## Phytotoxicity and efficacy of V-10366 in comparison to industry standards

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**Background.** The sponsor Valent U.S.A. (Walnut Creek, CA) requested trials to determine efficacy and phytotoxicity to field grown ornamentals from a new product, code named V-10336, which includes the active ingredients flumioxazin and pyroxasulfone. Flumioxazin is currently labeled for the nursery and landscape markets as either BroadStar (the granular formulation) or SureGuard (liquid formulation). Pyroxasulfone is a new chemistry in the isoxazoline family that inhibits very long chain fatty acids and is currently labeled for use in corn and soybeans.

## Materials and Methods.

Several trials were conducted to determine weed control and phytotoxicity from several herbicides and herbicide combinations at three locations in Ohio, which included Studebaker Nurseries, Inc., New Carlisle, OH; North Branch Nursery, Inc., Pemberville, OH, and Timbuk Farms, Granville, OH. Species at Studebaker Nurseries included boxwood (*Buxus* 'Green velvet') and yew (*Taxus densiformus*). Species at North Branch Nursery included eastern white pine (*Pinus strobus*) and white spruce (*Picea glauca*), and at Timbuk Farms, Canaan fir (*Abies balsamea var phanerolepis*). Liquid applications were applied via CO<sub>2</sub> backpack sprayer delivering 25 gal/ac and granular formulations were applied via handheld shaker jars. At each location, the rows were hoed just prior to first treatment application.

Studebaker Nurseries. Treatments were applied at Studebaker Nurseries on May 6, 2013 and included V-10366 (flumioxazin + pyroxasulfone, Valent U.S.A.) at 7.5, 15, and 30 oz/ac, Tower + Pendulum Aquacap (dimethenamid-p + pendulum, both from BASF Corp.) at 32 oz/ac + 2 qt/ac, respectively, and SureGuard (flumioxazin, Valent U.S.A.) at 6 oz and 12 oz/ac. Treatments were reapplied on June 17, 2013. Liquid applications were applied as directed sprays. For both boxwood and yew, there were four replications/treatment and three subsamples/replication arranged in a completely randomized design in the liner field for each species. Treatments were evaluated at 1 WAT (weeks after treatment) 2 WAT, 4 WAT and 1 WA2T (weeks after second treatment).

North Branch Nursery. Treatments were applied at North Branch on April 23, 2013 and included Gallery (isoxaben, Dow AgroSciences) + Barricade (Syngenta Crop Protection, Inc.) at 1.3 lb/ac + 21 oz/ac, respectively; Tower + Pendulum at 21 oz/ac + 2 qt/ac, respectively; Tower + Pendulum at 1 qt/ac + 1 qt/ac, respectively; Biathlon (oxyfluorfen + prodiamine, OHP, Inc.) at 100 lb/ac; Marengo G (indaziflam, OHP, Inc.) at 150 lb/ac;

V-10366 at 15 oz/ac; and SureGuard at 6 oz/ac. Treatments were reapplied on June 4, 2013. Liquid applications were applied as directed sprays. For each species, there were four replications with three subsamples/replication for each treatment in a completely randomized design within each species. Treatments were evaluated at 1 WAT, 2 WAT, 4 WAT, 1 WA2T, 2 WA2T, and 4 WA2T.

Timbuk Farms. Treatments were applied at Timbuk Farms on July 9, 2013 and included the same treatments describe above for North Branch Nursery, and the treatments were reapplied on September 3, 2013. At Timbuk, one species, Canaan Fir, *Abies balsamea var phanerolepis* also known as West Virginia fir was used. However, there were two growth stages evaluated, which were newly planted and trees in the ground for three years. Studies were also conducted in the fall of 2012 with three growth stages, newly planted, 3 years old and trees in the ground 5 years. The results of the fall 2012 study were presented with the SCBG 11-08 project. Treatments were applied over-the-top of the newly planted trees and as directed applications for the older trees. For each growth stage, there were three subsamples/replication with four replications/treatment randomized in a completely randomized design. Treatments were evaluated at 1 WAT, 2 WAT, 3 WAT, 4 WAT, 1 WA2T, and 2 WA2T.

