WEED CONTROL IN CALIFORNIA STRAWBERRIES WITHOUT METHYL BROMIDE

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INTRODUCTION. In all likelihood weed control costs in California strawberries will increase after the phase-out of methyl bromide. One strategy to enhance the efficacy of methyl bromide alternative fumigants such as chloropicrin or 1,3-D is to use herbicides to supplement the weed control activity of these fumigants. A field study was conducted in 1998-99 to evaluate the tolerance of strawberry to several herbicides applied pre-transplant, post-transplant and delayed post-transplant. The study objectives were: 1) To evaluate the tolerance of Selva and Camarosa strawberry cultivars to pre-transplant, post-transplant and delayed post-transplant herbicide applications, 2) To evaluate the weed control efficacy of the candidate herbicides.

METHODS. The site, near Salinas California, was fumigated with 125 lb/A of chloropicrin on 10-31-98. Pre-transplant treatments applied on 11-16-98 were corn gluten meal at 300 and 400 lb/A and DCPA at 9.0 lb/A (all rates are listed in lbs. of active ingredient per acre). The corn gluten meal was lightly incorporated in the top layer of soil immediately after application. Camarosa and Selva strawberry cultivars were transplanted on 11-18-98 in a 52-inch bed conformation with two rows per bed, i.e., one row of each variety was planted per bed. Post-transplant treatments applied on 11-19-98 included carfentrazone at 0.075 and 0.15 lb/A, cloransulam at 0.0156 and 0.0313 lb/A, dimethenamid at 0.94 and 1.2 lb/A, flumioxazin at 0.063 and 0.125 lb/A, halosulfuron at 0.032 and 0.047 lb/A, isoxaben at 0.5 and 1.0 lb/A, napropamide at 4.0 lb/A, rimsulfuron at 0.0156 and 0.0313 lb/A and sulfentrazone at 0.175 and 0.25 lb/A. Delayed post-transplant treatments made on 12-10-98 were: carfentrazone at 0.01 and 0.03 lb/A, cloransulam at 0.0078 and 0.0156 lb/A, dimethenamid at 1.5 lb/A, imazamox at 0.032 and 0.04 lb/A, isoxaben at 0.25 lb/A, sulfentrazone at 0.15 and 0.25 lb/A and triflusulfuron at 0.0156 and 0.0313 lb/A. The trial design was a randomized complete block with 4 replicates. All herbicides except corn gluten meal were applied with a CO_2 backpack sprayer. Corn gluten meal was applied undiluted with a shaker can. Stand counts were taken at 2, 4 and 7 weeks after transplanting (WAT), crop injury estimates at 4 and 7 WAT, plant diameters were measured at 16 and 20 WAT and above ground biomass was determined at 26 WAT. Weed densities were measured at 6 and 14 WAT.

RESULTS. Pre-transplant. Corn gluten meal and DCPA resulted in little or no crop injury, and had no adverse effects on plant diameters or crop biomass (Tables 1 and 2). Corn gluten meal at 400 lb/A resulted in 54% control of annual bluegrass, but provided no control of shepherdspurse, clover or corn spurry. DCPA at 9.0 lb/A provided 100% control of annual bluegrass and corn spurry, but provided no control of shepherdspurse or clover.

Post-transplant. In general Selva was more sensitive to post-transplant herbicide applications than Camarosa. The following treatments resulted in crop injury scores of 2.0 or less (0 = no injury, 10 = dead plants) and had no effect on plant diameters or crop biomass: carfentrazone at 0.075 lb/A, sulfentrazone at 0.175 and 0.25 lb/A and isoxaben at 0.5 lb/A (Tables 1 and 2). Marginally acceptable injury was observed with carfentrazone at 0.15 lb/A, napropamide at 4.0 lb/A and flumioxazin at 0.0625 lb/A. Treatments that clearly resulted in unacceptable injury were: cloransulam at 0.0156 and 0.0313 lb/A, dimethenamid at 0.94 and 1.2 lb/A, halosulfuron at 0.032 and 0.047 lb/A, and rimsulfuron at 0.0156 and 0.0313 lb/A.

