Tolerance of Supina Bluegrass to Pre and Post-Emergence Herbicides[1]

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Abstract

Supina bluegrass (*Poa supina*) is being increasingly used for shaded lawns and golf course tees due to its excellent shade tolerance. The herbicide tolerance, however, is undocumented because herbicide use on amenity turfs is banned in the European countries where supina bluegrass has been used for over 30 years. Several commonly used turf and ornamental herbicides are capable of harming or eradicating close relatives of supina bluegrass. In particular, Prograss (Ethofumesate) is used to selectively remove annual bluegrass (*Poa annua*) from mixed turf stands. Supina bluegrass is a putative ancestor of annual bluegrass and may have similar susceptibilities to chemicals. Fifteen pre and postemergence turf and ornamental herbicides were tested for their potential to damage or kill a mature stand of supina bluegrass. Field trials were conducted twice over two growing seasons. Herbicides with the active ingredients triclopyr, MCPP, quinclorac, and ethofumesate caused temporary phytotoxicity in at least one of the two years. Fall applications of Prograss (Ethofumesate) and Turflon Ester (Triclopyr) caused phytotoxicity the spring following autumn application in both years, while Strike 3 (Dicamba, MCPP, 2,4-D) and Confront (Triclopyr + Clopyralid) caused phytotoxicity in one year only. None of the compounds showed potential for selectively removing supina bluegrass from a mixed turf stand.

Index words: turf quality, phytotoxicity, chlorophyll fluorescence.

Herbicides used in this study: Acclaim Extra (Fenoxaprop-ethyl), +-ethyl2-[4-[(6-chloro-2-benzoxazolyl)oxy]phenoxy]propanoate; Banvel (Dicamba), 3,6-dichloro-o-anisic acid; Barricade (Prodiamine), N3,N3-Di-n-propyl-2,4-dinitro-6-(trifluoromethyl)-m-phenylenediamine; Confront (Triclopyr and Clopyralid), 3,5,6-trichloro-2-pyridinyloxyacetic acid and 3,6-dichloro-2-pyridinecarboxylic acid; Dimension (Dithiopyr), 3,5-pyridinedicarbothioic acid, 2-(difluoromethyl)-4-(2-methylpropyl)-6-(trifluoromethyl)-S,S-dimethyl ester; Drive (Quinclorac), 3,7-dichloro-8-quinolinecarboxylic acid; Lontrel (Clopyralid), 3,6-dichloro-2-pyridinecarboxylic acid; Manage (Halosulfuron), methyl5-{[(4,6-dimethyl-2-pyrimidinyl)amino]carbonylaminosulfonyl}-3-chloro-1-methyl-1-H-pyrazole-4-carboxylate; MCPP 4K (MCPP), 2-(2-methyl-4-chlorophenoxy) propionic acid; MSMA Turf (MSMA), monosodium acid methanearsonate; Prograss (Ethofumesate), 2-ethoxy-2,3-dihydro-3,3-dimethyl-5-benzofuranyl methanesulfonate; Strike 3 (2,4-D; MCPP; Dicamba), 2,4-dichlorophenoxy acetic acid, 2-(2-methyl-4-chlorophenoxy propionic acid), 3,6-dichloro-o-anisic acid; 2,4-D LV4 (2,4-D), 2,4-dichlorophenoxy acetic acid; Tupersan (Siduron), 1-(2-methylcyclohexyl)-3-phenylurea; Turflon (Triclopyr), 3,5,6-trichloro-2-pyridinyloxyacetic acid.

Significance to the Nursery Industry

Supina bluegrass is a relatively new turfgrass species which is well-suited to damp, shaded environments. Its use has grown from zero to several tons of seed per annum in the United States since 1990. Supina bluegrass is being increasingly used for shaded lawns and golf course tees yet there are no peer-reviewed data indicating its tolerance to commonly used turf and ornamental herbicides. The project describes a two-year study conducted to evaluate supina bluegrass tolerance to a variety of commonly used pre and post-emergence turf and ornamental herbicides. Several of the herbicides, notably Prograss and Turflon Ester, caused short-term phytotoxicity but no herbicide caused long-term damage. Future investigations are needed to determine a herbicide treatment that will selectively remove supina bluegrass from a mixed turf stand.

