

**Project Number:** 13K 3419 7228

**Title:** Weed control in vegetable seed crops.

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**Reporting Period:** 2011-12

**Accomplishments:** Four weed control trials in vegetable seed were conducted in 2011: one study in table beet seed and three studies in spinach seed. A fifth trial in cabbage seed winter killed in 2010-11.

**Results:**

*Spinach seed.*

Herbicide trial. Spinach was seeded May 25, 2011 at WSU Mount Vernon NWREC. Preplant-incorporated (PPI) and preemergence (PRE) treatments were applied May 25, and POST June 15. Weed control and crop injury were estimated June 16. All plants in each plot were counted and pulled from the soil July 27 and plants placed in the greenhouse and drying ovens to dry and spinach biomass was determined. Because this trial was midway between two commercial spinach seed fields, plants were removed at onset of flowering. The trial was a randomized complete block with four replicates.

Several products caused greater than 10% crop injury at 3 weeks after PPI/PRE and 1 day after POST (Table 1). These include Command at 6.4 fl.oz (PRE) alone or with Dual Magnum, Define + Nortron, Dual Magnum, or Ro-Neet (PRE), and Command at 10.7 fl.oz (PPI) + Dual Magnum. Command PPI alone or with partners other than Dual Magnum was generally safe, resulting in 1-9% injury. Asulox POST was safe with all sequential applications, although the rating was only 1 day following application. About half the treatments resulted in early-season weed control exceeding 90%, although cool, wet conditions resulted in poor spinach emergence and perhaps also slowed weed control. Products with the best combination of weed control and spinach biomass were Command alone (PRE), Command (3.4 fl.oz) + Nortron PRE, and Command + Dual Magnum (PRE), and Nortron PRE + Asulox POST.

Micro-rate trial. Spinach was seeded as in the herbicide trial. Herbicides were also applied the same day as in the herbicide trial. Two POST treatments were used in this trial, however, so the first, P7, was applied 7 days after spinach emergence (June 15) and the second, P14, was applied 14 days after spinach emergence (June 28). Crop injury and weed control estimates and plant harvest was conducted as in the herbicide trial. The trial was a randomized complete block with four replicates.

Weed control was maximized at 3 weeks after PPI/PRE by Dual Magnum treatments (95 to 98%) followed by either the Spin Aid or Stinger + Asulox micro-rates (Table 2). Crop injury was significantly higher with these treatments, too, but did not exceed 10%. As in the herbicide trial, however, spinach emergence was poor, which could have masked some injury and influenced weed control. The highest spinach biomass was achieved with Ro-neet followed by Spin Aid or Stinger + Asulox applied twice or by Nortron followed by either Spin Aid or Stinger + Asulox applied once or twice.

Charcoal seeding study. Spinach was seeded June 1 at WSU Mount Vernon NWREC. Activated charcoal slurry (300 lbs/acre applied in 800 gallons/acre) was applied June 3, 2011; herbicides were applied later the same day. Crop injury and weed control estimates were made June 16, and spinach and weeds were harvested separately on July 27, placed in a drying oven, and weighed. The trial was a split-plot, randomized complete block with four replicates. Herbicide was the main plot, charcoal was the split-plot.

Spinach injury with these three herbicides was dramatically reduced by charcoal (Table 3). This was particularly true with Chateau and Lorox. Weed control was also reduced by charcoal, although weed control reduction was not as great as was the increase in crop safety. Spinach weight was markedly improved by charcoal in all herbicide-treated spinach plots, although weed biomass was not changed appreciably by charcoal (Table 4). This indicates that additional herbicides or hand weeding would be necessary to provide complete

weed control. Additional testing with Ro-Neet PPI or Asulox POST is warranted in 2012, based on these results.

*Table beet herbicide screen.* Red beet stecklings were transplanted May 19 and 20, 2011 at WSU Mount Vernon NWREC. PPI treatments were applied May 19, PRE treatments were applied May 24 and POST treatments were applied June 15 and 28 and July 6. Crop injury and weed control were estimated June 16 and August 10. Beet stand was estimated October 3, and beets were pulled from the plots October 3 to 6, dried in the greenhouse, threshed, and cleaned.

