

COMPARING INVASIVE AND OPPORTUNISTIC WEEDS IN GRASS SEED CROPS

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Abstract

Annual bluegrass (*Poa annua*, POAAN) is an opportunistic weed in perennial ryegrass (*Lolium perenne*, LOLPE) grown for seed, relying on thin crop stands to proliferate. Poor post-harvest regrowth and damage from weed control treatments are primary factors thinning perennial ryegrass stands. Maximum perennial ryegrass yield loss in dense stands of annual bluegrass averaged 44%. Downy brome (*Bromus tectorum*, BROTE), an invasive weed in Kentucky bluegrass (*Poa pratensis*, POAPR) grown for seed, weakens and destroys stands through intense competition. Complete Kentucky bluegrass yield loss occurred at 15 to 20 downy brome per ft². In perennial ryegrass, crop safety must be emphasized when selecting treatments to control or suppress annual bluegrass. In Kentucky bluegrass, control of downy brome must be maximized, and crop safety is a secondary concern.

Introduction

Stand loss and weed encroachment in perennial grasses grown for seed are interrelated, and causality is often unclear. Separating these phenomena could provide insights into past management failures and suggest improvements for the future. The question is a classic case of “which came first, the chicken or the egg?” Do stands thin because they are invaded by weeds, or do weeds proliferate because stands have thinned? Answers are important because they can tell us whether we need to try harder to control weeds or try harder to keep our stands healthy, objectives frequently at odds with each other using current technology.

Contamination by annual bluegrass is a serious concern in turfgrass seed production, and growers lose large quantities of crop seed while removing the weed to meet market demands for “*Poa*-free” seed. Because of the high costs associated with removing annual bluegrass seed during seed cleaning, growers try to control annual bluegrass in their fields with herbicides. Spectacular success was achieved in the 1970s in crops such as perennial ryegrass with the development of the carbon-plant, broadcast-diuron method for establishing new stands, along with the introduction of the selective herbicide ethofumesate (Nortron) (Lee, 1973 and 1981). During the recent phasedown in field burning in western Oregon, many perennial ryegrass seed growers experienced explosive increases in annual bluegrass populations. Various reasons for this have been proposed, and growers are modifying their management practices based on research results, personal experience, and guesswork.

Decreased use of field burning and the development of resistance to diuron, ethofumesate, and other herbicides are major causes of the annual bluegrass outbreak. The severity of the problem, however, varies greatly with herbicide treatment and post-harvest residue management. Results from field trials over several years were used to test the hypothesis that thin stands of perennial ryegrass were the primary culprit in severe infestations of annual bluegrass, rather than the invasiveness of this weed.

Growers of Kentucky bluegrass seed in the intermountain regions of the Pacific Northwest have been plagued by downy brome for decades. Although downy brome impedes the seed cleaning process, it is not listed as noxious, and the presence of a few downy brome seeds in an official seed sample has lesser impact on profits than occurs with annual bluegrass. Growers often cite too much “cheatgrass” (downy brome) as their main reason for taking Kentucky bluegrass fields out of production. Results from field trials over several years were used to test the hypothesis that the invasiveness of downy brome was the primary reason for problems with this weed.

Materials and Methods

Tests were conducted over multiple years in established stands of perennial ryegrass near Tangent, Oregon, and Kentucky bluegrass near Madras, Oregon. Post-harvest residue was removed each year by open field burning, by baling followed by vacuum sweeping (VS), or by baling, flailing, and raking, or full straw load chop (FSLC) was used to reduce the residue to a fine mulch. Herbicides were applied between late-summer and early-winter at 26 gal/a to plots 9 by 60 ft in size. Plots were swathed at maturity, and 275 ft² was harvested by combine when windrows were dry. Seed was cleaned to 98% purity for annual bluegrass, perennial ryegrass, downy brome, and Kentucky bluegrass. Treatment means were separated at the $P \leq 0.05$ level of significance, and ground cover values were log transformed to correct for non-homogeneous variances. Ground cover was measured in mid to late March in all years, and, in 1998, it was measured again in mid-April to evaluate the effect of glufosinate (Rely) applied in late March. Regressions were conducted on treatment averages of 4 replications in all cases except the 1998 perennial ryegrass test. To reduce table size, only selected treatments are shown. Graphs include all treatments, but some were excluded from regressions based on excessive crop damage or variation in herbicide resistance.