Introduction

Supina bluegrass (*Poa supina* Schrad.) is a cool-season turfgrass native to the European Alps (2). Found naturally in high traffic areas (human and cattle paths), supina bluegrass has been used in Europe as a turf for over 30 years (2, 11). Supina bluegrass is a stoloniferous turfgrass with the ability to form a dense turf at low mowing heights (8). In northern areas of the United States and Canada, supina bluegrass is being increasingly used for athletic fields due to its apparent cold tolerance and recuperative abilities; since 1990, seed sales of supina bluegrass in North America have risen from zero to several tons annually. In addition, supina bluegrass thrives in moist, densely shaded environments making it a prime candidate for shaded lawns and golf course tees (15).

Information concerning the effects of herbicides on supina bluegrass is needed so management practices for supina bluegrass can be developed. Since herbicide use on amenity turfgrasses is prohibited in Germany and Austria, where supina bluegrass has primarily been used outside of the United States, there is no documented information on herbicide tolerance. Prograss (Ethofumesate) was of particular interest as Prograss is used both pre and post-emergence to eradicate annual bluegrass (*Poa annua* L.) (1). Since supina bluegrass appears to be a 'parent' or close relative of annual bluegrass (6), their susceptibilities to chemicals may be similar. The objective of our research was to determine which pre and post-emergence herbicides are safe for use on an established stand of supina bluegrass.

Materials and Methods

Plots were established from supina bluegrass (*Poa supina* Schrad.) 'Supranova' seed (96 kg/ha; 2 lb 1000/sq ft) in June 1998 at the O.J. Noer Turfgrass Research Station in Verona, WI. The soil type was a Troxel silt loam with a 6.3 pH and medium-high phosphorus and potassium levels (129 kg/ha

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and 442 kg/ha, or 115 and 395 lb/A, resp.). Plots were mowed three times weekly with a reel mower at 3.8 cm (1.5 in) without clipping removal. Turf was irrigated weekly to replenish 100% of the moisture lost to evapotranspiration rate (ET). ET rates were based on local weather data. Turf was fertilized with an 18–3–18 fertilizer containing 5.0% ammoniacal nitrogen, 2.1% urea nitrogen, 4.9% slowly available water soluble nitrogen in the form of methylene ureas, and 6.0% water insoluble nitrogen. Fertilizer was applied at a rate of 48 kg N/ha (1 lb N 1000/sq ft) in late May, early July, and late October, with 24 kg N/ha (0.5 lb N 1000/sq ft) applied during early September in each year. Plots were irrigated with 1.2 cm (0.5 in) water within 24 hr of fertilization. Plots received no traffic other than routine maintenance. No pesticides other than those used for treatments were applied at any time during establishment or the trial period.

The 2.5 sq m (28 sq ft) plots were arranged in a randomized complete-block design with four replications. Fifteen commercially available broadleaf and grass herbicides were applied in mid-October and mid-May following full spring greenup for comparison to untreated turf. Treatments began autumn 1999 and were repeated during 2000–2001. All herbicides were applied at the median label rate with the exception of Prograss. Prograss was applied at both a low (0.858 kg ai/ha (0.776 lb ai/A)) and high rate (1.716 kg ai/ha (1.532 lb ai/A)) using three label treatment strategies for annual bluegrass control: fall only, spring only, and a fall plus spring application. Treatments were applied in 817 liters H_2O/ha (2 gal 1000/sq ft) using a CO_2 backpack sprayer equipped with 8004XR flat fan nozzles (Teejet, Minneapolis, MN). The sprayer was rinsed with approximately 2 liters (0.5 gal) of H_2O between treatment applications to avoid potential contamination among treatments.

Turf evaluations were made pre-treatment and weekly for a period up to four weeks after treatment. Plots were rated visually according to turf color (1 = yellow/brown, 9 = dark green; 6 = acceptable), turf quality (1 = necrotic turf or bare soil, 9 = dense, uniform turf; 6 = acceptable), turf density (0–100% ground cover), weed percentage (0–100% of vegetation), and phytotoxicity (1 = no burn; 5 = necrotic turf). Turf quality ratings represented the overall appearance and homogeniety of a specific plot. This rating was derived by assessing turf color (25%), turf density (25%), and aesthetic appearance and uniformity (50%). Phytotoxicity ratings were based on turf appearance with 1 = no burn, 2 = leaf tip burn, 3 = 50% necrosis, 4 = 80% necrosis, and 5 = 100% necrotic turf. All plots treated in autumn also received a winter recovery rating. Phytotoxicity was rated for the first three weeks following winter snow melt with turf color ratings collected during the fourth and fifth weeks following snow melt.

