Ground Ivy (*Glechoma hederacea* L.) Control in a Kentucky Bluegrass Turfgrass with Borax[1]

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Abstract

Field experiments were conducted to evaluate ground ivy (*Glechoma hederacea* L.) control and Kentucky bluegrass (*Poa pratensis* L.) tolerance to Twenty Mule Team Borax, Super Trimec, and Sharpshooter applications. Ground ivy control improved with time in 1991 whereas the inverse was true in 1992. Liquid borax at 610 g/100m^2 and Super Trimec at 560 ml/100m^2 controlled ground ivy consistently (≥85%) during 1991 and 1992. Ground ivy control with dry borax was not as good as liquid borax when each application was applied at 305 g/100m^2. Unacceptable ground ivy control occurred with Sharpshooter. All treatments caused turfgrass injury in 1991. At 4 weeks after treatment (WAT), injury increased to 30 and 40% for the 305 and 610 g/100 m^2 (10 and 20 oz/1000 ft$^{2)}$ liquid borax treatments, respectively. No turfgrass injury however was observed the following spring. In 1992, only Sharpshooter caused injury 2 WAT. Weather differences after the applications contributed to the variability in ground ivy control and turfgrass injury between years. These results indicate that boron can be used to selectively control ground ivy in a Kentucky bluegrass turf with a 610 g/100 m^2 (20 oz/1000 ft^2) liquid borax application with only temporary turfgrass injury.

Index words: weed control, boron toxicity, creeping charlie, phytotoxicity.

Chemicals used in this study: Super Trimec [2,4-D + dicamba + dichlorprop ((2,4-dichlorophenoxy)acetic acid + 3,6-dichloro-2-methoxybensoic acid + (±)-2-(2,4-dichlorophenoxy)propanoic acid)]; Twenty Mule Team Borax (sodium tetraborate); Sharpshooter (saturated fatty acids of potassium salts).

Significance to the Nursery Industry

Ground ivy (*Glechoma hederacea* L.) is an invasive, creeping perennial that is difficult to control weed in a cool-season turfgrass. Research indicates that borax can be used to selectively control ground ivy in a cool-season turfgrass with only minor and temporary injury to the grass. A late spring application of 610 g/100 m^2 (20 oz/1000 ft^2) liquid Twenty Mule Team Borax provided acceptable and consistent ground ivy control and was comparable to a standard herbicide application of Super Trimec. The lack of injury to other broadleaf plants within the turfgrass plots suggests that at the borax rates used in the experiment, only minor injury will occur to most other broadleaves present in the application area. Research should be conducted in order to evaluate the effects on ornamentals and turfgrasses, from single and multiple borax applications of 610 g/100 m^2 (20 oz/1000 ft^2).

Introduction

Borax (sodium tetraborate) was used as a herbicide as early as 1926 when Thompson and Robbins tried to use borax and boric acid to eradicate common barberry (*Berberis vulgaris* L.) (19). Generally, high applications (25,000 to 70,000 g/100 m^2 (800 to 2400 oz/1000 ft^2)) were required to destroy fire-hazardous and unsightly vegetation (12) and to prevent weeds from growing through asphalt (20). Kaudy et al. (11) reported the use of borax in sugar beets (*Beta vulgaris* L.) to selectively control weeds.

The physiological action of boron in plants is likely the herbicidal mode of action for borax (5). In general, monocotyledons are more tolerant of boron than dicotyledons (1). However, species sensitivity to boron varies greatly, and often the concentration range between boron deficiency and toxicity is narrow (1, 2, 6, 9). Boron accumulates via movement in the transpiration stream resulting in toxicity symptoms initially along leaf tips and margins in the leaves (9, 13). Yet, the amount of boron accumulated in a plant does not correlate with boron sensitivity (4). Oertli and Kohl (15) suggested that boron tolerance was a function of the boron accumulation rate and the ability to localize excess boron instead of differential tissue tolerance to boron. Therefore one would expect the rate of boron accumulation and subsequent tolerance to be dependant upon the rate of uptake by roots and transpiration rate. Tanaka (18) showed that monocotyledon roots absorb less boron than dicotyledon roots. Such results may explain the suggestion by Robbins et al. (17) that borax was invaluable in treating broadleaf weeds on grass ranges.

Ground ivy is an invasive creeping perennial, native to Europe, that was brought to the United States and Canada by early settlers (14). It has a number of colloquial names including: cat's foot, creeping charlie, creeping jenny, gill-over-the-ground, and turnhoof (14). Ground ivy is very difficult to control and thrives in shady, moist conditions. It is commonly found throughout the eastern United States, from Maine to North Dakota and south to Georgia and Kansas, and as far west as Colorado (10). No research has investigated the sensitivity of ground ivy to boron in comparison to a cool-season turfgrass.

