments except fluroxypyr. Although fluroxypyr, mesotrione, and dicamba plus diflufenzopyr reduced shoot biomass 82 to 99% of the weedy check, no differences between herbivory levels were observed for shoot biomass (Table 5).

There was a significant interaction between herbivory and herbicide treatment for tuber number and tuber biomass (Table 4). Twenty-one percent fewer tubers were produced in the nontreated check with herbivory, compared with herbivory (Table 5). Mesotrione with and without herbivory was more effective at reducing tuber number than dicamba plus diflufenzopyr alone. Similarly, herbivory from CPB reduced tuber biomass in the weedy check by 33% (Table 5). However, all herbicides reduced tuber biomass 90% or more, relative to the weedy check. Although nonsignificant, herbivory resulted in mean tuber biomass that was 14 to 79% less than the herbivory-absent treatments for fluroxypyr, mesotrione, and dicamba plus diflufenzopyr (Table 5).

Corn yield was unaffected by herbivory of volunteer potato from CPB (data not shown), indicating the effect herbivory had on weed fitness did not result in a measurable gain in crop tolerance to volunteer potato.

There is a clear benefit of CPB herbivory reducing tuber production in the absence of herbicide application. However, when herbicides alone are highly effective, the role of CPB herbivory to manage volunteer potato in field corn is less obvious. The reduction in weed fitness because of CPB herbivory depends upon herbicide ef-

Table 5. Mean shoot biomass and leaf area approximately 9 WAT and at-harvest tuber number and biomass of potato after treating with herbicides and Colorado potato beetle herbivory in field corn.[a]

Factor	Level	Shoot biomass	Leaf area	Tuber number	Tuber biomass
		g/m²	cm²/m²	no./m²	g/m²
Herbivory					
	−	107.2 a	4,170 a	31.8 a	1,740 a
	+	105.2 a	1,931 b	26.4 b	1,314 a
	Herbicide[b]				
	Nontreated	328.2 a	9,609 a	73.4 a	5,366 a
	Fluroxypyr	59.1 b	1,871 b	18.2 b	348 b
	Mesotrione	3.0 b	550 b	1.5 b	13 b
	Dicamba + diflufenzopyr	34.5 b	174 b	23.3 b	380 b
Herbicide	CPB herbivory				
Nontreated	−	322.5 a	14,100 a	81.8 a	6,056 a
Nontreated	+	333.9 a	5,117 b	65.0 b	4,677 b
Fluroxypyr	−	62.2 a	1,525 bc	19.7 cd	457 c
Fluroxypyr	+	56.0 a	2,217 bc	16.7 cd	240 c
Mesotrione	−	4.8 a	826 bc	1.6 d	39 c
Mesotrione	+	1.3 a	273 c	1.5 d	8 c
Dicamba + diflufenzopyr	−	39.4 a	234 c	24.2 c	409 c
Dicamba + diflufenzopyr	+	29.5 a	115 c	22.5 cd	351 c

[a] For each factor, means within a column followed by the same letter do not differ according to LSD at a P = 0.10 level.

[b] Mesotrione treatments included crop oil concentrate at 1% (v/v) and a 32% nitrogen solution at 2.5% (v/v) spray solution. Fluroxypyr and dicamba treatments included nonionic surfactant at 0.25% (v/v) spray solution.

fectiveness, where at high herbicide doses, differences in plant response to herbivory levels can be difficult to discern (Williams et al. 2004). These researchers found that CPB herbivory reduced potato fitness the most when environmental conditions favored rapid CPB development and densities were high (e.g., 6 to 50 beetles/plant). Effectiveness of CPB herbivory increased as the length of time increased, giving CPB a greater amount of time to defoliate the weed. Both corn and potato grew well early in the season; however, because the corn canopy developed and shaded the ground, potato growth slowed. By mid-July, when the corn canopy was well established, potato shoots had senesced and no regrowth was observed. Although this provided enough time for potato to produce tubers in field corn, conditions limited the period of potato growth, and consequently, limited the time for defoliation from CPB.

A combination of low CPB densities, short period of defoliation, and highly effective herbicides could limit the contribution of herbivory from CPB in field corn. Although CPB may supplement volunteer potato suppression under these conditions, herbivory may play a larger role in reduced or low-input weed management systems, particularly in less competitive crops where volunteer potato grows longer and is subjected to more herbivory.

Potato Variety Response to Mesotrione. Greenhouse-grown Ranger Russet, Russet Burbank, Russet Norkotah, and Shepody potato initially responded similarly to mesotrione applied POST at 0.11 kg/ha. At 2 WAT, mesotrione caused severe chlorosis of all foliage exposed at the time of herbicide application and there were no differences in potato response among varieties (data not shown). New unharmed shoots eventually emerged in a few plants of all four varieties either from the soil or from auxiliary buds on the stem, but most plants of all varieties were severely injured.

Shoot dry weight 6 WAT was reduced approximately 80% by mesotrione in all four varieties (Table 6), although slightly more regrowth of shoot tissue was noted in Russet Burbank (data not shown). New tuber production at 6 WAT by Ranger Russet, Russet Burbank, and Shepody was eliminated, whereas in Russet Norkotah, new tuber production and new tuber weight were reduced by 96 and 99%, respectively, compared with nontreated checks. Nontreated checks of the same four varieties produced 6, 15, 17, and 9 tubers per plant, respectively.

Stolons that could potentially give rise to additional tubers were counted at 6 WAT. Mesotrione reduced the number of stolons by 67, 82, 50, and 71% compared with nontreated checks of Ranger Russet, Russet Norkotah, Russet Burbank, and Shepody, respectively (Table 6). Nontreated checks of the same four varieties produced 14, 33, 28, and 14 stolons per plant, respectively. On the basis of the amount of new shoot growth and number of stolons produced, these data suggest that all four potato varieties were susceptible to mesotrione with Russet Burbank exhibiting slightly more tolerance.

Table 6. Percent reduction in shoot dry weight, tuber weight, tuber number, and number of stolons of four potato varieties grown in a greenhouse at 6 wk after treatment with mesotrione at 0.11 kg/ha[a]. Spray solution included crop oil concentrate at 1% (v/v) and a 32% nitrogen solution at 2.5% (v/v).

Variety	Shoot dry weight	Tuber weight	Tuber number	Stolons
	— % reduction compared with nontreated check —			
'Ranger Russet'	83 a	100 a	100 a	67 a
'Russet Norkotah'	78 a	99 a	96 b	82 a
'Russet Burbank'	80 a	100 a	100 a	50 b
'Shepody'	82 a	100 a	100 a	71 ab

[a] Means within a column followed by the same letter are not significantly different according to Fisher's protected least significance difference test at $P = 0.05$ level.

Integrated volunteer potato management preventing yield loss of the rotation crop, eliminating host plants of potato diseases and nematodes, and reducing new tuber production is desirable to producers. All herbicides tested in this study prevented corn yield loss when volunteer potato was present. However, mesotrione reduced new tuber production more than any of the other herbicides. The potential of mesotrione to reduce the number of new tubers produced coupled with the reduced fitness of plants emerging from those tubers could greatly improve management of volunteer potatoes in the crop following corn.

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