In 2000, chlorophyll fluorescence measurements were collected from turf of selected treatments three days after the fall herbicide applications. Chlorophyll fluorescence is useful for determining photosynthetic efficiencies of plants and has been used to detect stresses caused by herbicide application in some broadleaf plant species (12). Measurements were collected *in situ* with a modulated chlorophyll fluorometer (Model OS5, Opti-Sciences, Tyngsboro, MA) from five subsamples in each plot. Each subsample consisted of four leaves, each from a separate plant, taped side-by-side and dark-acclimated for five minutes using a fluorometer leaf clip. An actinic light pulse was used to saturate the photosystems and the resulting Fv:Fm ratio was used to compare photosynthetic efficiencies of the turf across treatments (9).

Data were subjected to one-way ANOVA to determine if significant treatment effects existed (10). Fisher's protected

Table 1. Pre- and post-emergence herbicides tested for phytotoxicity to supina bluegrass (Verona, WI, 1999–2001).

Trade name	Common name	Type of use	Rate kg ai/ha (lb ai/A)	Phytotoxicity[z]
Spring-applied herbicides[y]				
Prograss	Ethofumesate	Pre and post-emergence	0.858 (0.776)	np
Prograss	Ethofumesate	Pre and post-emergence	1.716 (1.532)	np
Dimension	Dithiopyr	Pre-emergence	0.426 (0.38)	np
Barricade	Prodiamine	Pre-emergence	0.728 (0.65)	np
Tupersan	Siduron	Pre-emergence	22.9 (20.4)	np
MSMA Turf	MSMA	Pre-emergence	2.3 (2.6)	(+)
Acclaim Extra	Fenoxaprop-ethyl	Pre-emergence	0.104 (0.093)	np
Drive[x]	Quinclorac	Pre and post-emergence	0.84 (0.75)	(+)
Fall-applied herbicides[w]				
Prograss	Ethofumesate	Pre and post-emergence	0.858 (0.776)	+[v]
Prograss	Ethofumesate	Pre and post-emergence	1.716 (1.532)	++[v]
MCPP 4K	MCPP	Post-emergence	2.67 (2.38)	+
2,4D LV4	2,4-D	Post-emergence	1.06 (0.95)	np
Banvel	Dicamba	Post-emergence	0.7 (0.625)	np
Lontrel	Clopyralid	Post-emergence	0.34 (0.3)	np
Strike 3	2,4-D, MCPP, dicamba	Post-emergence	1.62 (1.45)	+
Turflon	Triclopyr	Post-emergence	0.84 (0.75)	+
Confront	Triclopyr, Clopyralid	Post-emergence	0.63 (0.56)	+
Manage	Halosulfuron	Post-emergence	0.05 (0.045)	np

[z]Rating scale was as follows: np = no phytotoxicity, (+) = lighter green turf but no necrosis, + = mild phytotoxicity (<10% damage), ++ = moderate phytotoxicity (10–50% damage), +++ = severe phytotoxicity (>50% damage).

[y]Applied on May 10, 2000, and May 11, 2001.

[x]Tested with and without methylated seed oil.

[w]Applied on October 18, 1999, and October 17, 2000.

[v]Phytoxicity occurred in the spring following application, not in the fall.

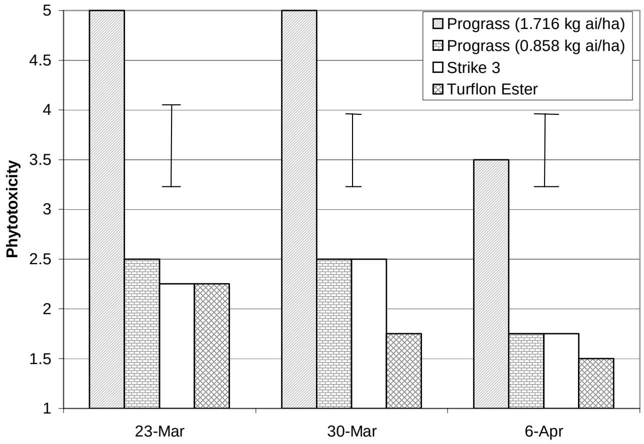

Fig. 1. **Chemical phytotoxicity of autumn-applied herbicides (October 18, 1999) to supina bluegrass during spring greenup 2000. Scale was 1–5; 1 = no phytotoxicity (e.g., untreated control), 5 = 100% phytotoxicity. Vertical error bars represent LSD (0.05) values.**

