Title: Herbicide Phytoxicity to Red Beet Transplants

Reporting Period: December 1012 to February 2013

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Materials and Methods:

Red beet transplants were received from Alf Christianson Seed Company in mid-December, 2012. Where possible, two seedlings of each of five seed lines were selected for this herbicide phytotoxicity trial. Ten treatments or treatment combinations were tested in this trial; a nontreated check pot was included for comparison. Pots were prepared containing moist field soil from WSU Mount Vernon NWREC on December 12, 2012. All herbicides were applied using a CO_2-pressurized backpack sprayer equipped with a single nozzle boom delivering the equivalent of 25 gal/a of spray solution. Pre-plant incorporated (PPI) treatments were simulated by removing soil from the top two inches of appropriate pots, placing it in a plastic tray, smoothing it to a uniform depth, applying the proper amount of herbicide, thoroughly mixing the soil, then refilling the pots with the treated soil. Pre-transplant (PRETR) herbicides were applied immediately prior to transplanting red beet seedlings into appropriate pots, while post-transplant (POSTR) treatments were made immediately following transplanting of red beet seedlings. PPI, PRETR, and POSTR treatments were applied on December 13, 2012. Soil was then irrigated with sufficient water to reach field capacity. Water was applied to each pot, with care being taken to not wet beet foliage until 24 hours after herbicide applications. Subsequent irrigations were made over the tops of seedlings using a hose-end spray attachment. Initial injury rating (0% = no injury, 100% = dead seedling) was estimated the day after transplanting to more accurately estimate herbicide injury over time. One more POSTR application (Table 1) was made to appropriate pots on December 20. Additional beet injury ratings were made on December 21 (PPI, PRETR, and POSTR), December 28 (POSTR + 7d) and January 30 (all). Weeds germinating in each pot (from resident weed seeds in the soil that was used for the trial) were counted on January 4 and those weeds removed by hand. One beet seedling for each treatment was clipped at the soil level on January 31, and foliage was bagged, dried at 75 C for three days, and weighed. The second plant (if any) was then returned to Alf Christianson Seed Company for determination whether beet seedling vernalization was achieved.

The trial was a completely random design with four replicates. Fisher's Protected LSD ($P < 0.05$) was used to separate treatment means.

Results:

<u>Herbicide effects</u>.

Initial beet injury at one day after transplanting (December 14) ranged from 31 to 44% (Table 1). All these injuries were due to leaf mortality within the original seedling trays, and all were statistically similar to that for nontreated plants at that timing (38%). Seedling injury did not differ by treatment at one week after treatment (December 21 for PPI, PRETR, and POSTR treatments; December 28 for POSTR + 7d) (Table 1). By January 30, however, injury for four treatments exceeded that of nontreated beet

seedlings (2%): Command applied PPI and PRETR (25 and 17%, respectively) and Asulox + UpBeet + Stinger applied POSTR and POSTR + 7d (9 and 14%, respectively) (Table 1). Injury symptoms with Command were moderately to severely whitened leaves, while injury with the "micro-rate" treatments were slightly to moderately rolled leaves, presumably due primarily to the Stinger component of the herbicide tank mixture. These symptomatic plants did not differ in final dry weight compared to nontreated seedlings, however (Table 2). The only treatment that reduced seedling dry weight was Dual Magnum PRETR, which reduced dry weight from 0.34 to 0.27 g/plant.

Weed count was relatively variable, and most treatments did not differ in total weed seedlings as compared to nontreated pots (Table 2). Only Dual Magnum POSTR reduced weed number compared to nontreated pots (0.2 and 1.0 weeds/pot, respectively).

Seed line injury.

Beet seedling injury at one day after transplanting (December 14) ranged from 29 to 42% (Table 3). As previously pointed out, this initial injury was due to leaf mortality within the original seedling trays and did not represent injury due to herbicide treatment. The seed lines recovered during the 6 weeks of the trial, with injury slightly lessened by December 21 and all five lines displaying 11% injury or less by January 30, when averaged across all herbicide treatments. Seed line VBE008G was the most tolerant to these herbicide treatments (3% injury), while VBE003G displayed more injury than VBE401G (11 and 7%, respectively).

Most seed lines responded similarly to all treatments (data not shown). However seed line VBE008G was more tolerant to Command than were the other four seed lines (9 and 2% injury from PPI and PRETR, respectively, compared with an average of 29 and 23% injury from PPI and PRETR, respectively, for the other four lines). Also, seed line VBE401G was slightly less injured by POSTR Asulox + UpBeet + Stinger than were the other four seed lines (1% injury for VBE401G compared to an average of 12% for the other four seed lines); all five seed lines seemed similarly susceptible to the POSTR + 7d application (11 to 19%).

Herbicide treatment did not significantly affect seedling mortality in this trial (data not shown). Seedling survival was 08 to 100% for four seed lines, but only 90% for VBE008G was after six weeks (Table 3).

