BASF FORESTRY RESEARCH REPORT 98-12

Screening of Imazaquin, Pendimethalin and Trifluralin for Weed Control in Hybrid Poplar: The 1998 Sandpiper Farm Study (Eastern Washington)

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EXECUTIVE SUMMARY

In January 1998, SCEPTER® 70 DG herbicide was labeled for use in hybrid poplar and eastern cottonwood fiber farms or tree plantations. Following soil-applied treatments, rainfall is required for optimum SCEPTER activity. Alternatively, a cultivation may be used to uniformly incorporate SCEPTER into the soil. This study was established to test SCEPTER as a preplant incorporated application in irrigated hybrid poplar stands in a very low rainfall area of the Pacific Northwest.

Tank mixes with trifluralin and PENDULUM® 3.3 EC herbicide were tested because these are commonly used with SCEPTER to increase the spectrum of preemergence weed control. Treatments were compared to the operational standard of 2 lb ai/acre trifluralin. Major findings were:

• Preplant incorporated tank mix treatments of SCEPTER + trifluralin or SCEPTER + PENDULUM improved weed control and resulted in substantial hybrid poplar growth responses over the standard treatment of trifluralin.

• Adding 2.8 oz/acre SCEPTER and 2 lb ai/acre trifluralin increased stem volume index 46% over the standard treatment of 2 lb ai/acre trifluralin. A tank mix of 2.4 qt/acre PENDULUM + 2.8 oz SCEPTER increased stem volume index 16% over the standard treatment of 2 lb ai/acre trifluralin.

• For both trifluralin + SCEPTER and PENDULUM + SCEPTER tank mixes, there were positive hybrid poplar diameter responses to a SCEPTER rate increase. For tank mixes with 2.4 qt/acre PENDULUM, stem volume index increased 29% for a SCEPTER rate increase from 2.8 to 5.6 oz/acre. For tank mixes with 2 lb ai/acre trifluralin, stem volume index increased 15% for a SCEPTER rate increase from 2.8 to 5.6 oz.

• The best treatment was 5.6 oz SCEPTER + 2 lb ai/acre trifluralin. This treatment resulted in trees at the end of the first growing season with an average height over 13 feet and an average groundline diameter over 2.3 inches. Stem volume growth was 68% greater than the standard trifluralin treatment.

• The relative impact on groundline diameter was greater than the impact on tree height. Groundline diameter response to the preplant tank mixes over straight trifluralin ranged from 0.2 to 0.5 inches (10% to 30%), while height response ranged from -0.2 to 0.7 feet (-1% to 5%).

INTRODUCTION

The greatest emphasis in research and commercial scale development of high production hardwood fiber farms in the USA has been with Populusspp. (cottonwood, hybrid poplar and aspen). The wood is attractive for paper production and composite products such as oriented strand board. Effective weed control is essential to ensure the survival and maximum growth of newly planted trees. Mechanical cultivation has limitations: the area closest to the hardwood seedling is not weeded, hardwood roots and above ground portions may be damaged, cultivation must be repeated several times during the growing season, inclement weather sometimes prevents timely cultivation, and on drip-irrigated sites, options are limited due to the presence of drip lines. One-way cultivation leaves a band of weeds within the row. Two-way cultivation alleviates some of the problem, but trees must be planted on a perfect grid pattern, and some weeds will still be left at the base of the seedling. Use of disks on cutover sites requires extensive land clearing. In addition to removal of competition, weed control is necessary to keep drip-irrigation lines free of vegetation to allow for regular maintenance, and to remove cover for rodents (mice and voles), slugs and insects that can damage the trees or irrigation lines.