Results and Discussion

A key question when classifying weeds as opportunistic or invasive is whether the loss of crop stand occurs before or after prolonged competition? Stands of perennial ryegrass thin as plants die due to a variety of stresses, especially moisture, during the post-harvest regrowth period of late-summer and early-fall, and also when treated in fall and

early-winter with marginally selective herbicides such as diuron (Karmex), oxyfluorfen (Goal), and metolachlor (Dual) (Chastain et al., 1998). Surviving perennial ryegrass grows well in late-winter and spring, and competes with the annual bluegrass. The major problem is that too many gaps exist during fall and winter, and these niches are filled by annual bluegrass. For downy brome in Kentucky bluegrass, a different pattern is seen. In the absence of downy brome, stands damaged by fire, drought, or herbicides will fill back in because of the spreading growth habit of this crop, often yielding nearly as well as undamaged stands. If downy brome is present, yields will be reduced, even if crop stands were initially full. Even more telling is the fact that crop stands will thin and downy brome populations will increase in each successive year of competition.

Graphs of crop seed yield versus weed density can characterize weed species as opportunistic or invasive. Several features of the relationship between perennial ryegrass seed yield and annual bluegrass ground cover reveal the opportunistic nature of this weed (Fig. 1). First, the maximum observed annual bluegrass ground cover between crop rows in early spring was only 49, 65, and 50% in 1996, 1997, and 1998, respectively (Tables 1, 2, and 3). Second, although perennial ryegrass seed yield decreased with increasing annual bluegrass ground cover, the theoretical maximum yield loss at 100% annual bluegrass ground cover was only 46% in 1996, 44% in 1997, and 43% in 1998. In contrast, the theoretical maximum yield loss in Kentucky bluegrass approached 100% as downy brome density increased (Fig. 2 and 3). Complete yield loss at downy brome densities of 16, 17, and between 10 and 34 plants/ft² was predicted in 1995, 1996, and 1997, respectively. The maximum observed downy brome density was 29% of that required for complete crop failure in 1995, rising to 67% in 1996, and exceeding 100% in 1997. Another indication of the invasiveness of downy brome was the increase in population density from year to year, which ranged from 5 to 20-fold in untreated checks, with similar increases occurring in many herbicide treatments. Individual downy brome plants in the untreated checks were less competitive in 1997 than in previous years because their population density was so high they strongly competed with each other, resulting in a smaller average size than in previous years. Within three years of use at Madras, downy brome with increased resistance to primisulfuron (Beacon) had appeared. Resistant plants were injured by tank-mixes of primisulfuron + terbacil (Sinbar), but survived and produced seed. Resistant plants competed less vigorously with the crop, perhaps due to lingering stunting from the herbicides, and crop yield with 15 to 25 resistant downy brome per ft² was similar to that with 0 to 5 nonresistant downy brome per ft² (Fig. 3a). When competition was expressed as crop seed yield versus downy brome seed yield, results from resistant plots and untreated checks fell near the re-

gression line for normal primisulfuron-susceptible downy brome (Fig. 3b).

Another indication of the opportunistic nature of annual bluegrass is the interaction between it and volunteer perennial ryegrass seedlings. A large fraction of the volunteer perennial ryegrass was controlled simply by vacuum sweeping without any herbicide (Tables 1, 2, and 3). However, annual bluegrass density in the untreated checks was always higher in vacuum sweep than full straw load chop conditions, indicating that annual bluegrass was filling in space vacated by seedling perennial ryegrass. Treatments seriously damaging the established crop often increased annual bluegrass ground cover or seed yield. Examples include full straw 0.25 lb/a oxyfluorfen + 1.6 lb/a diuron in 1996 and 1997, full straw 0.25 lb/a azafenidin (Milestone) in 1997, and vacuum sweep azafenidin + metolachlor followed by azafenidin + diuron in 1998. High rates of pendimethalin (Prowl) or moderate rates of it followed by 0.125 lb/a oxyfluorfen + 1.2 lb/a diuron maximized perennial ryegrass and minimized annual bluegrass seed yield. Pendimethalin was finally registered for this use in October 1998. Safety must be paramount when selecting treatments to control annual bluegrass in perennial ryegrass.