Comments on weed control efficacy will be made only for herbicides with acceptable or marginal selectivity for strawberries. Carfentrazone at 0.075 lb/A provided 100% control of shepherdspurse, 40 to 77% control of annual bluegrass and corn spurry, and no control of clover. Napropamide at 4.0 lb/A and sulfentrazone at 0.25 lb/A provided 100% control of annual bluegrass and corn spurry, and 73 and 67% control, respectively, of clover and shepherdspurse. Isoxaben at 0.5 lb/A provided 100% control of clover, corn spurry and shepherdspurse, and 31% control of annual bluegrass. Flumioxazin at 0.0625 lb/A provided 100% control of annual bluegrass, clover and corn spurry, and 73% control of shepherdspurse.

Delayed post-transplant. Isoxaben at 0.25 lb/A and triflusulfuron at 0.0156 and 0.0313 lb/A applied 3 weeks after transplanting resulted in crop injury scores of 2.0 or less, and had no adverse effects on plant diameters or crop biomass (Tables 1 and 2). All of the other treatments resulted in unacceptable crop injury in one or more of the following categories: crop injury scores ≥2.0, significant reductions in plant diameters or plant biomass.

Triflusulfuron at 0.0313 lb/A resulted in 100% control of annual bluegrass and shepherdspurse, and about 70% control of clover and corn spurry. Isoxaben at 0.25 lb/A resulted in 100% control of annual bluegrass, clover and corn spurry, and 73% control of shepherdspurse.

SUMMARY AND RECOMMENDATIONS. Of all the candidate herbicides, sulfentrazone appears to have the greatest potential for pre-transplant and immediate post-transplant use. Triflusulfuron has the greatest potential for use as a delayed post-transplant herbicide (Tables 1 and 2). Strawberries have some level of tolerance for carfentrazone at 0.075 lb/A, isoxaben at 0.5 lb/A and flumioxazin at 0.0625 lb/A when applied immediately after transplanting. There is also some tolerance for isoxaben at 0.25 lb/A applied 3 weeks after transplanting.

Further evaluation of carfentrazone, flumioxazin, isoxaben and sulfentrazone for use as pre-transplant or immediate post-transplant herbicides, and triflusulfuron for use as a delayed post-transplant herbicide in strawberries is recommended. Napropamide, already registered for use in California strawberries, appears to cause some crop biomass inhibition; therefore it will be difficult to build a long-term weed control strategy based on this herbicide alone. No further work is recommended for cloransulam, dimethenamid, halosulfuron, imazamox or rimsulfuron in strawberry.

Table 1. Stand counts, crop injury, plant diameter and biomass assessments in Selva strawberries.