At all locations, phytotoxicity visual ratings were based on a 0-10 scale with 0 being no phytotoxicity and 10 death with ≤3 commercially acceptable. Efficacy visual ratings were based on a 0-10 scale with 0 being no control and 10 perfect control with ≥7 commercially acceptable. For phytotoxicity, treatment means were compared to a control using Dunnett's t-test with  $\alpha$  = 0.10 and 0.05 using Proc Mixed in SAS® software. For efficacy, treatment means were compared using Ismeans in Proc Mixed with  $\alpha$  = 0.05.

## Results.

Studebaker Nurseries. None of the treatments were phytotoxic to either *Buxus* 'Green velvet' or *Taxus densiformus* at any evaluation date (Table 1). All treatments provided commercially acceptable weed control ( $\geq$  7) at Studebaker Nurseries through 4 WAT. Only the V-10366 at 30 oz/ac was commercially acceptable 1 WA2T (Table 2) (Fig. 1). By the second application, there was severe weed pressure at Studebaker Nurseries including Canada thistle, field bindweed and many of the weeds listed in Table 2, including musk thistle which favor abandoned sites and is indicative of the severe weed pressure at Studebaker Nurseries (Fig. 2).



Fig. 1. *Buxus* 'Green velvet' providing commercially acceptable weed control (≥ 7) at Studebaker Nurseries, New Carlisle, OH at 1 WA2T with V-10366 at 30 oz/ac.



**Fig. 2.** (Left) *Buxus* 'Green velvet' field at Studebaker Nurseries, New Carlisle, OH at 1 WA2T showing severe weed pressure including many of the weeds in Table 2 including musk thistle (below) which favors abandoned sites.



**Table 1.** Phytotoxicity on selected ornamentals from several herbicides at Studebaker Nurseries, New Carlisle, OH trial was initiated on May 6, 2013.

Treatment	Rate/ac	1 WAT <sup>z</sup>	2 WAT	4 WAT	1 WA2T
V-10336	7.5 oz	0.8 <sup>yx</sup>	0.5	0.3	0.6
V-10336	15 oz	0.7	0.3	1.3	1.7
V-10336	30 oz	0.6	0.3	0.7	0.8
Tower + Pendulum	32 oz + 2 qt	0.0	0.0	0.0	0.0

Buxus 'Green velvet'

SureGuard	12 oz	0.0	0.0	0.8	0.8
SureGuard	6 oz	0.8	0.7	1.8	1.9
Untreated		0.4	0.3	0.3	0.6
Taxus densifo	ormus				
Treatment	Rate/ac	1 WAT	2 WAT	4 WAT	1 WA2T
V-10336	7.5 oz	0.0	0.0	0.8	1.0
V-10336	15 oz	0.8 **	0.1	0.0 **	0.0 **
V-10336	30 oz	0.0	0.2	1.1	1.4
Tower + Pendulum	32 oz + 2 qt	0.0	0.0	0.2 *	0.3 *
SureGuard	12 oz	0.0	0.2	0.4 *	0.5 **
SureGuard	6 oz	0.0	0.0	0.5	1.0
Untreated		0.0	0.1	1.5	2.1

z = weeks after treatment

y = Phytotoxicity visual ratings based on a 0-10 scale with 0 being no phytotoxicity and 10 death with  $\leq$ 3 commercially acceptable

x = Treatment means followed by \*,\*\* are significantly different from the untreated control for that date ( $\alpha$  = 0.10 and 0.05, respectively).

**Table 2.** Efficacy with several herbicides at Studebaker Nurseries, New Carlisle, OH trial was initiated on May 6, 2013.