References

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Table 1. Herbicide treatments on annual bluegrass and perennial ryegrass seedling density and yield, 1996.

Herbicide treatment and residue management	Seedling density		Seed yield	
	POAAN	LOLPE	POAAN	LOLPE
---- (lb a.i./a and date applied, fall 1995)-----	-- (% ground cover)---		----(lb/a pure seed)----	
Untreated check VS	18 b-e	4 b	46 ab	734 b
Untreated check FSLC	16 cde	26 a	49 ab	879 ab
Pendimethalin 2 (Sept. 26) / oxyfluorfen 0.125 + diuron 1.2 (Nov. 16)				
VS	6 f	0 e	36 b	888 ab
FSLC	14 de	4 b	46 ab	1004 a
Pendimethalin 2 (flail inc. Oct. 2) / Oxyfluorfen 0.125 + diuron 1.2 (Nov. 16) FSLC	10 ef	2 bcd	50 ab	1055 a
No herbicide (flail Oct. 2) / Oxyfluorfen 0.25 + diuron 1.6 (Nov. 16) FSLC	31 a-d	2 bc	69 a	741 b
Metolachlor 1.5 + oxyfluorfen 0.28 (Oct. 2) / Oxyfluorfen 0.125 + diuron 1.2 (Nov. 16) FSLC	10 ef	0 de	71 a	607 b
Oxyfluorfen 0.25 + diuron 1.6 (flail inc. Oct. 2) FSLC	49 a	1 cde	65 a	876 ab
Rotary hoe (Nov. 16) - no herbicide FSLC	33 abc	1 cde	71 a	746 ab

Annual bluegrass and volunteer perennial ryegrass seedling density was measured in mid to late March.

Table 2. Herbicide treatments on annual bluegrass and perennial ryegrass seedling density and yield, 1997.

Herbicide treatment and residue management	Seedling density		Seed yield	
	POAAN	LOLPE	POAAN	LOLPE
---- (lb a.i./a and date applied, fall 1996)-----	-- (% ground cover)---		--- (lb/a clean seed) ---	
Untreated check VS	45 ab	16 ef	356 bcd	928 a-e
Untreated check FSLC	13 d	61 a	277 cd	974 abc
Pendimethalin 3 (Sept. 19) VS	50 ab	6 h	341 bcd	926 a-e
Pendimethalin 3 (Sept. 19) FSLC	25 c	44 ab	267 d	1038 a
Pendimethalin 2 + oxyfluorfen 0.25 (Sept. 26) / oxyfluorfen 0.125 + diuron 1.2 (Oct. 24)				
VS	33 bc	1 j	394 bc	852 b-f
FSLC	48 ab	21 de	404 ab	1026 ab
Azafenidin 0.125 (Sept. 23) VS	36 bc	3 i	376 bcd	943 a-d
Azafenidin 0.125 (Sept. 23) FSLC	52 ab	28 bcd	382 bcd	751 ef
Azafenidin 0.25 (Sept. 23) FSLC	65 a	7 gh	422 ab	712 f
Rotary hoe (Oct. 1) - no herbicide FSLC	34 bc	38 abc	396 abc	814 c-f
Oxyfluorfen 0.25 + diuron 1.6 (Oct. 24) FSLC	63 a	11 fg	520 a	767 def
Oxyfluorfen 0.25 + metolachlor 1.5 (Sept. 26) / Oxyfluorfen 0.125 + diuron 1.2 (Oct. 24) FSLC	43 ab	11 fg	383 bcd	860 a-f

Annual bluegrass and volunteer perennial ryegrass seedling density was measured in mid to late March.

Table 3. Herbicide treatments on annual bluegrass and perennial ryegrass seedling density and yield, 1998.