No	Treatment	Lb ai/A	No. strawberry plants 2 m^{-1} [a]			Crop injury [b]		Plant diameter (cm)		Biomass (g) [c]
Pre-transplant										
1	Corn Gluten	300	5.75	7.25	7.25	0.50	0	22.78	33.63	1923
2	Corn Gluten	400	6.75	7.50	7.00	0	0	22.65	36.15	2139
3	DCPA	9	5.50	6.50	6.75	0	0	20.13	35.44	2021
4	Untreated	-	6.00	6.50	6.75	0	0	19.03	28.80	1519
Post-transplant										
5	Carfentrazone	0.075	5.25	7.00	7.50	1.00	0.75	20.78	33.45	1924
6	Carfentrazone	0.15	4.25*	6.50*	6.50	1.50	1.50	22.40	35.30	1772*
7	Sulfentrazone	0.175	7.00	6.25*	6.75	0.25	0	19.85	34.23	1925
8	Sulfentrazone	0.25	5.75	7.25	7.25	0	0.50	18.88	33.39	2110
9	Cloransulam	0.0156	5.50	7.25	6.50	2.75	2.00	13.28*	26.03	1230*
10	Cloransulam	0.0313	5.00	6.50*	6.50	2.25	2.75	11.40*	24.05	856*
11	Isoxaben	0.5	5.75	7.25	7.25	0.50	0.25	18.55	29.28	1907
12	Isoxaben	1.0	7.25	7.00	7.25	0	1.00	14.33*	21.10*	985*
13	Dimethenamid	0.94	6.25	7.25	7.00	1.25	1.00	13.85*	25.28	920*
14	Dimethenamid	1.2	6.00	7.00	7.50	2.50	3.00	14.38*	20.60*	714*
15	Halosulfuron	0.032	6.50	7.50	7.00	2.50	2.50	8.83*	14.30*	277*
16	Halosulfuron	0.047	4.25*	6.50*	6.75	5.50	5.25	7.25*	7.98*	52*
17	Rimsulfuron	0.0156	5.00	7.00	7.75	2.75	2.25	10.73*	20.33*	863*
18	Rimsulfuron	0.0313	4.75	7.00	7.00	3.75	4.75	9.60*	13.80*	283*
19	Flumioxazin	0.0625	5.50	6.00*	6.75	1.75	0.75	20.75	33.75	1927
20	Flumioxazin	0.125	6.00	7.25	7.00	1.25	1.50	19.63	30.55	1895
21	Napropamide	4.0	6.00	7.00	7.25	1.00	1.00	16.10	33.08	1739*
22	Untreated	-	6.00	7.50	7.25	0	0	24.20	38.35	2411
Delayed post-transplant										
23	Carfentrazone	0.01	-	6.75	6.75	5.00	3.75	19.75	35.28	2125
24	Carfentrazone	0.03	-	7.25	7.25	7.00	6.50	16.18	30.28	1619
25	Sulfentrazone	0.15	-	7.00	6.75	5.00	4.50	17.88	32.73	1803
26	Sulfentrazone	0.25	-	6.75	7.50	5.75	5.50	15.10	28.15	1250*
27	Cloransulam	0.0078	-	6.25	6.75	1.50	1.25	10.43*	21.95	835*
28	Cloransulam	0.0156	-	6.50	6.50	1.50	2.25	9.38*	12.95*	299*
29	Dimethenamid	1.5	-	7.00	7.75	1.25	1.50	12.13	18.33*	519*
30	Imazamox	0.032	-	6.50	7.00	1.25	1.25	6.73*	14.05*	242*
31	Imazamox	0.04	-	6.50	6.75	2.25	2.25	5.88*	10.50*	228*
32	Triflusulfuron	0.0156	-	7.25	6.75	0.25	0.25	20.00	35.00	2325
33	Triflusulfuron	0.0313	-	7.50	7.25	0.25	0	19.38	36.03	2309
34	Isoxaben	0.25	-	7.00	7.00	0.50	0.25	18.63	29.20	1316*
35	Untreated	-	-	7.00	7.00	0	0	20.93	33.68	1995
	LSD 0.05		1.47	0.92	0.89	NA	NA	9.17	15.15	536.4
	Weeks after transplanting		2	4	7	4	7	16	20	26

[a] Only plants that were in leaf and growing were counted

[b] 0 = no injury, 10 = dead plants

[c] Grams of biomass per 2 m of row

* Indicates that the value is significantly less than the untreated check at P=0.05

Table 2. Stand counts, crop injury, plant diameter and biomass assessments in Camarosa strawberries.