Weed control

Treatment	Rate/ac	1 WAT		2 WAT		4 WA	Т	1 WA2T		
V-10336	7.5 oz	10.0 <sup>wv</sup>	а	9.6 a	ab	8.8	bc	5.4	b	
V-10336	15 oz	10.0	а	9.8 a	ab	9.5	ab	6.4	ab	
V-10336	30 oz	10.0	а	9.9 a	a	10.0	а	7.5	а	
Tower + Pendulum	32 oz + 2 qt	9.5	b	7.7 c	5	8.4	cd	5.9	b	
SureGuard	12 oz	10.0	а	9.7 a	ab	9.5	ab	6.0	b	
SureGuard	6 oz	9.9	а	9.1 b	С	9.3	abc	4.2	С	
Untreated		9.2	С	7.8 c	<b>c</b>	7.7	d	1.4	d	

w = Weed control ratings based on a 0-10 scale with 0 being no weed control and 10 perfect weed control with  $\geq$ 7 commercially acceptable

v = Treatment means followed by the same letter in the same column are not significantly different based on lsmeans ( $\alpha = 0.05$ )

*North Branch Nursery.* All treatments were safe on the *Pinus strobus* and *Picea glauca*. Canada thistle, spiny sowthistle, yellow nutsedge, and prickly lettuce were the main weeds. The *Pinus strobus* was hoed prior to the second application, while *Picea glauca* was not. Therefore, only in the *Pinus strobus* were there two treatments that provided commercially acceptable weed control over all dates (Table 3). Biathlon was the best treatment for weed control in each species averaged across dates with a 7.8 rating in *Pinus strobus* and 5.0 rating in the *Picea glauca* (Fig. 3) (Table 3). Marengo also provided commercially acceptable weed control across all dates in the *Pinus strobus* (rating 7.3) (Table 3). V-10366 at 15 oz/ac provided comparable control to the non-treated (control plots) across all dates (Fig. 4) in pine (Table 3). Biathlon, however, was more capable of suppressing Canada thistle, which is why it had the highest ratings in both species (Table 10).



**Fig. 3**. **A and B**. **A.** (left) Note the region behind the first *Picea glauca* in the foreground where Biathlon was applied at North Branch Nursery, 4WAT compared to **B.** (below) Control plot in *Picea glauca*. Note the severe Canada thistle infestation on the control.





**Fig. 4. A and B**. **A.** (above) Note the region behind the first *Pinus strobus* in the foreground where V-10366 at 15 oz/ ac was applied at North Branch Nursery, 4WAT compared to **B**. Control plot in *Pinus strobus*. Note the control with V-10336 at 15 oz/ ac was comparable to the un-treated plots over all dates.

**Table 3.** Phytotoxicity and efficacy (weed control) on selected ornamentals with several herbicides at North Branch Nursery, Pemberville, OH the trial was initiated on April 23, 2013 averaged across 6 dates of evaluation with reapplication at 6 WAT and evaluations being conducted to 4 WA2T.

			Pinus str	obus	Picea glauca					
	Dete/ee			Weed	t		-	Weed	b	
Treatment	Rale/ac	Phytoto	oxicity <sup>z</sup>	contro	bl	Phytote	oxicity	control		
Gallery +	$1.3 \text{ lb} \pm 21.07$	0 OV	no diff	2 ∩xw	cd	13	no diff	1.8	h	
Barricade	1.5 10 + 21 02	0.0	no um	2.0	cu	1.5	no un	1.0	D	
Tower +	21  oz + 2  ot	1 2	no diff	62	ah	0.1	no diff	25	ah	
Pendulum	21 02 <del>+</del> 2 qi	1.5	no un	0.5	au	0.1	no un	2.0	au	
Tower +	1 at 1 at	0.5	no diff	10	ha	1.2	no diff	22	ah	
Pendulum	i qi + i qi	0.5	no un	4.0	bC	1.2	no un	2.3	au	
Biathlon	100 lbs	0.1	no diff	7.8	а	0.3	no diff	5.0	а	
Marengo G	150 lbs	0.6	no diff	7.3	ab	0.3	no diff	3.5	ab	
V-10336	15 oz	0.5	no diff	2.5	cd	0.4	no diff	3.5	ab	
SureGuard	6 oz	0.6	no diff	1.5	d	0.0	no diff	2.0	b	
Untreated		0.8	no diff	2.3	cd	0.0	no diff	2.0	b	