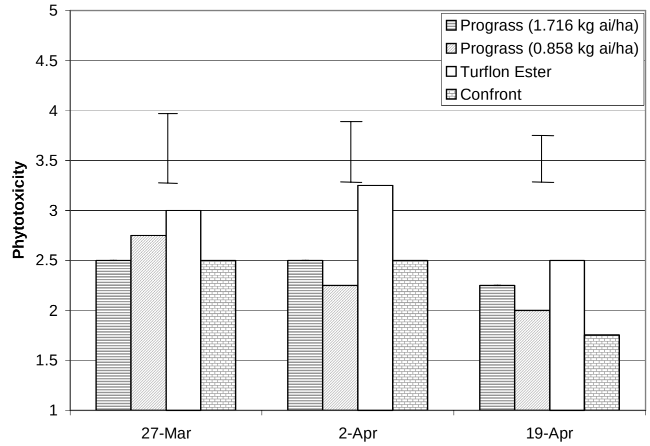

Fig. 2. **Chemical phytotoxicity of autumn-applied herbicides (October 17, 2000) to supina bluegrass during spring greenup 2001. Scale was 1–5; 1 = no phytotoxicity (e.g., untreated control), 5 = 100% phytotoxicity. Vertical error bars represent LSD (0.05) values for comparison to untreated control.**

LSD values were calculated to separate treatment means when appropriate.

Results and Discussion

Fall-applied, postemergence herbicides. Post emergence herbicides applied in the fall were fairly safe to supina bluegrass though phytoxicity did occur with a few compounds (Table 1). MCPP 4K (MCPP) and Strike 3 (MCPP, 2,4-D, and Dicamba) caused phytotoxicity to turf leaf tips in autumn 1999 for one to two weeks after application although no injury occurred in 2000 (data not shown). Additional phytotoxicity symptoms from several treatments were evident the following spring. Strike 3 caused phytoxicity and delayed greenup in 2000 while Confront (Triclopyr plus Clopyralid) resulted in similar symptoms in spring 2001 (Figs. 1 and 2). Turflon Ester (Triclopyr) and both rates of Prograss also caused significant phytotoxicity ($p < 0.05$) and delayed spring greenup for approximately three to four weeks in both 2000 and 2001. All turf recovered from phytotoxicity three to four weeks after untreated turf developed full green color and did not appear to suffer long-term negative effects.

With the exception of Prograss, the fall-applied herbicides are utilized in turf management for selective control of broadleaf weeds in cool-season turfgrasses. Herbicides containing the same compounds as Strike 3 have been reported to cause phytotoxicity to bermudagrass (13) but should be safe on supina bluegrass since it is a cool-season (C_3) grass. Since MCPP 4K also caused damage during the same year as Strike 3, MCPP was likely the cause of the phytotoxicity and products containing only 2,4-D and/or Dicamba can be regarded as safe for use on supina bluegrass.

Since Turflon Ester and Confront caused phytotoxicity in 2001 while Lontrel (Clopyralid) did not, much or all of the phytotoxicity caused by Confront was likely due to the triclopyr rather than the clopyralid. Damage from Confront, which contained only 33% triclopyr, was less than damage from Turflon Ester which contained 66% triclopyr. Product formulation may have contributed to the phytotoxicity, as Clopyralid was formulated as an amine salt and esters are generally more volatile and likely to be phytotoxic (4).

The inconsistent damage caused by treatments containing MCPP and triclopyr could have been due to different environmental conditions between the years although there was no apparent reason for the difference based on weather data alone.