Beet steckling injury was greatest following Command applied PRE at either rate or by Callisto (Table 5). Early season weed control was poor to excellent, with micro-rate applications generally achieving the best weed control in August. Ro-Neet with three micro-rate applications, Nortron with two, and Dual Magnum with one or three, averaged the highest control ratings. In addition, Goal, Lorox, and Chateau provided a similar level of weed control as did the micro-rates. Table beet stand was not significantly affected by herbicide application. Beet seed yield per plant was maximized by treatment with Chateau, Diuron, or Lorox. Based on these results, additional testing with these products is warranted in 2011.

Table 1. Crop injury and weed control in spinach seed after treatment with several herbicides (2011).

Treatment <sup>a</sup>	Rate product/a	Timing <sup>b</sup>	Crop injury %	Weed control %	Spinach biomass g
Ro-Neet + Command	1.3 pt + 6.4 fl.oz	PPI + PPI	1 i	91 b-e	119 c-h
Ro-Neet + Command	1.3 pt + 10.7 fl.oz	PPI + PPI	9 e-h	90 cde	141 b-h
Ro-Neet + Dual Magnum	1.3 pt + 8.4 fl.oz	PPI + PRE	9 e-h	100 a	68 h
Ro-Neet + Define	1.3 pt + 1 pt	PPI + PRE	15 b-e	100 a	55 h
Ro-Neet + Command	1.3 pt + 3.4 fl.oz	PPI + POST	1 i	79 gh	131 c-h
Ro-Neet + Command	1.3 pt + 6.4 fl.oz	PPI + POST	0 i	76 gh	98 gh
Ro-Neet + Asulox	1.3 pt + 3 pt	PPI + POST	0 i	76 gh	166 b-g
Command + Nortron	6.4 fl.oz + 4.6 fl.oz	PPI + PRE	1 i	89 def	135 c-h
Command + Nortron	10.7 fl.oz + 4.6 fl.oz	PPI + PRE	10 d-g	89 def	135 c-h
Command + Nortron	3.4 fl.oz + 4.6 fl.oz	PRE + PRE	4 ghi	94 a-d	210 abc
Command + Nortron	6.4 fl.oz + 4.6 fl.oz	PRE + PRE	0 i	73 hi	88 gh
Nortron + Dual Magnum	4.6 fl.oz + 5.9 fl.oz	PRE + PRE	0 i	79 gh	120 c-h
Nortron + Define	4.6 fl.oz + 1 pt	PRE + PRE	18 bc	99 ab	112 e-h
Nortron + Asulox	4.6 fl.oz + 3 pt	PRE + POST	0 i	68 ij	207 a-d
Command + Dual Magnum	6.4 fl.oz + 8.4 fl.oz	PPI + PRE	9 e-h	93 a-d	121 c-h
Command + Dual Magnum	10.7 fl.oz + 8.4 fl.oz	PPI + PRE	13 c-f	98 abc	169 c-f
Command + Dual Magnum	3.4 fl.oz + 8.4 fl.oz	PRE + PRE	6 f-i	99 ab	231 ab
Command + Dual Magnum	6.4 fl.oz + 8.4 fl.oz	PRE + PRE	29 a	100 a	206 a-e
Dual Magnum + Define	8.4 fl.oz + 1 pt	PRE + PRE	16 bcd	100 a	111 fgh
Dual Magnum + Asulox	8.4 fl.oz + 3 pt	PRE + POST	0 i	93 a-d	127 c-h
Command	6.4 fl.oz	PPI	3 hi	81 fg	123 c-h
Command	10.7 fl.oz	PPI	9 e-h	84 efg	125 c-h
Command	3.4 fl.oz	PRE	0 i	93 a-d	201 a-f
Command	6.4 fl.oz	PRE	20 b	95 a-d	281 a
Hand weeded	---	---	2 i	60 j	115 d-h

Means within a column followed by the same letter, or not followed by a letter, are not statistically different ( $P < 0.05$ ).

Spinach was seeded May 25, 2011, weed control and crop injury estimated June 16, and biomass collected July 27.

<sup>a</sup>MSO = methylated seed oil.

<sup>b</sup>PPI = pre-plant incorporated (May 25); PRE = preemergence (May 25); P7 = postemergence (June 15).

Table 2. Crop injury and weed control in spinach seed after treatment with several herbicides (2011).