No	Treatment	Lb ai/A	No. strawberry plants 2 m^{-1} [a]			Crop injury [b]		Plant diameter (cm)		Biomass (g) [c]
Pre-transplant										
1	Corn Gluten	300	5.00	6.25	6.75	0.00	0.75	20.38	30.55	1524
2	Corn Gluten	400	5.75	6.75	7.00	0.00	0.50	19.73	31.95	1659
3	DCPA	9	4.75	6.00	6.00	0.75	0.00	17.55	30.78	1376
4	Untreated	-	5.00	6.50	6.50	0.00	0.00	18.45	32.10	973
Post-transplant										
5	Carfentrazone	0.075	5.50	7.25	6.75	0.00	0.00	21.93	32.73	1769
6	Carfentrazone	0.15	4.25	6.00	6.00	0.00	0.00	22.53	34.90	1639
7	Sulfentrazone	0.175	5.00	6.25	6.25	0.00	0.50	19.88	33.80	1498
8	Sulfentrazone	0.25	5.75	6.50	6.25	0.00	0.00	19.10	33.23	1453
9	Cloransulam	0.0156	5.25	6.75	6.75	0.50	0.00	11.49	38.35	844
10	Cloransulam	0.0313	4.50	6.25	6.00	1.75	0.00	9.75*	19.65	478*
11	Isoxaben	0.5	4.25	6.00	6.25	0.50	0.00	14.63	25.48	965
12	Isoxaben	1.0	5.25	7.00	6.50	0.00	0.00	11.00	15.05*	353*
13	Dimethenamid	0.94	5.50	6.50	6.50	0.00	0.00	13.40	18.53	573*
14	Dimethenamid	1.2	5.25	6.00	6.50	1.00	0.00	11.18	20.33	491*
15	Halosulfuron	0.032	4.25	5.75	6.25	2.00	0.00	8.70*	11.34*	104*
16	Halosulfuron	0.047	2.50*	5.25	6.00	5.50	0.00	6.00*	6.38*	29*
17	Rimsulfuron	0.0156	4.50	6.50	6.50	1.00	1.00	10.33*	16.48	472*
18	Rimsulfuron	0.0313	3.75	6.00	6.50	2.50	0.00	8.28*	9.18*	108*
19	Flumioxazin	0.0625	3.00	6.50	6.50	2.50	0.00	18.20	28.98	1222
20	Flumioxazin	0.125	5.50	6.75	6.75	1.25	0.00	9.80*	19.35	529*
21	Napropamide	4.0	5.75	6.75	7.25	0.00	0.00	16.68	27.98	1401
22	Untreated	-	4.25	6.25	6.25	0.00	0.00	19.70	31.48	1206
Delayed post-transplant										
23	Carfentrazone	0.01	-	5.25*	5.75*	6.00	2.25	14.90	27.30	1063*
24	Carfentrazone	0.03	-	5.75	6.50	7.25	0.00	17.35	26.93	1100*
25	Sulfentrazone	0.15	-	6.25	6.75	5.75	1.50	15.90	30.23	1243
26	Sulfentrazone	0.25	-	5.75	6.25	5.75	2.75	12.03*	25.10	880*
27	Cloransulam	0.0078	-	6.75	6.00	1.50	2.00	8.75*	16.88	434*
28	Cloransulam	0.0156	-	6.75	6.50	1.75	0.50	7.13*	10.03*	118*
29	Dimethenamid	1.5	-	6.25	6.50	1.50	0.75	8.68*	14.90*	320*
30	Imazamox	0.032	-	6.00	5.75	1.75	1.50	5.18*	14.68*	255*
31	Imazamox	0.04	-	5.75	6.25	2.50	0.00	5.03*	15.20*	328*
32	Triflusulfuron	0.0156	-	6.75	7.00	1.00	1.50	18.31	31.13	1514
33	Triflusulfuron	0.0313	-	6.50	6.50	0.00	0.00	15.33	28.73	1197
34	Isoxaben	0.25	-	6.25	6.25	0.00	0.00	19.85	28.22	1311
35	Untreated	-	-	6.50	7.00	0.00	0.00	21.65	32.18	1620
	LSD 0.05		1.74	1.17	1.02	NA	NA	8.98	15.47	428.2
	Weeks after transplanting		2	4	7	4	7	16	20	26

[a] Only plants that were in leaf and growing were counted

[b] 0 = no injury, 10 = dead plants

[c] Grams of biomass per 2 m of row

* Indicates that the value is significantly less than the untreated check at P=0.05