Herbicide options for weed control in hybrid poplar are limited. In January 1998, SCEPTER 70 DG herbicide was labeled for use in hybrid poplar and eastern cottonwood fiber farms or tree plantations. SCEPTER provides preemergence control of a broad spectrum of weeds and postemergence control of a limited spectrum of weeds. SCEPTER may be applied prior to crop tree budbreak or over the top of actively growing trees following label directions. Following soil-applied treatments, rainfall is required for optimum activity. Alternatively, a cultivation may be used to uniformly incorporate SCEPTER into the top 1 to 2 inches of soil. This study was established to test SCEPTER and SCEPTER tank mixes for preplant incorporated applications in irrigated hybrid poplar stands in a very low rainfall area of the Pacific Northwest. Tank mixes with trifluralin and PENDULUM 3.3 EC herbicide were tested as these are commonly used with SCEPTER to increase the spectrum of preemergence weed control.

METHODS

The study was established in cooperation with Boise Cascade on a drip-irrigated, second-rotation, hybrid poplar site in the desert region of eastern Washington. Following harvest of the previous crop, larger branch debris were removed from the site to facilitate subsequent mechanical treatments. Stumps from the previous rotation were left. In March 1998, the site was ripped along lines centered in the middle of old stump rows. This was followed by application of the preplant herbicide treatments on the morning of March 18, with incorporation in the afternoon of the same day. Trees were planted into the rip lines on April 6. Sixty days after the preplant treatments, postplant SCEPTER treatments were applied over the top of the hybrid poplar. All treatments were applied in a 6-footwide band centered over the tree rows. A CO2 pressurized backpack sprayer was used to apply 18 gallons of spray solution per acre.

Preplant incorporated (PPI) treatments included an untreated check, an operational check of 2 lb ai/acre trifluralin, 2.4 and 4.8 qt PENDULUM, 2.8 and 5.6 oz SCEPTER and tank mixes of PENDULUM + SCEPTER and trifluralin + SCEPTER. TRI-SCEPT® herbicide, a premix product of SCEPTER + trifluralin was also tested. Postplant treatments included sequential applications of SCEPTER 60 days after 2 lb ai/acre trifluralin PPI. No surfactants were used. Experimental design was a randomized complete block with three blocks. Each treatment plot was a row of 10 measurement trees with a buffer tree on each end.

Weed control and crop injury were assessed 60, 90 and 120 days after the PPI treatments (DAT). Weed-free area and percent cover for grasses and broadleaf weeds was ocularly estimated. At 60 and 90-DAT, control of dominant weed species was assessed as cover reduction in comparison to the unsprayed area between treated strips. Individual weed species were not assessed at 120-DAT because unsprayed strips between the rows had been mown. At each assessment, the status of each tree was recorded as one of the following: normal, dead, missing, herbicide injury, animal or mechanical damage, terminal dieback (not herbicide injury), foliage and/or stem necrosis (not herbicide injury), wind damage or resprout from the root collar. If any injury was present, the severity was rated as very light (1%-5%), light (6%-35%), moderate (36%-65%), severe (66%-95%) or very severe (96%-99%). If herbicide injury was present, the symptoms were recorded. On September 25 at the end of the first growing season after treatment, crop height and groundline diameter were recorded.

The study site was part of an operational block and, with the exception of PPI herbicide treatments, operational treatments were also applied to the study area. In May, after the 60-DAT assessment, tree rows were sprayed with STINGERTM herbicide. The spray was targeted to miss the top 6 inches of the hybrid poplar terminals. In June, after the 90-DAT assessment, stump sprouts from the previous rotation were cut by mowing between the rows. One week before the 120-DAT assessment in July, weeds and stump sprouts between the rows were sprayed with a glyphosate + 2, 4-D mix using a hooded sprayer. After the 120-DAT treatment, large weeds within the planted rows were hand pulled. The hooded sprayer treatment was repeated in August.

All live trees were used to calculate mean height, groundline diameter and stem volume index, with the exception of a continuous row of six trees in one treatment plot, which were recorded as missing at the 60-DAT assessment and as resprouts at the 90-DAT assessment. These trees likely did not grow initially

due to faulty or misplaced irrigation emitters. Stem volume index was calculated separately for every tree using the formula for the volume of a cone: 1/3[(p x (Ground line diameter)2/4)] Height

WEED CONTROL

Control of main vegetation components

With the exception of the straight SCEPTER treatments, grass control was generally good (Table 1). Straight SCEPTER released barnyardgrass, resulting in 70% and 96% grass cover at 120-DAT for 2.8 oz and 5.6 oz SCEPTER, respectively. The higher SCEPTER rate controlled more broadleaf weeds, resulting in the higher level of grass cover.