Treatment <sup>a</sup>	Rate	Timing <sup>b</sup>	Crop injury	Weed control	Spinach biomass
	product/a		%	%	g
Ro-Neet + (Spin Aid + Asulox + MSO)	1.3 pt + (2 fl.oz + 1.8 pt + 1.5%)	PPI + (P7)	3 bc	79 bc	151 bc
Ro-Neet + (Spin Aid + Asulox + MSO)	1.3 pt + 3 pt + (2 fl.oz + 1.8 pt + 1.5%)	PPI + (P7 + P14)	1 bc	81 bc	173 abc
Ro-Neet + (Stinger + Asulox + MSO)	1.3 pt + (2.7 fl.oz + 1.8 pt + 1.5%)	PPI + (P7)	4 abc	81 bc	143 bc
Ro-Neet + (Stinger + Asulox + MSO)	1.3 pt + (2.7 fl.oz + 1.8 pt + 1.5%)	PPI + (P7 + P14)	0 c	76 c	216 ab
Nortron + (Spin Aid + Asulox + MSO)	6.1 fl.oz + (2 fl.oz + 1.8 pt + 1.5%)	PRE + (P7)	0 c	79 bc	239 a
Nortron + (Spin Aid + Asulox + MSO)	6.1 fl.oz + (2 fl.oz + 1.8 pt + 1.5%)	PRE + (P7 + P14)	0 c	80 bc	207 ab
Nortron + (Stinger + Asulox + MSO)	6.1 fl.oz + (2.7 fl.oz + 1.8 pt + 1.5%)	PRE + (P7)	1 bc	84 b	163 abc
Nortron + (Stinger + Asulox + MSO)	6.1 fl.oz + (2.7 fl.oz + 1.8 pt + 1.5%)	PRE + (P7 + P14)	1 bc	81 bc	157 abc
Dual Magnum + (Spin Aid + Asulox + MSO)	10.8 fl.oz + (2 fl.oz + 1.8 pt + 1.5%)	PRE + (P7)	5 ab	98 a	141 bc
Dual Magnum + (Spin Aid + Asulox + MSO)	10.8 fl.oz + (2 fl.oz + 1.8 pt + 1.5%)	PRE + (P7 + P14)	5 ab	95 a	144 bc
Dual Magnum + (Stinger + Asulox + MSO)	10.8 fl.oz + (2.7 fl.oz + 1.8 pt + 1.5%)	PRE + (P7)	8 a	96 a	117 c
Dual Magnum + (Stinger + Asulox + MSO)	10.8 fl.oz + (2.7 fl.oz + 1.8 pt + 1.5%)	PRE + (P7 + P14)	8 a	96 a	115 c
Hand weeded	---	---	0 c	65 d	131 bc

Means within a column followed by the same letter, or not followed by a letter, are not statistically different ( $P < 0.05$ ). Spinach was seeded May 25, 2011, weed control and crop injury estimated June 16, and biomass collected July 27.

<sup>a</sup>MSO = methylated seed oil.

<sup>b</sup>PPI = pre-plant incorporated (May 25); PRE = preemergence (May 25); P7 = postemergence (June 15), 7 days after spinach emergence; P14 = postemergence (June 28) 14 days after spinach emergence.

Table 3. Spinach<sup>a</sup> injury, weed control, with and without charcoal<sup>b</sup> prior to herbicide application (2011).

Herbicide treatment	Rate	Spinach injury <sup>c</sup>		Weed control <sup>c</sup>	
		With char	w/o char	with char	w/o char
	product/a	%	%	%	%
Karmex	1 lb	0	4	76	88
Karmex	2 lb	9	19	78	91
Lorox	1.6 lb	5	81	70	89
Lorox	3.2 lb	33	99	80	91
Chateau	2.2 oz	8	65	79	94
Chateau	4.4 oz	11	90	78	96
Non-treated check	---	0	0	59	59

<sup>a</sup>Spinach seeded June 1, 2011.

<sup>b</sup>Activated charcoal slurry (300 lbs/acre applied in 800 gallons/acre) was applied June 3, 2011; herbicides were applied later the same day.

<sup>c</sup>Crop injury and weed control estimated June 16, 2011.

Table 4. Spinach<sup>a</sup> and weed biomass with and without charcoal<sup>a</sup> prior to herbicide application (2011).

