Evaluating Chemical Treatments and Suppression Methods to Alter Red: Far Red in Perennial Groundcovers

Cynthia A. Bartel—postdoctoral scholar, Department of Agronomy

Kenneth J. Moore—professor, Department of Agronomy

Shuizhang Fei—professor, Department of Agronomy

Andrew W. Lenssen—professor, Department of Agronomy

Roger Hintz—research scientist, Department of Agronomy

Sam Kling—intern, Department of Agronomy

Natural resources degradation in conventional cropping systems, renewable fuels agendas, and private and public incentives for ecosystems services delivery such as carbon sequestration, have driven interest in the development of alternative cropping systems, which can both 1) conserve natural resources and 2) meet global demands for food, feed, fiber, and fuel. Without the development of such systems, natural resources degradation ultimately will compromise long-term agricultural productivity. The integration of low-growing, shallow-rooted, ecologically appropriate perennial groundcovers (PGC) into annual row cropping systems can alleviate many of the negative consequences of the winter fallow period, merging scalable soil and water conservation with high-yield, row crop production. The PGC system is uniquely positioned to achieve production goals and regenerate marginal and fragile lands, as it recognizes infrastructure investments, market forces, and the federal agricultural policy framework.

However, system refinement is necessary before broad deployment to ensure effective groundcover suppression during early season maize growth. Competition from the PGC elicits deleterious early season stressors for the maize crop and the shade avoidance response (SAR) with rapid post-suppression groundcover recovery. This experiment was designed to assess chemical suppression timing with two herbicide combinations applied to PGC at consecutive early season maize growth stages and the impact on 1) R:FR ratio, 2) maize developmental morphology, yield, and yield components, and 3) weed community, using contact, nonselective, postemergence herbicides (Gramoxone as paraquat [1,1′-dimethyl-4,4′-bipyridinium dichloride, Gramoxone SL 2.0, Syngenta Canada] and Gramoxone+Glufosinate-ammonium [‘Glufosinate’, Liberty 280 SL, Bayer CropScience LP]) for groundcover defoliation and burndown after spring strip-tillage.

Materials and Methods

Experiment design at the Sorenson Research Farm at Ames, Iowa, in 2020-2021 was a randomized complete block with four replications and 17 unique 10 by 20-ft. plots per block. Treatments included suppression of Kentucky bluegrass ‘Midnight’ on day of maize planting and each of seven consecutive maize development stages (VE, V1, V2, V3, V4, V5, and V6) + control (no suppressant).

Plots were fertilized and cultivated prior to maize planting on May 7 in Year 1 and April 30 in Year 2. Herbicides were sprayed as needed. Stand density was measured at early vegetative (V2) and late reproductive (R6) stages. Maize maturity (stage), maize height, and red:far-red (R:FR) ratio were recorded weekly.

A 5-ft. row of maize was hand harvested at R6 on September 28, 2020, in Year 1 from the two center maize rows in each plot in blocks 1-3; on September 29, 2020, in block 4, and all plots in Year 2 on September 21, 2021. The two center rows per plot, less the hand harvest, were combine harvested on October 8, 2020, and October 1, 2021, for moisture, weight, and yield. Plant and ear number, fresh weight of stover and ears were recorded, from which yield and components (kernel rows/ear, kernels/row, and kernels/ear) were estimated.

Grain quality was evaluated by transmittance Near Infrared Spectroscopy (NIRS). Modified grid sampling technique was used post-harvest to assess PGC establishment. Fall, post-harvest weed communities also were measured for weed control benefits of PGC.

Results and Discussion

The R:FR ratio increased after suppressant chemistries were applied in both years. While decreased R:FR ratio triggered SAR and taller maize plants in early vegetative growth stages, final maize plant height was taller in earlier suppressed treatments with greater yield. Gramoxone+Glufosinate was overall the more effective suppression, with 8% greater maize grain yield than Gramoxone alone across application dates in Year 1, and 13% greater stover and 8% greater total aboveground biomass (TAB) in Year 2, as well as decreased end-of-season PGC frequency at several dates.

The PGC suppressed at earlier maize stages likely recovered before the end of the critical period for weed control (CPWC), but held for the duration of the maize SAR preceding the CPWC, based on R:FR results. The greater values observed in maize grain, stover, and TAB for earlier suppressed treatments underscore the importance of weed control in the early maize growth stages; almost all suppression treatments increased yield components in maize over the controls.

In 2020, fewer fall weeds were observed in the Gramoxone treatments than Gramoxone+Glufosinate overall. In 2021, greater weed density was observed in most of the treatments than the controls. The Gramoxone+Glufosinate contact herbicide combination in Year 2 suppressed PGC more effectively on days when weather conditions enhanced efficacy. Dormancy and chemical applications may both be needed to suppress PGC through SAR and CPWC.

Table 1. Treatment averages and significance for grain yield (GY), stover yield, total aboveground biomass (TAB), harvest index (HI), and maize rows/ear (RE), at Sorenson Research Farm in 2020-2021. Grain yield is expressed at 15% moisture content for maize. TAB, stover yield, and HI are on an oven-dry basis.

Treatment†	GY	Stover	TAB	HI	RE	GY	Stover	TAB	HI	RE
	bu./ac.	lb./sc.			#/ear	bu./ac.	lb./sc.			#/ear
	2020					2021				
DOP-G	152	4,947	12,225	0.72	14.5	124	4,697	10,636	0.66	12.8
DOP-G+G	180	5,903	14,520	0.70	14.6	126	5,447	11,484	0.62	13.4
Yr 1 VE-G	173	7,653	15,886	0.61	15.1	157	5,733	13225	0.67	12.9
Yr 1 VE-G+G	172	7,349	15,574	0.63	14.9	133	5,840	12,216	0.61	12.9
V2-G	183	7,207	15,958	0.59	14.6	167	5,403	13,377	0.70	13.8
V2-G+G	182	7,126	15,833	0.62	15.0	173	7,617	15,878	0.61	13.9
V3-G	146	6,233	13,199	0.64	13.8	168	5,867	13,904	0.69	13.6
V3-G+G	174	6,599	14,895	0.65	14.1	166	8,028	15,967	0.58	14.2
V4-G	165	6,099	13,975	0.61	13.7	154	6,867	14,243	0.61	13.7
V4-G+G	170	5,376	13,484	0.67	13.8	175	6,242	14,609	0.67	13.6
V5-G	166	5,671	13,600	0.67	14.5	157	5,581	13,100	0.67	12.9
V5-G+G	175	5,894	14,234	0.71	14.2	159	6,599	14,190	0.63	13.7
V6-G	140	5,546	12,234	0.68	13.7	162	6,010	13,752	0.66	13.2
V6-G+G	159	4,786	12,386	0.69	13.7	166	4,920	12,823	0.73	12.5
Control	128	5,554	11,654	0.65	13.9	117	5,206	10,770	0.61	12.6
	Significant (P > F)									
	0.0007	0.0049	<0.0001	0.1138	0.0009	<0.0001	0.0006	<0.0001	0.0354	0.0001

† Treatment abbreviations include: DOP, day of maize planting; G, Gramoxone; G+G, Gramoxone+Glufosinate.