Broadleaf cover on the operational trifluralin treatment was 75% at 120 days after treatment. This decreased to 52% cover with the addition of 2.8 oz/acre SCEPTER and 19% with the addition of 5.6 oz SCEPTER. PENDULUM + SCEPTER treatments also decreased broadleaf weed cover over straight trifluralin, with cover decreasing from 62% to 50% for an increase in the SCEPTER rate from 2.8 oz/acre to 5.6 oz/acre. A high rate of straight PENDULUM (4.8 qt/acre) performed well with only 35% broadleaf weed cover.

Weed-free area

Differences between treatments increased with time (Figure 1). Weed-free area for the operational trifluralin treatment was 20% at 120 days after treatment. This increased to 42% weed-free area with the addition of 2.8 oz/acre SCEPTER and 77% with the addition of 5.6 oz SCEPTER. PENDULUM + SCEPTER treatments also increased weed-free area over straight trifluralin, with 30% and 45% weed-free area for 2.8 and 5.6 oz/acre SCEPTER, respectively. The sequential SCEPTER treatments at 60 days after the preplantincorporated trifluralin treatment increased weed-free area to 29% and 48% for 2.8 and 5.6 oz/acre SCEPTER, respectively. Individual species control 90 days after PPI treatments

Russian thistle (Salsola iberica)

Both SCEPTER and PENDULUM provided some degree of control, although neither is currently labeled for control of this species (Table 2). For straight SCEPTER, the average control was 91% for both rates, with no rate response. For straight PENDULUM, there was a strong rate response with control increasing from 57% to 94% for a rate increase from 2.4 to 4.8 qt/acre. Straight trifluralin resulted in 92% control. Control increased to over 98% for 2.4 qt PENDULUM + 5.6 oz SCEPTER and for all the trifluralin + SCEPTER combinations (Figure 2).

Nightshade (Solanum sp.) For straight SCEPTER, control increased from 87% to 92% as rate increased from 2.8 to 5.6 oz/acre. PENDULUM at 2.4 oz/acre provided little control, but 4.8 oz/acre provided 63% control. Straight trifluralin did not control nightshade. For SCEPTER tank mixes with trifluralin or PENDULUM, control increased from over 70% for 2.8 oz/acre to over 94% for 5.6 oz/acre SCEPTER (Figure 2). The sequential applications of SCEPTER following trifluralin PPI were not as successful, with control increasing from 22% to 52% as SCEPTER rate increased from 2.8 to 5.6 oz/acre.

Lambsquarters (Chenopodium sp.)

For straight SCEPTER, control increased from 57% to 88% for a rate increase from 2.8 to 5.6 oz/acre. For straight PENDULUM, control increased from 67% to 99% for a rate increase from 2.8 to 5.6 oz/acre. Over 97% control was achieved from straight trifluralin, the trifluralin + SCEPTER tank mixes, and PENDULUM + 5.6 oz SCEPTER (Figure 2).

Smartweed (Polygonaceae sp.)

Control increased from 75% for straight trifluralin, to 88% for trifluralin + 2.8 oz/acre SCEPTER, to 100% for trifluralin + 5.6 oz/acre SCEPTER. For SCEPTER + PENDULUM, control was <50%. Smartweed did not occur uniformly over the study area and additional testing is required to verify the treatment differences noted in this study.

Barnyardgrass (Echinochloa crus-galli)
Barnyardgrass was controlled on all the plots with the exception of straight SCEPTER, which released this species. The grass grew vigorously from the water emitters at the base of the hybrid poplar. This resulted in severe competition for the crop trees. PENDULUM, trifluralin and tank mixes with SCEPTER controlled barnyardgrass.