Herbicide treatment	Rate	Spinach biomass <sup>c</sup>		Weed biomass <sup>c</sup>	
		With char	w/o char	with char	w/o char
	product/a	g	g	g	g
Karmex	1 lb	53	30	50	44
Karmex	2 lb	52	43	35	16
Lorox	1.6 lb	25	6	28	25
Lorox	3.2 lb	11	1	17	11
Chateau	2.2 oz	33	26	37	48
Chateau	4.4 oz	44	8	35	28
Non-treated check	---	32	29	38	43

<sup>a</sup>Spinach seeded June 1, 2011.

<sup>b</sup>Activated charcoal slurry (300 lbs/acre applied in 800 gallons/acre) was applied June 3, 2011; herbicides were applied later the same day.

<sup>c</sup>Spinach and weeds harvested July 27, 2011.

Table 4. Weed control in table beet seed after treatment with several herbicides (2011).

Treatment <sup>a</sup>	Rate product/a	Timing <sup>b</sup>	Crop injury %	Weed control % %	
Hand weeded	---	---	0 d	31	73
Ro-Neet + Asulox	2.7 pt + 3 pt	PPI + P21	0 d	68	35
Ro-Neet + (Asulox + UpBeet + Stinger + MSO)	2.7 pt + (1.5 pt + 0.1 oz + 1.3 fl.oz + 1.5%)	PPI + (P7)	0 d	74	51
Ro-Neet + (Asulox + UpBeet + Stinger + MSO)	2.7 pt + (1.5 pt + 0.1 oz + 1.3 fl.oz + 1.5%)	PPI + (P7, P14)	0 d	71	66
Ro-Neet + (Asulox + UpBeet + Stinger + MSO)	2.7 pt + (1.5 pt + 0.1 oz + 1.3 fl.oz + 1.5%)	PPI + (P7, P14, P21)	1 d	63	88
Nortron + (Asulox + UpBeet + Stinger + MSO)	1.5 pt + (1.5 pt + 0.1 oz + 1.3 fl.oz + 1.5%)	PRE + (P7)	0 d	66	69
Nortron + (Asulox + UpBeet + Stinger + MSO)	1.5 pt + (1.5 pt + 0.1 oz + 1.3 fl.oz + 1.5%)	PRE + (P7, P14)	0 d	59	88
Nortron + (Asulox + UpBeet + Stinger + MSO)	1.5 pt + (1.5 pt + 0.1 oz + 1.3 fl.oz + 1.5%)	PRE + (P7, P14, P21)	0 d	39	74
Dual Magnum + (Asulox + UpBeet + Stinger + MSO)	2 pt + (1.5 pt + 0.1 oz + 1.3 fl.oz + 1.5%)	PRE + (P7)	0 d	76	84
Dual Magnum + (Asulox + UpBeet + Stinger + MSO)	2 pt + (1.5 pt + 0.1 oz + 1.3 fl.oz + 1.5%)	PRE + (P7, P14)	0 d	49	71
Dual Magnum + (Asulox + UpBeet + Stinger + MSO)	2 pt + (1.5 pt + 0.1 oz + 1.3 fl.oz + 1.5%)	PRE + (P7, P14, P21)	0 d	73	89
Command	6.4 fl.oz	PPI	0 d	86	54
Command	10.7 fl.oz	PPI	4 cd	91	53
Command	3.4 fl.oz	PRE	34 b	91	40
Command	6.4 fl.oz	PRE	39 b	91	49
EPTC	3.5 pt	PPI	0 d	78	26
EPTC	3.5 pt	PRE	0 d	36	25
Callisto	3 fl.oz	PRE	53 a	95	19
Prowl H2O	2.5 pt	PRE	0 d	59	30
Goal	2 pt	PRE	8 c	95	81
Lorox	1 lb	PRE	0 d	99	94
Diuron	1 lb	PRE	0 d	96	78
Kerb	2 lb	PRE	0 d	94	60
Kerb	2 lb	P7	0 d	56	56
Chateau	2 oz	PRE	0 d	100	76

Means within a column and followed by the same letter (or with no letters) are not statistically different ( $P < 0.05$ ).

Table beet stecklings were transplanted May 19, 2011. Weed control was estimated June 16 and August 10, beets were counted October 3 and plants harvested October 3-6.