The first report suggesting selective control with borax occurred in 1941 when common foxtail (*Hordeum murinum* L.) survived a borax application of 7,000 g/100 m^2 (80 oz/1000 ft^2) (2). Research by Oertli et al. (16) further suggested that selective broadleaf weed control in grasses can be obtained with borax. They showed that grasses had little decline in vigor and negligible boron toxicity symptoms when

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Table 1. **Herbicide rates and method of application used in 1991 and 1992.**

Herbicide	Rate		Application method
	g/100 m²	oz/1000 ft²	
Twenty Mule Team Borax (sodium tetraborate)	153	5	Liquid[z]
	305	10	Liquid
	610	20	Liquid
	610	20	Granular
	(ml/100 m²)		
Super Trimec (2,4-D + dicamba + dichlorprop)	560	1.1	Liquid
Sharpershooter (saturated fatty acids of potassium salts)	ready to use		Liquid

[z]Liquid applications with Twenty Mule Team Borax were made by dissolving granules in water.

frequent clipping was conducted. The objective of this research was to evaluate the selectivity of borax in a cool-season turfgrass for ground ivy control.

Materials and Methods

Ground ivy control experiments were conducted at two Ames, Iowa, locations that had large, uniform, and dense ground ivy populations. The low maintenance Kentucky bluegrass (*Poa pratensis* L.) sites received no herbicide, fertilizer, or additional water. The grass was mowed as needed at a 6.4 cm (2.5 in) height and clippings were returned. The soil type was a Clarion-Nicollet-Webster, Harps loam, Okoboji clay soil with 6.6% organic matter and a pH of 7.8.

Herbicide applications were made June 18, 1991, and May 29, 1992. Six herbicide treatments and an untreated control were included; Twenty Mule Team Borax (sodium tetraborate) at 153, 305, and 610 g/100 m² (5, 10, and 20 oz/1000 ft²); Super Trimec (2,4-D + dicamba + dichlorprop) at 560 ml/100 m² (1.1 oz/1000 ft²); and Sharpshooter (saturated fatty acids of potassium salts), a ready to use contact herbicide (Table 1). All borax treatments were liquid applications except for 610 g/100 m² (20 oz/1000 ft²) which was also applied as a granule. Borax liquid applications were made after granules were dissolved in 118 ml (4 oz) of hot water and diluted to a final spray volume of 10.2 liter/100 m² (2.5 gal/1000 ft²). All spray applications were made with a hand-held CO_2-pressurized sprayer at 172 kPa (25 psi) equipped with a three-flat-fan nozzle (TeeJet 8002 VS flat-fan nozzle tip, Spraying Systems Co., Wheaton, IL 60188) boom. Sharpshooter was applied on a spray-to-wet basis. Percent control and injury ratings were taken 4, 8, and 40 weeks after treatments (WAT). Ratings were based on 0 = no control or no injury and 100 = plant death.

Experiments were designed as randomized complete blocks with three replications. Data were subjected to analysis of variance and means were separated by Fisher's protected least significant difference procedure at $P < 0.05$, where appropriate. Visual injury ratings were analyzed as percentages and as transformed (arcsin \ $\sqrt{x}$) percentages. Transformation did not affect the results and untransformed data are presented.

Results and Discussion

Weed control. Preliminary greenhouse experiments showed that ground ivy was extremely sensitive to borax applications compared with cool-season grasses and other broadleaf weeds that are commonly found in landscapes (data not reported). In the field, ≥85% control occurred 4 WAT with liquid borax applied at 305 and 610 g/100 m² (10 and 20 oz/1000 ft²) in 1991 whereas in 1992, only liquid borax

Table 2. **Visual ground ivy control ratings as influenced by year, herbicide treatment and time after application.**

Treatment[z]	Rate		1991			1992		
	g/100 m²	oz/1000 ft²	2WAT[z]	4 WAT	Spring	2 WAT	4 WAT	Spring
			%					
Liquid borax	153	5	73	68	98	87	55	70
	305	10	80	93	93	90	80	70
	610	20	92	97	100	93	90	85
Super Trimec	560	1.1	95	72	100	67	83	85
Dry borax	610	20	57	52	94	50	47	53
Sharpshooter[y]			30	17	63	63	23	33
LSD (0.05)			18	24	37	28	46	29

[z]Abbreviation WAT = weeks after treatment.
[y]Sharpshooter applied as a spray-until-wet basis.