Herbicide treatment and residue management	Seedling density		Seed yield	
	POAAN	LOLPE	POAAN	LOLPE
---- (lb a.i./a and date applied, fall 1997)-----	-- (% ground cover)---		--- (lb/a clean seed) ---	
Untreated check VS	50 a	9 c	314 a	1001 c
Untreated check FSLC	18 c	67 a	211 bcd	1035 c
Pendimethalin 3 + oxyfluorfen 0.125 (Sept. 15) VS	30 abc	1 d	216 bc	1333 ab
Pendimethalin 3 + oxyfluorfen 0.125 (Sept. 15) FSLC	29 abc	25 b	222 bc	1218 abc
Pendimethalin 6 + oxyfluorfen 0.125 (Sept. 15) VS	17 c	1 d	135 e	1380 a
Pendimethalin 6 + oxyfluorfen 0.125 (Sept. 15) FSLC	18 c	6 ghi	138 e	1321 ab
s-Metolachlor 0.94 + oxyfluorfen 0.25 (Sept. 15) / diuron 1.6 (Oct. 23)				
VS	32 ab	1 d	254 b	1205 abc
FSLC	22 bc	10 bc	185 cde	1210 abc
Azafenidin 0.075 + s-metolachlor 0.94 (Sept. 15) / azafenidin 0.075 + diuron 1.2 (Oct. 23)				
VS	25 bc	0 d	252 b	1129 bc
FSLC	28 bc	13 bc	157 de	1302 ab

Ground cover measured in late March, prior to application of Rely.

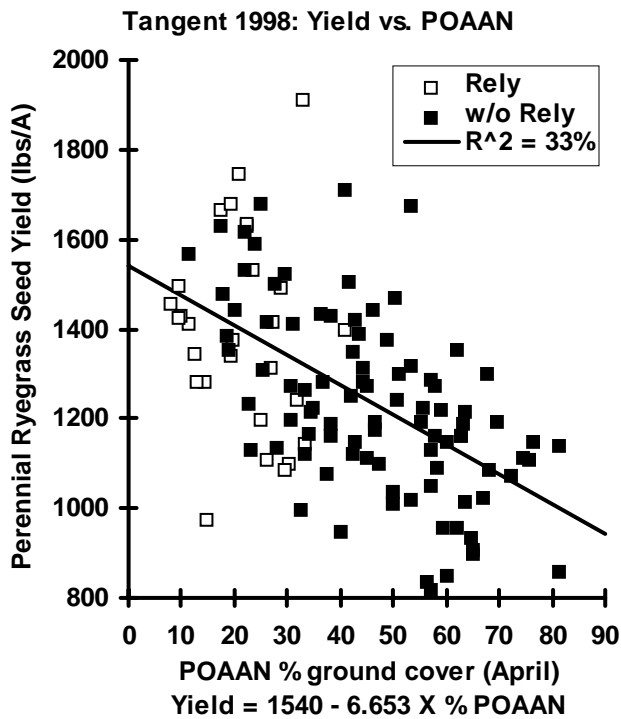
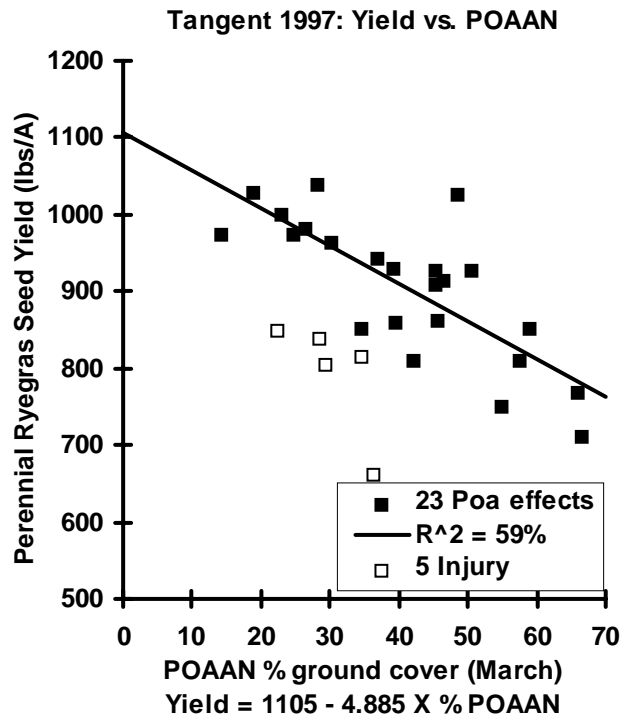
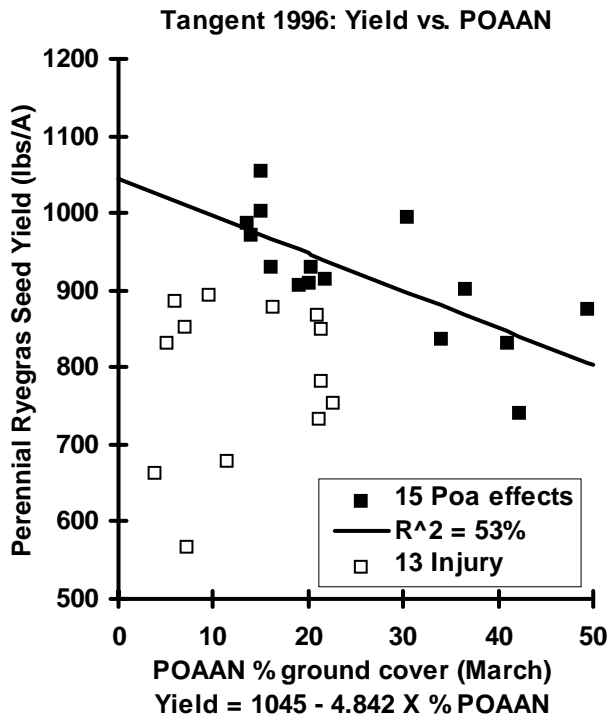