The study site was sprayed with an operational STINGER herbicide (clopyralid) treatment in May, between the 60- and 90-DAT assessments. STINGER controls a narrow spectrum of weeds and is used in hybrid poplar management for selective control of thistles (Cirsium spp). STINGER does not control Russian thistle (Salsola iberica), lambsquarters or barnyardgrass, three of the dominant competitors in the study area. STINGER is labeled for control of some nightshade species and for suppression of green smartweed. However, there were noticeable differences between study treatments for nightshade and smartweed control, so the overall impact of STINGER on the study was small.

HYBRID POPLAR RESPONSE

Injury

At the 60-DAT assessment, 60% of the sprouts had foliar damage characterized as leaf curling and black margins. This was not related to herbicide treatment and was likely due to 50-mph winds experienced during the first few weeks of growth.

Herbicide symptoms were evident at the 90- and 120-DAT assessments on trees that received over-the-top SCEPTER applications 60 days after the PPI trifluralin treatment. Symptoms included shortened internodes and bushier crowns. Only three other trees were recorded with light herbicide injury.

Injury characterized as foliage desiccation was evident on 74 trees at the 120-DAT assessment. This was due to severe weed competition resulting in the crop trees receiving insufficient water. Desiccated trees were restricted to the untreated check (26 trees), straight SCEPTER at 2.8 and 5.6 oz/acre (25 and 18 trees, respectively) and straight PENDULUM at 2.4 and 4.8 qt (4 trees and 1 tree, respectively).

Most of the trees recorded as missing or dead at the 60-DAT treatment had started to sprout by the 90-DAT assessment. At the final assessment, there were 10 missing or dead trees in the untreated check (33%) and 7 in the 2.8 oz straight SCEPTER treatment (23%). No more than two missing or dead were recorded for any other treatment (Table 3).

Tree Growth

Hybrid poplar responded to the increased weed control provided by tank mixes of trifluralin + SCEPTER or PENDULUM + SCEPTER. On a percentage basis, groundline diameter responded more than height. Groundline diameter response to the preplant tank mixes over straight trifluralin ranged from 0.2 to 0.5 inches (10% to 30%), while height response ranged from -0.2 to 0.7 feet (-1% to 5%). Stem volume index response of the tank mixes over straight trifluralin ranged from 24 to 101 cubic inches (16% to 68%) (Table 4 and Figure 3).

For both trifluralin + SCEPTER and PENDULUM + SCEPTER tank mixes, there were positive groundline diameter growth responses to a SCEPTER rate increase. For tank mixes with 2.4 qt/acre PENDULUM, stem volume index increased 29% for a SCEPTER rate increase from 2.8 to 5.6 oz/acre (Figure 3). For tank mixes with 2 lb ai/acre trifluralin, stem volume index increased 15% for a SCEPTER rate increase from 2.8 to 5.6 oz. Rate responses for SCEPTER, PENDULUM and trifluralin were all statistically significant with no interaction between the rates (Appendix A). The high rate of straight PENDULUM (4.8 oz/acre) performed well with a stem volume index 27% greater than the operational 2 lb ai/acre trifluralin treatment.

When SCEPTER was applied as a sequential treatment, following a PPI trifluralin treatment, shortening of the internodes was noted at the 90- and 120-day assessments (30 and 60 days after the sequential SCEPTER treatment). At the end of the growing season, suppressed height growth was still evident but

diameter growth responded positively. There was a 39% increase in stem volume index for a sequential application of 5.6 oz/acre SCEPTER following an operational trifluralin treatment.

Growth on the check plots and straight SCEPTER treatments was severely impacted by weed competition. Hand pulling of weeds occurred after the last weed cover assessment and was limited to the most prolific weeds, including the untreated check plots and barnyardgrass on the straight SCEPTER plots. Without this operation, mortality levels and suppression would have been higher on these plots. Overall, hybrid poplar stem growth correlated well with weed control levels at 120-DAT (Figure 4).