Discussion:

First, it must be pointed out that these treatments are not completely indicative of what might happen from the same herbicide applications in the field. Irrigation in small pots in the greenhouse was probably greater than might be expected to occur from rainfall in the field, and temperatures in the greenhouse were higher than might be expected to occur in the field during April and May. So it will be important to test these applications in the field to have fuller confidence in these results; this is my intention for 2013.

Visual injury from Command was moderate to severe for most seed lines, but dry weight of these beet seedlings did not differ from the weight of nontreated beet

seedlings. Similarly, injury from Asulox + UpBeet + Stinger was greater than for nontreated seedlings, although, again, these treated plants were of similar weights. Command is not currently registered for red beets, and these data indicate that it may be too risky to consider for this use. Similarly, we conclude that "micro-rate" treatments were also too injurious in this trial to currently consider for treatment of seedlings immediately or seven days after transplanting.

Dual Magnum PRETR at 2 pt/a reduced dry weight of beet seedlings after six weeks, but Nortron was equivalent to Betamix in this trial. Consequently, Nortron may offer the best current alternative to Betamix. Dual Magnum at less than 2 pt/a may offer some degree of crop safety, as may expansion of the current Dual Magnum label to allow for POSTR application to seedlings. Use of PPI Ro-Neet may also help to improve weed control, although sequential applications of these herbicides with Ro-Neet wasn't tested in this trial.

Table 1. Percent red beet injury after treatment with various herbicides (2012-13).

Treatment[a]	Rate	Timing[a]	Beet injury			
			Dec 14	Dec 21	Dec 28	Jan 30
	product/a		%	%	%	%
Command	6.4 fl.oz	PPI	35 b	28	---	25 a
Command	3.4 fl.oz	PRETR	38 ab	32	---	17 b
Dual Magnum	2 pt	PRETR	32 b	29	---	2 d
Dual Magnum	2 pt	POSTR	37 ab	32	---	2 d
Nortron	1.5 pt	PRETR	37 ab	26	---	2 d
Nortron	1.5 pt	POSTR	35 ab	31	---	2 d
Betamix	3 pt	PRETR	32 b	26	---	2 d
Betamix	1.5 pt	POSTR	35 ab	29	---	2 d
Asulox + UpBeet + Stinger + MSO	1.5 pt + 0.1 oz + 1.3 fl.oz + 1.5%	POSTR	31 b	28	---	9 c
Asulox + UpBeet + Stinger + MSO	1.5 pt + 0.1 oz + 1.3 fl.oz + 1.5%	POSTR + 7d	44 a	27	24	14 bc
Nontreated check	---	---	38 ab	27	---	2 d

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

[a]Pre-plant-incorporated (PPI), pre-transplant (PRETR), and post-transplant (POSTR) applications were made December 14, 2012; POSTR + 7d application was made December 20, 2012; MSO = methylated seed oil.

Table 2. Weed counts and red beet seedling dry weight after treatment with various herbicides (2012-13).

Treatment[a]	Rate	Timing[a]	Weed count[b]	Beet dry weight[c]
	product/a		no./pot	g/plant
Command	6.4 fl.oz	PPI	1.4 a	0.32 abc
Command	3.4 fl.oz	PRETR	0.7 a-d	0.28 bc
Dual Magnum	2 pt	PRETR	0.4 cd	0.27 c
Dual Magnum	2 pt	POSTR	0.2 d	0.32 abc
Nortron	1.5 pt	PRETR	0.8 a-d	0.31 abc
Nortron	1.5 pt	POSTR	0.6 bcd	0.31 bc
Betamix	3 pt	PRETR	1.2 ab	0.38 a
Betamix	1.5 pt	POSTR	1.1 abc	0.33 abc
Asulox + UpBeet + Stinger + MSO	1.5 pt + 0.1 oz + 1.3 fl.oz + 1.5%	POSTR	0.5 bcd	0.28 bc
Asulox + UpBeet + Stinger + MSO	1.5 pt + 0.1 oz + 1.3 fl.oz + 1.5%	POSTR + 7d	1.0 abc	0.29 bc
Nontreated check	---	---	1.0 a-c	0.34 ab

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

[a]Pre-plant-incorporated (PPI), pre-transplant (PRETR), and post-transplant (POSTR) applications were made December 14, 2012; POSTR + 7d application was made December 20, 2012; MSO = methylated seed oil.

[b]Weed counts made January 4, 2013.

[c]Beets were harvested January 31, 2013.

Table 3. Injury, dry weight, and survival of red beet seed lines after treatment with various herbicides[a] (2012-13).

Seed line	Beet injury			Beet dry weight[b]	Survival[b]
	Dec 14	Dec 21	Jan 30		
	%	%	%	g/plant	%
VBE008G	31 b	27 b	3 c	0.32 b	90 b
VBE003G	29 b	20 c	8 ab	0.40 a	100 a
VBE006G	42 a	34 a	8 ab	0.27 cd	98 a
VBE007G	32 b	27 b	11 a	0.30 bc	99 a
VBE401G	45 a	35 a	7 b	0.26 d	100 a

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

[a]Herbicides were applied December 14 and 20, 2012.

[b]Beets were harvested and survival calculated January 31, 2013.