z = Phytotoxicity and weed control ratings are averaged over all evaluation dates

y = Phytotoxicity visual ratings based on a 0-10 scale with 0 being no phytotoxicity and 10 death with  $\leq$ 3 commercially acceptable

x = Weed control ratings based on a 0-10 scale with 0 being no weed control and 10 perfect weed control with  $\ge$ 7 commercially acceptable

w = Treatment ratings followed by the same letter in the same column are not significantly different based on Ismeans ( $\alpha = 0.05$ )

*Timbuk Farms.* With the newly planted Canaan Fir, Abies *balsamea* var phanerolepis also known as West Virginia Fir trees, Tower + Pendulum at 21 oz + 2 qt (Fig. 5 A), V-10366 at 15 oz/ac (Fig. 5 B) and SureGuard at 6 oz/ac (Fig. 6 C) caused significant, non- commercially acceptable injury (Table 4). The most phytotoxic treatment was the V-10366 on the newly planted trees (Table 4). The Tower + Pendulum at 21 oz + 2 qt and SureGuard injury, on the newly planted trees, were after the second application (Table 4). The V-10366 injury was after the first and second application (Table 4).

On the three year old trees the V-10366 at 15 oz/ac again caused the most injury; however, the injury occurred after the second application (Table 4). The Tower + Pendulum at 21 oz + 2 qt also became injurious at non-commercially acceptable levels after the second application to the three year old trees (Table 4). The addition of 1 qt of pendulum caused increased injury with both stages of Canaan fir. This was opposite to the container trial at North Branch where the increase in Tower caused more injury but a similar result to Willoway, Huron, OH where the higher rate of pendulum increased injury on *Azalea* and *Hydrangea*.



**Fig. 5 A, B and C. A**. (left) Newly planted *Abies balsamea* var phanerolepis, Canaan fir applied with Tower + Pendulum at 21 oz + 2 qt with significant, non- commercially acceptable injury 1WA2T at Timbuk Farms, Granville, OH; **B**. (below-left) applied with SureGuard 6 oz/ac. and **C**. (below – right) applied with V-10366 15 oz/ac.





Commercially acceptable ( $\geq$  7) weed control occurred with all treatments until 1 WA2T averaged across dates (Table 12). At 1 WA2T Tower + Pendulum (21 oz + 2 qt) (Fig. 5 A) (1 qt + 1 qt); V-10366 at 15 oz/ac (Fig. 5 C); and SureGuard at 6 oz/ac (Fig. 5 B) were still providing commercially acceptable efficacy across dates (Table 12). Weed pressure was quite severe in the untreated plots by 1 WA2T (Fig. 6). By 2 WA2T, only Tower + Pendulum (21 oz + 2 qt), V-10366 and SureGuard were commercially acceptable across dates (Table 12). V-10366 at 15 oz/ac was the best treatment overall and Gallery + Barricade was the worst treatment for weed control (Table 12).



**Fig. 6.** Newly planted *Abies balsamea* var phanerolepis, Canaan fir showing untreated plot with severe weed pressure 1 WA2T at Timbuk Farms, Granville, OH.

**Table 4.** Phytotoxicity on two different sizes of field grown Canaan fir Christmas trees from several herbicides at Timbuk Farms, Granville, OH trial was initiated on July 9, '13. First year Canaan fir