CONCLUSION

Preplant incorporated tank mix treatments of SCEPTER 70 DG herbicide + trifluralin or SCEPTER 70 DG + PENDULUM 3.3 EC herbicide improved weed control and resulted in substantial hybrid poplar growth responses over the standard treatment of trifluralin. Increasing the rate of SCEPTER in the tank mix from 2.8 to 5.6 oz/acre resulted in improved weed control that translated into improved tree growth. Differences in weed control between 2.8 and 5.6 oz/acre increased with time. The best treatment was 5.6 SCEPTER + 2 lb ai/acre trifluralin. This treatment resulted in trees at the end of the first growing season with an average height over 13 feet and an average groundline diameter over 2.3 inches. Stem volume growth was 68% greater than the standard trifluralin treatment.

Future work in the region includes testing SCEPTER tank mixes at the start of the site preparation season in November or December. Different incorporation techniques should also be explored because herbicide performance can improve markedly with a shallow, uniform incorporation.

Table 1. Weed cover for main vegetation categories and weed-free area at 60, 90 and 120 days after the preplant incorporated treatments. Due to overlapping crowns, grass cover plus broadleaf cover plus weed-free area may add to more than 100%.

	Grass and sedge			Broadleaf weeds			Weed-free area		
	60	90	120	60	90	120	60	90	120
Treatment	DAT	DAT	DAT	DAT	DAT	DAT	DAT	DAT	DAT
	.....% cover.....			.....% cover.....			.....% cover.....		
Trifluralin									
2lb ai/acre	1	2	5	13	40	75	87	60	20
PENDULUM + SCEPTER									
2.4 qt/acre + 2.8 oz/acre	1	1	8	5	18	62	95	82	30
2.4 qt/acre + 5.6 oz/acre	1	1	7	2	10	50	97	91	45
Trifluralin + SCEPTER									
2lb ai/acre + 2.8 oz/acre	1	4	8	2	13	52	96	83	42
2lb ai/acre + 5.6 oz/acre	0	1	4	1	3	19	99	97	77
Trifluralin + SCEPTER 60 days later									
2 lb ai/acre + 2.8 oz/acre	1	1	4	28	45	68	72	55	29
2 lb ai/acre + 5.6 oz/acre	1	0	6	20	22	50	80	78	48
TRI-SCEPT									
37.2 oz	1	3	2	6	17	45	94	83	53
74.4 oz	1	1	15	2	4	27	98	94	60
PENDULUM 3.3 EC									
2.4 qt	2	2	37	20	45	60	79	53	7
4.8 qt	2	2	5	8	27	35	91	73	60
							92		
SCEPTER 70 DG									
2.8 oz	7	75	70	7	17	43	88	17	0
5.6 oz	9	63	96	4	13	7	88	28	4
							89		
Untreated check	4	37	92	58	73	37	40	3	0

PENDULUM = PENDULUM 3.3 EC (2.4 qt = 2 lb ai pendimethalin)
SCEPTER = SCEPTER 70 DG (2.8 oz = 0.125 lb ae imazaquin)
TRI-SCEPT = Premix of imazaquin and trifluralin (37.2 oz = 0.125 lb imazaquin + 0.75 lb trifluralin)

Table 2. Percent control with respect to unsprayed strips for the most common weed species on the study site. The assessment was 90 days after the preplant incorporated treatments.

Treatment	Russian thistle	Nightshade	Lambsquarters	Smartweed
	.....% control.....	.....% control.....	.....% control.....	.....% control.....
Trifluralin				
2 lb ai/acre	92	0	97	75
PENDULUM + SCEPTER				
2.4 qt/acre + 2.8 oz/acre	90	80	92	50
2.4 qt/acre + 5.6 oz/acre	98	94	98	45
Trifluralin + SCEPTER				
2 lb ai/acre + 2.8 oz/acre	99	72	99	88
2 lb ai/acre + 5.6 oz/acre	100	95	100	100
Trifluralin + SCEPTER 60 days later				
2 lb ai/acre + 2.8 oz/acre	98	22	83	97
2 lb ai/acre + 5.6 oz/acre	100	52	92	90
TRI-SCEPT				
37.2 oz	94	74	100	70
74.4 oz	100	68	100	98
PENDULUM 3.3 EC				
2.4 qt	57	3	67	50
4.8 qt	94	63	99	80
SCEPTER 70 DG				
2.8 oz	97	87	57	23
5.6 oz	85	92	88	50

Table 3. Number of missing or dead trees by treatment at each assessment.