Spring-applied, pre and postemergence herbicides. No spring-applied herbicides caused phytotoxicity or reduced turf color in 2000. In 2001, Drive (Quinclorac; with and without methylated seed oil) and MSMA Turf (MSMA) resulted in a lighter green turf color compared to untreated turf for a two week period followed by complete recovery (Fig. 3). MSMA reduced turf color in weeks three and four following application, while Drive reduced turf color in weeks four

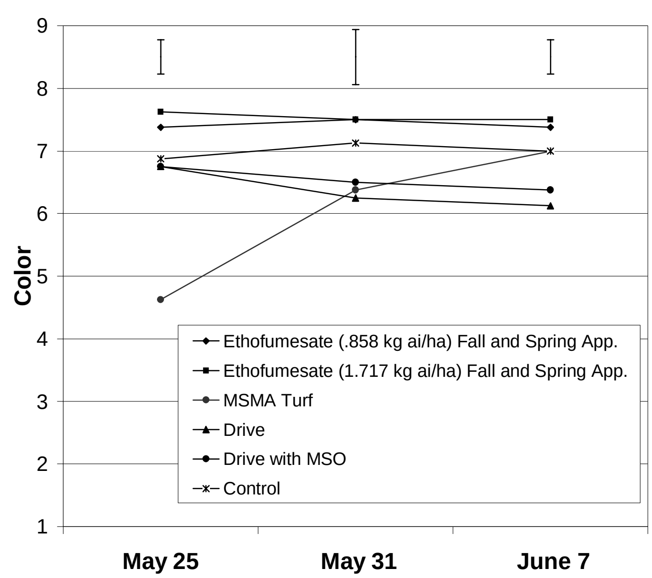

Fig. 3. **Color of supina bluegrass as affected by herbicides applied May 11, 2001. Scale was 1–9; 1 = necrotic turf, 9 = dark green, 6 = acceptable green color. MSO = methylated seed oil, a surfactant. Vertical error bars represent LSD (0.05) values.**

and five following application. Methylated seed oil by itself did not cause phytotoxicity (data not shown). No spring applications of Prograss, alone or applied subsequent to fall treatments of Prograss, caused phytotoxicity.

Products containing MSMA have been used for postemergence crabgrass (*Digitaria* spp.) control in cool-season turf for over 30 years and can sometimes discolor desirable cool-season turf (3). Drive is an enzymatic inhibitor and has only been labeled for use in cool-season turf since 1998. It is labeled as a pre and postemergence control for crabgrass and other annual weeds. Drive can be phytotoxic to bentgrass (*Agrostis* spp.) but is labeled safe for use on Kentucky bluegrass (*Poa pratensis* L.) according to Street and Stewart (16).

Ethofumesate. In 2001 the high rate of Prograss, 1.716 kg ai/ha (1.532 lb ai/A), applied in the spring and both rates applied sequentially in fall and spring significantly improved turf quality ($p < 0.05$) following spring greenup compared to untreated turf. Between May 17 and June 7, 2001, quality of untreated turf was approximately 6.2 to 6.5. Turf treated with Prograss (1.716 kg ai/ha) in the spring had turf quality ranging from 7.1 to 7.2, while both rates of the sequential fall/spring applications produced the highest quality turf (7.6 to 7.9). The mechanism of the quality response is unknown but the phenomenon has also been observed in creeping bentgrass (*Agrostis palustris*) (7). In our study, spring applications of Prograss increased turf color and density, with fewer weeds, compared to untreated control plots (data not shown). The increase in color may have been due the elimination of annual bluegrass from the turf as Prograss is labeled for selective pre and postemergence control of annual bluegrass in turf. Turf quality could also have been improved by preventing the development of terminal reproductive shoots in supina bluegrass which can lead to temporarily decreased turf quality when they die. Supina bluegrass typically produces seedheads in mid to late May, and spring applications of Prograss visibly reduced seedhead emergence of supina bluegrass although data were not collected. Chlorophyll concentration could also have been increased similar to the effect caused by the plant growth regulator Primo (Trinexapac-ethyl) (15).

Photosynthetic efficiency. None of the herbicides caused any significant differences in photosynthetic efficiency (data not shown). The average Fv:Fm ratio across all treatments was 0.816 with a standard deviation of 7.5×10^{-4}. Typical values for unstressed plants are approximately 0.8 (9), indicating none of the herbicide treatments caused stresses which directly or indirectly affected photosynthetic efficiency. While herbicides that affect photosynthesis would obviously affect Fv:Fm (5, 9), other herbicide types along with temperature stress and disease may also decrease photosynthetic efficiency values (12).

This research shows many of the most commonly used pre and postemergence turf herbicides do not have a permanent long-term adverse effect on supina bluegrass. Fall applications of Prograss at both low and high rates and herbicides containing triclopyr and MCPP may delay spring greenup. Spring applications of Drive and MSMA Turf temporarily reduced turf color. None of the herbicides tested appear capable of selectively removing supina bluegrass from a mixed turf stand.

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