Treatment	Rate/ac	1 WAT <sup>z</sup>	2 WAT	3 WAT	4 WAT	1 WA2T	2 WA2T
Gallery + Barricade	1.3 lb + 21 oz	0.6 <sup>yx</sup>	0.0	0.8	0.6	2.9	2.8
Tower + Pendulum	21 oz + 2 qt	0.5	0.9	1.4	0.9	3.3 *	3.3 **
Tower + Pendulum	1 qt + 1 qt	1.2	0.2	1.0	0.0	2.3	2.5
Biathlon	100 lbs	0.8	0.6	0.5	0.0	0.9	0.9
Marengo G	150 lbs	0.8	0.6	0.5	0.0	1.4	1.1
V-10366	15 oz	3.4 **	3.0 **	2.6	2.5 *	5.8 **	6.5 **
SureGuard	6 oz	1.3	1.1	1.3	0.1	2.8	3.0
Untreated		1.4	0.5	1.3	0.3	0.3	0.4
3 year Canaan fir							
Treatment	Rate/ac	1 WAT	2 WAT	3 WAT	4 WAT	1 WA2T	2 WA2T
Gallery + Barricade	1.3 lb + 21 oz	0.0	0.0	0.4	0.1	1.6	2.1
Tower + Pendulum	21 oz + 2 qt	0.0	0.0	0.0	1.5	3.9	3.1
Tower + Pendulum	1 qt + 1 qt	0.7	0.5	0.0	0.0	1.5	1.5
Biathlon	100 lbs	0.0	0.0	0.0	-0.1	0.1	0.3
Marengo G	150 lbs	4.1 **	0.0	0.0	0.4	0.5	0.6
V-10366	15 oz	0.0	0.4	1.8 **	2.5 **	4.5 **	4.4
SureGuard	6 oz	0.0	0.0	0.0	0.0	1.5	1.4
Untreated		0.0	0.3	0.4	0.0	1.3	1.5

z = weeks after treatment

y = phytotoxicity visual ratings based on a 0-10 scale with 0 being no phytotoxicity and 10 death with  $\leq$ 3 commercially acceptable

x = treatment means followed by \*,\*\* are not significantly different from the untreated control at that evaluation date based on Dunnett's t-test ( $\alpha = 0.10$  and 0.05, respectively)

Treatment	Rate/ac	1 WA	Tz	2 W.	AT	3 WAT		4 WAT 1 W		A2T <sup>y</sup>	y 2 WA2T		
Gallery + Barricade	1.3 lb + 21 oz	9.3 <sup>xw</sup>	a b	8.4	b	9.3	ab c	7.8	с	6.3	с	5.6	d
Tower + Pendulum	21 oz + 2 qt	9.1	b	8.9	a b	9.4	ab c	8.8	ab c	7.3	ab c	7.2	a b
Tower + Pendulum	1 qt + 1 qt	9.4	a b	8.9	a b	9.1	bc	8.2	bc	7.0	ab c	6.7	bc
		9.5	а	8.8	а	9.2	ab	9.3		6.7		6.1	
Baithlon	100 lbs		b		b		С		а		bc		cd
		9.7		8.8	а	9.3	ab	9.1		6.8		6.1	
Marengo G	150 lbs		а		b		С		ab		bc		cd
V-10366	15 oz	9.6	а	9.7	а	9.8	ab	9.3	а	8.2	а	8.1	а
		9.7		9.5		9.9		9.7		7.6		7.5	а
SureGuard	6 oz		а		а		а		а		ab		b
		9.4	а	9.0	а	9.0		8.2		3.8		3.8	
Untreated			b		b		С		bc		d		е

Table 5. Weed control from several herbicides in field grown Canaan fir Christmas trees at Timbuk Farms near Granville, OH

z = weeks after treatment

y = weeks after second treatment

x = weed control ratings based on a 0-10 scale with 0 being no weed control and 10 perfect weed control with  $\ge$ 7 commercially acceptable

w = treatment means followed by the same letter in the same column are not significantly different based on Ismeans ( $\alpha = 0.05$ )

**Closing remarks.** V-10336 can be used as a directed spray around numerous ornamentals, including many of those in these trials. The only phytotoxicity observed in these trials was with the young ( $\leq$ 3 years old) Canaan fir. However, on older Canaan firs, no injury was observed. The 15 oz/ac rate seems to be sufficient for weed control and is comparable or better than industry standards.