	60 DAT	90 DAT	120 DAT	Final
	...Number of trees...	...Number of trees...	...Number of trees.....	...Number of trees...
Trifluralin				
2 lb ai/acre	1	0	0	1
PENDULUM + SCEPTER				
2.4 qt/acre + 2.8 oz/acre	5	0	0	0
2.4 qt/acre + 5.6 oz/acre	3	1	1	1
Trifluralin + SCEPTER				
2 lb ai/acre + 2.8 oz/acre	1	1	1	1
2 lb ai/acre + 5.6 oz/acre	4	1	1	2
Trifluralin + SCEPTER 60 days later				
2 lb ai/acre + 2.8 oz/acre	3	1	1	1
2 lb ai/acre + 5.6 oz/acre	3	1	1	1
TRI-SCEPT				
37.2 oz	2	0	0	1
74.4 oz	4	0	0	0
PENDULUM 3.3 EC				
2.4 qt	3	0	0	0
4.8 qt	0	0	0	0
SCEPTER 70 DG				
2.8 oz	2	2	3	7
5.6 oz	2	1	1	2
Untreated check	6	3	4	10

Numbers do not include a continuous row of six trees in one treatment plot that were recorded as missing at the 60-DAT assessment and as resprouts at the 90-DAT assessment (rep C, plot 10). These trees likely did not grow initially due to faulty or misplaced irrigation emitters.

Figure 1. Weed-free area at 60, 90 and 120 days after PPI treatments.

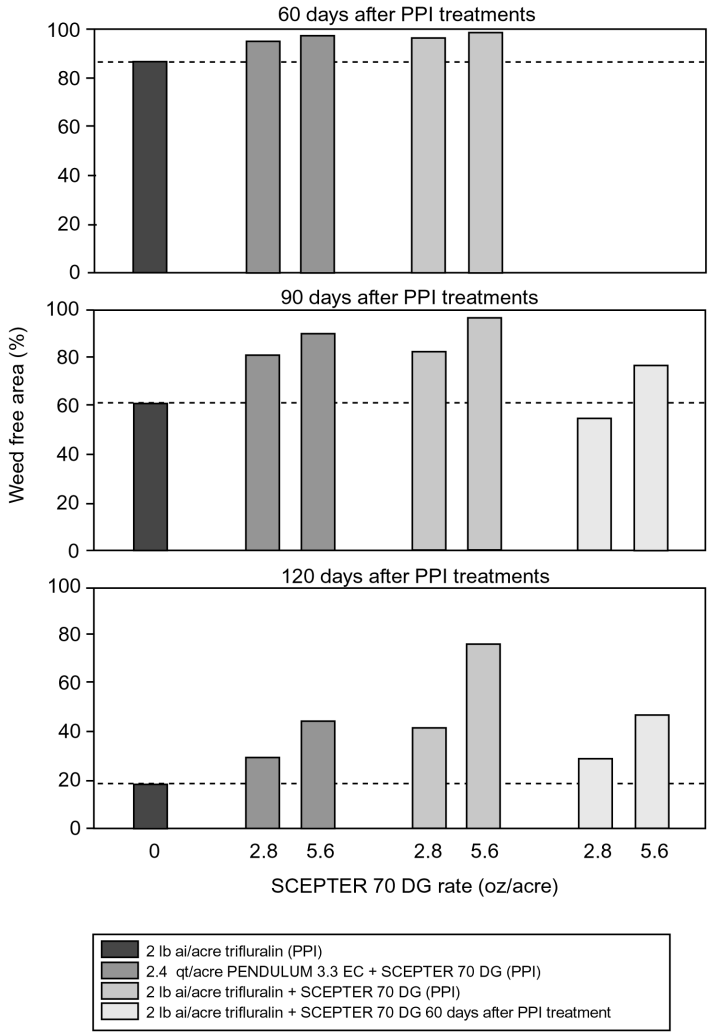

Figure 2. Percent control with respect to the unsprayed strips for the most common weed species. The assessment was 90 days after the PPI treatments.