Table 3. **Monthly total precipitation, average high and low temperature.**

Month	1991 Rainfall[z]	High	Low	1992 Rainfall	High	Low
	mm (in)	C (F)	C (F)	mm (in)	C (F)	C (F)
May	132 (5.2)	22 (71)	13 (56)	254 (1.0)	24 (75)	10 (49)
June	107 (4.2)	29 (84)	18 (64)	15 (0.6)	26 (78)	14 (57)
July	46 (1.8)	30 (85)	17 (63)	259 (10.2)	24 (75)	16 (60)
August	94 (3.7)	27 (81)	16 (60)	56 (2.2)	25 (76)	12 (54)
September	61 (2.4)	24 (75)	11 (52)	104 (4.1)	22 (71)	11 (51)
October	84 (3.3)	18 (64)	4 (39)	13 (0.5)	18 (64)	4 (39)
November	71 (2.8)	2 (35)	−7 (20)	117 (4.6)	4 (38)	−3 (27)

[z]Rain and snow that was melted prior to measurements.

at 610 g/100 m^2 (20 oz/1000 ft^2) provided acceptable control (Table 2). Liquid borax applied at 305 and 610 g/100 m^2 (10 and 20 oz/1000 ft^2) demonstrated better ground ivy control through 4 WAT by approximately 25% in comparison with the 610 g/100 m^2 (20 oz/1000 ft^2) dry application. These results support previous research that showed greater boron concentrations in leaf tissue from foliar applications compared with soil applications (7).

Ground ivy control improved with time in 1991 whereas the inverse was true in 1992. Average ground ivy control increased from 72 to 91% in 1991 (LSD 0.05 = 7) and from 75 to 66% in 1992 (LSD 0.05 = 7). All borax treatments and Super Trimec provided >90% ground ivy control the spring following the 1991 applications whereas only liquid borax and Super Trimec controlled ground ivy (85%) the spring following the 1992 applications. This variation may have resulted from weather differences after application (Table 3). Boron availability is increased by good soil moisture conditions (8). Many plants will withstand more boron during cooler weather as opposed to warm, humid conditions (3).

Early borax injury symptoms consisted of ground ivy leaf margin necrosis that proceeded inward towards the petiole. Only petioles and stem tissue remained green from the 610 g/100 m^2 (20 oz/1000 ft^2) liquid borax treatment at 2 WAT. No other plant species were controlled with borax. Temporary leaf margin chlorosis was observed on dandelions (*Taraxacum officinale* Weber), white clover (*Trifolium repens* L.), and broadleaf plantain (*Plantago major* L.); whereas Super Trimec provided acceptable control of these weeds (data not shown).

Turfgrass tolerance. All treatments caused bluegrass leaf tip necrosis from 1 to 6 WAT (data not shown). In 1991, liquid borax at 305 and 610 g/100 m^2 (10 and 20 oz/1000 ft^2) caused approximately 35% injury when compared to the untreated control at 4 WAT, whereas in 1992, only Sharpshooter injured bluegrass at 2 WAT (Table 4). Weather differences between the two years were considered responsible for the observed variations. Hot, dry weather in 1991 may have accentuated bluegrass injury. Previous research suggests that frequent mowing alleviates leaf tip necrosis even during periods of slowed growth presumably by removing excess boron (16).

Liquid borax applied at 610 g/100 m^2 (20 oz/1000 ft^2) provided consistent ground ivy control. The control was acceptable (>80%) when treated with liquid borax at ≤305 g/100 m^2 (10 oz/1000 ft^2) and dry borax at 610 g/100 m^2 (20 oz/1000 ft^2) in 1991 but not 1992. The decrease in ground ivy control after the 1992 applications with borax and espe-

Table 4. **Visual turfgrass injury ratings as influenced by year, herbicide treatment and time after application.**

Treatment[z]	Rate g/100 m^2	Rate oz/1000 ft^2	1991 2WAT[z]	1991 4 WAT	1991 Spring	1992 2 WAT	1992 4 WAT	1992 Spring
			%					
Liquid borax	153	5	3	10	5	0	2	0
	305	10	18	30	12	0	2	0
	610	20	13	40	10	0	0	0
Super Trimec	560	1.1	10	8	2	8	15	0
Dry borax	610	20	13	18	12	0	0	0
Sharpshooter[y]			10	17	8	23	10	0
LSD (0.05)			NS	22	NS	22	NS	NS

[z]Abbreviation WAT = weeks after treatment.
[y]Sharpshooter applied as a spray-until-wet basis.

cially the dry borax, demonstrate how precipitation and temperature can affect boron availability to ground ivy. These results indicate that boron can provide good/acceptable ground ivy control, but that it can cause discoloration that can persist for 6 weeks in Kentucky bluegrass.

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