Figure 1. Relationship between perennial ryegrass seed yield and annual bluegrass ground cover in 1996, 1997, and 1998 at Tangent, Oregon. Annual bluegrass biotypes were resistant to diuron. Ground cover in 1998 was measured April 16, approximately 3 weeks after Rely treatment.

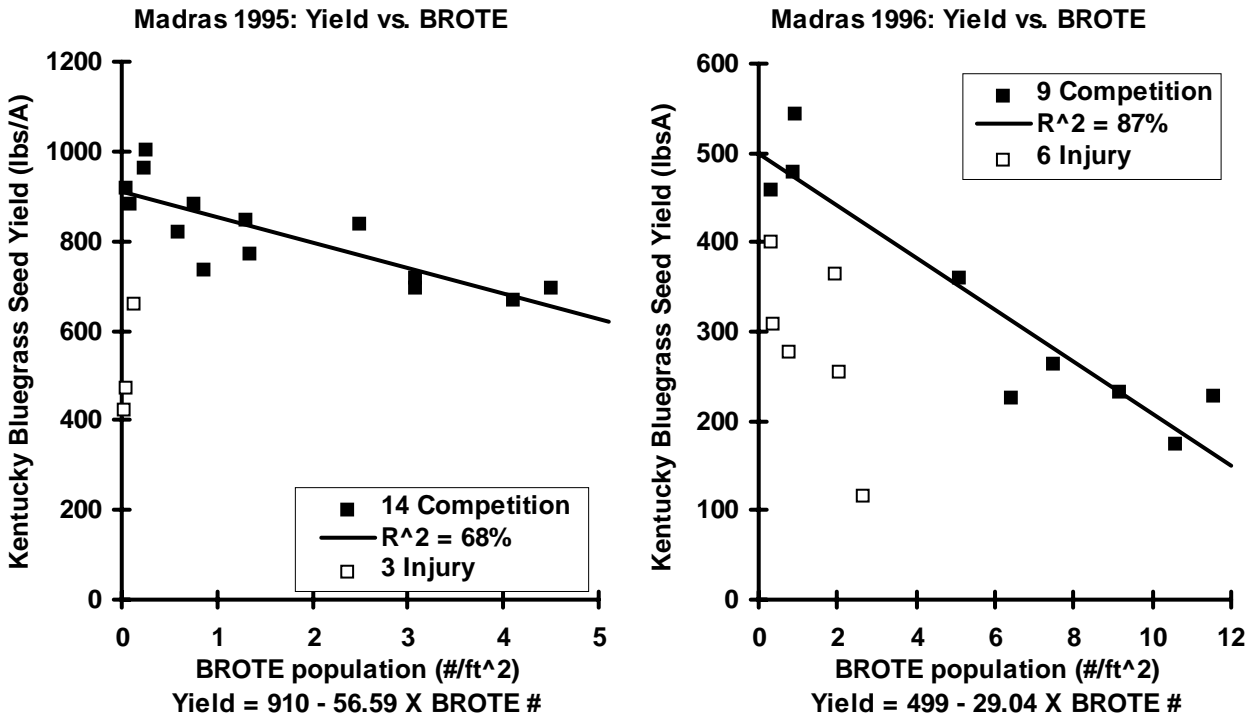


Figure 2. Relationship between Kentucky bluegrass seed yield and