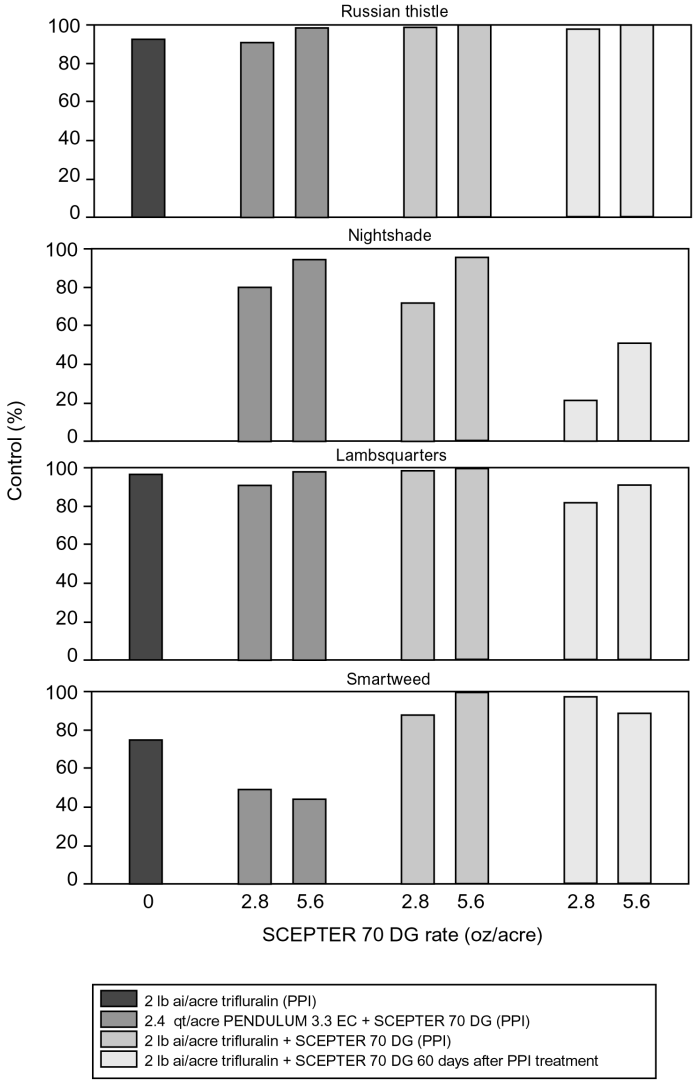

Figure 3. Hybrid poplar stem volume index at the end of the first growing season.

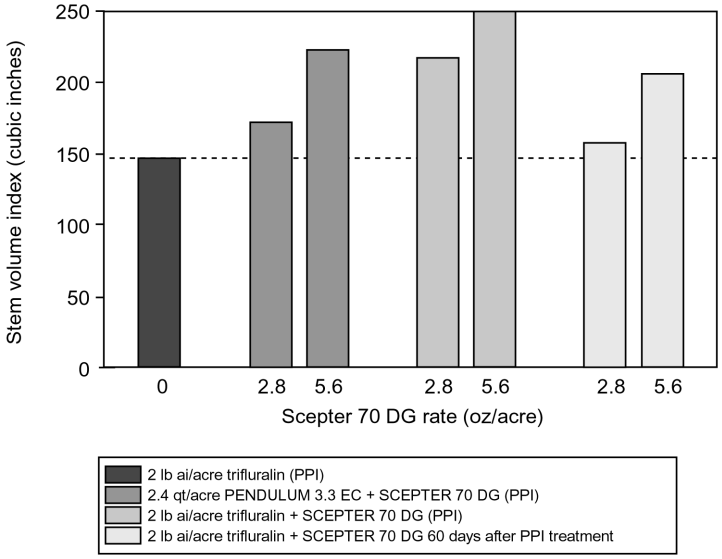

Figure 4. Relationship between hybrid poplar stem volume index at the end of the first growing season and weed-free area 120 days after PPI treatments.