<sup>a</sup>MSO = methylated seed oil.

<sup>b</sup>PPI = pre-plant incorporated (May 19); PRE = preemergence (May 24); P7 = postemergence (June 15), 7 days after beet leaf emergence; P14 = postemergence (June 28), 14 days after beet leaf emergence; P21 = postemergence (July 6), 21 days after beet leaf emergence.

Table 4. Table beet plant stand and seed yield after treatment with several herbicides (2011).

Treatment <sup>a</sup>	Rate product/a	Timing <sup>b</sup>	Beet stand no./plot	Seed yield g/plant
Hand weeded	---	---	3.3	17 c
Ro-Neet + Asulox	2.7 pt + 3 pt	PPI + P21	4.3	6 c
Ro-Neet + (Asulox + UpBeet + Stinger + MSO)	2.7 pt + (1.5 pt + 0.1 oz + 1.3 fl.oz + 1.5%)	PPI + (P7)	4.5	13 c
Ro-Neet + (Asulox + UpBeet + Stinger + MSO)	2.7 pt + (1.5 pt + 0.1 oz + 1.3 fl.oz + 1.5%)	PPI + (P7, P14)	5.0	7 c
Ro-Neet + (Asulox + UpBeet + Stinger + MSO)	2.7 pt + (1.5 pt + 0.1 oz + 1.3 fl.oz + 1.5%)	PPI + (P7, P14, P21)	3.4	22 c
Nortron + (Asulox + UpBeet + Stinger + MSO)	1.5 pt + (1.5 pt + 0.1 oz + 1.3 fl.oz + 1.5%)	PRE + (P7)	9.5	11 c
Nortron + (Asulox + UpBeet + Stinger + MSO)	1.5 pt + (1.5 pt + 0.1 oz + 1.3 fl.oz + 1.5%)	PRE + (P7, P14)	4.8	11 c
Nortron + (Asulox + UpBeet + Stinger + MSO)	1.5 pt + (1.5 pt + 0.1 oz + 1.3 fl.oz + 1.5%)	PRE + (P7, P14, P21)	6.8	12 c
Dual Magnum + (Asulox + UpBeet + Stinger + MSO)	2 pt + (1.5 pt + 0.1 oz + 1.3 fl.oz + 1.5%)	PRE + (P7)	7.0	12 c
Dual Magnum + (Asulox + UpBeet + Stinger + MSO)	2 pt + (1.5 pt + 0.1 oz + 1.3 fl.oz + 1.5%)	PRE + (P7, P14)	5.0	9 c
Dual Magnum + (Asulox + UpBeet + Stinger + MSO)	2 pt + (1.5 pt + 0.1 oz + 1.3 fl.oz + 1.5%)	PRE + (P7, P14, P21)	2.8	5 c
Command	6.4 fl.oz	PPI	3.5	20 c
Command	10.7 fl.oz	PPI	6.0	13 c
Command	3.4 fl.oz	PRE	5.3	22 c
Command	6.4 fl.oz	PRE	5.8	19 c
EPTC	3.5 pt	PPI	5.0	10 c
EPTC	3.5 pt	PRE	5.5	10 c
Callisto	3 fl.oz	PRE	0	0 c
Prowl H2O	2.5 pt	PRE	4.5	19 c
Goal	2 pt	PRE	5.0	27 bc
Lorox	1 lb	PRE	5.8	53 ab
Diuron	1 lb	PRE	6.0	61 a
Kerb	2 lb	PRE	5.3	30 bc
Kerb	2 lb	P7	4.3	17 c
Chateau	2 oz	PRE	3.3	70 a

Means within a column and followed by the same letter (or with no letters) are not statistically different ( $P < 0.05$ ).

Table beet stecklings were transplanted May 19, 2011. Weed control was estimated June 16 and August 10, beets were counted October 3 and plants harvested October 3-6.

<sup>a</sup>MSO = methylated seed oil.

<sup>b</sup>PPI = pre-plant incorporated (May 19); PRE = preemergence (May 24); P7 = postemergence (June 15), 7 days after beet leaf emergence; P14 = postemergence (June 28), 14 days after beet leaf emergence; P21 = postemergence (July 6), 21 days after beet leaf emergence.