downy brome population density, Madras, Oregon, 1995 and 1996 harvests. Stand was sown in August 1992, with first harvest in July 1993.

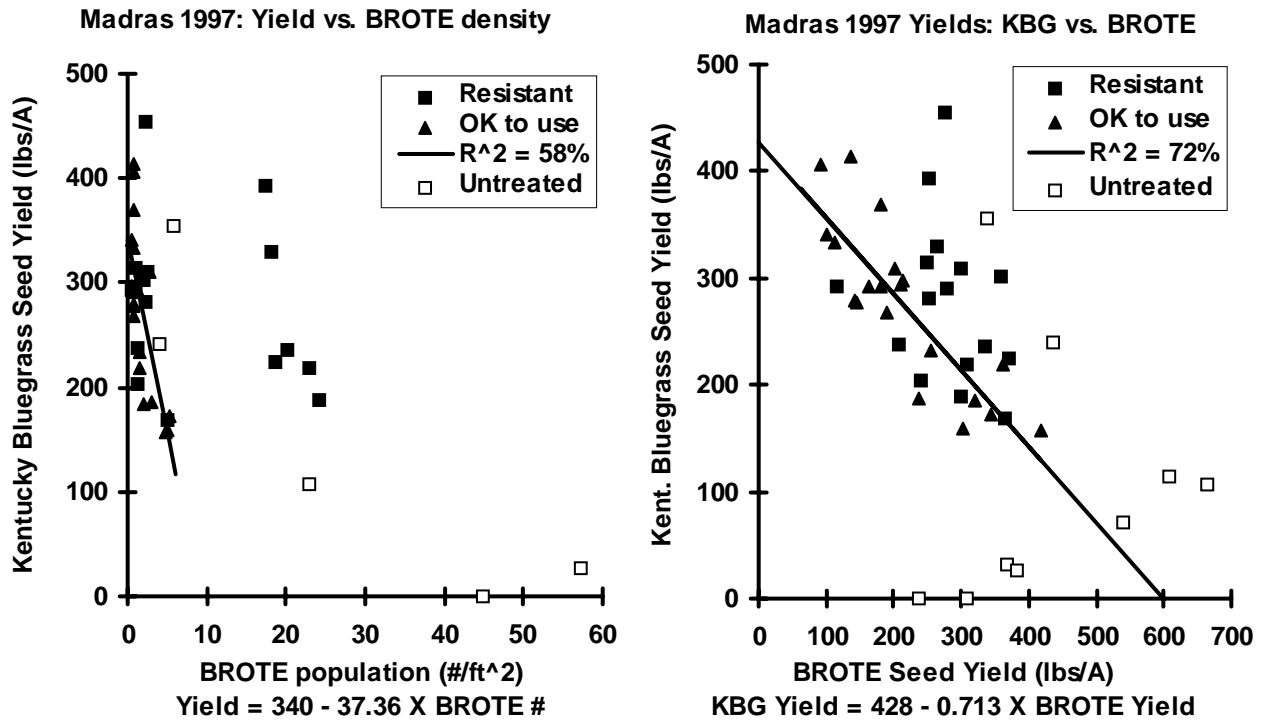


Figure 3. Relationship between Kentucky bluegrass seed yield and downy brome population density or seed yield, Madras, Oregon, 1997 harvest. Regressions exclude plots with resistant brome and untreated checks.