WEEDSOFT PREDICTIONS OF CORN AND SOYBEAN YIELD LOSS

Mark R. Jeschke, David E. Stoltenberg, J. Anita Dille, Gregg A. Johnson, George O. Kegode, Stevan Z. Knezevic, Shawn M. Hock, and Christy M. Sprague[1]

Introduction

WeedSOFT is a decision support system that brings together a wealth of information on weed biology and management efficacy to improve weed management decision-making (Neeser et al. 2004). An essential part of maintaining WeedSOFT as the state-of-the-art weed management tool is validation and improvement of the crop yield loss model in the ADVISOR module. One of the most novel aspects of the crop yield loss model is the use of an adjusted competitive index (ACI) whereby the competitiveness of a given weed species is adjusted by a competitive index modifier (CIM) based on relative weed and crop growth stages (Tables 1 and 2). In this manner, weeds that emerge at the same time as the crop are considered more competitive than weeds that emerge at a later crop growth stage. The weed CI values are species-specific and differ among the several state versions of WeedSOFT due to regional differences in weed competitiveness. However, the CIM matrix is constant among crops and weed species.

Table 1. WeedSOFT crop and weed growth stages.

Growth stage	Corn	Soybean	Weeds
			inches
1	V1	V1	0-2
2	V2-V4	V2-V3	2-4
3	V5-V8	V4-V5	4-8
4	V9-V14	R1-R8	>8

Table 2. WeedSOFT competitive index modifier (CIM) values.

Crop growth stage	1	2	3	4
Weed Stage 1	1	0.6	0.3	0.1
Weed Stage 2	1.25	0.75	0.35	0.15
Weed Stage 3	2	1.25	0.65	0.25
Weed Stage 4	2.5	1.5	0.75	0.35

The ability of WeedSOFT to model the competitiveness of weeds in mixed-species communities that emerge at different times (i.e., cohorts) relative to the crop has not been assessed across the north central region. Therefore, research was conducted to determine corn

[1] Graduate Research Assistant and Professor, Dept. of Agronomy, Univ. of Wisconsin, Madison, WI 53706; Assistant Professor, Dept. of Agronomy, Kansas State Univ., Manhattan, KS 66506; Associate Professor, Dept. of Agronomy and Plant Genetics, Univ. of Minnesota, St. Paul, MN 55108; Assistant Professor, Dept. of Plant Sciences, North Dakota State Univ., Fargo, ND 58105; Associate Professor and Graduate Research Assistant, Dept. of Agronomy and Horticulture, Univ. of Nebraska, Lincoln, NE 68583; Assistant Professor, Dept. of Crop and Soil Sciences, Michigan State Univ., East Lansing, MI 48824.

and soybean yield loss associated with cohorts of mixed-species weed communities. Crop yield loss observed in these experiments was compared to yield loss predicted by WeedSOFT in order to assess model accuracy using current CIM values.

Methods

Research was conducted in corn and soybean at several sites in the north central region in 2004 and 2005. Separate experiments were conducted for corn and soybean. Research sites were chosen based on the presence of natural infestations of at least two species among common lambsquarters, giant ragweed, velvetleaf, redroot pigweed, tall waterhemp, woolly cupgrass, giant foxtail, barnyardgrass, yellow foxtail, and large crabgrass. The experimental design was a randomized complete block with at least four replications of four weed cohorts and a weed-free treatment. Weed cohorts were established relative to crop growth stage (Table 3).

Table 3. Weed cohort establishment timings.

Cohort	Corn growth stage	Soybean growth stage
1	VE	VE
2	V2	VC
3	V4	V1
4	V6	V3

Glyphosate was applied to maintain plots weed-free prior to targeted weed emergence times. Corn was planted at 32,000 seeds/acre in rows spaced 30-inches apart and soybean was planted at 200,000 seeds/acre in rows spaced 7.5-inches apart. Plot size was 10 ft by 30 ft. Weed community data was collected from two 10-inch by 30-inch quadrats in each plot. Corn and soybean were harvested by machine to determine grain yield.

Crop yield data were analyzed using linear mixed-effects models, with a random blocking factor and a fixed cohort factor. Crop yield loss relative to the weed-free treatment was determined by testing linear combinations using Bonferroni adjusted 95% simultaneous confidence intervals. WeedSOFT crop yield loss predictions were based on weed density measurements made 2 weeks following cohort establishment. Crop yield from the season-long weed-free treatment was used as the weed-free yield in WeedSOFT predictions. State-specific versions of WeedSOFT do not exist for Minnesota and North Dakota, so the Wisconsin version was used for data analysis from these sites. Crop growth stage at the time of weed community sampling was input for each cohort timing. All weeds were assumed to be at growth stage 1 at the time of sampling (Table 1).

Results

Weed communities across research sites consisted largely of grass species and moderately competitive broadleaf species (Figures 1 and 2). Foxtail species were among the most abundant grass species. The effect of weed cohort on crop yield was significant in all corn site-years and in four of six soybean site-years for cohort 1, and in one corn and one soybean site-year for cohort 2 (Tables 4 and 5). Crop yield loss due to weed interference occurred only for weed cohorts 1 and 2, although yield loss of up to 83% and 97% occurred in soybean and corn, respectively (Figures 3 and 4).

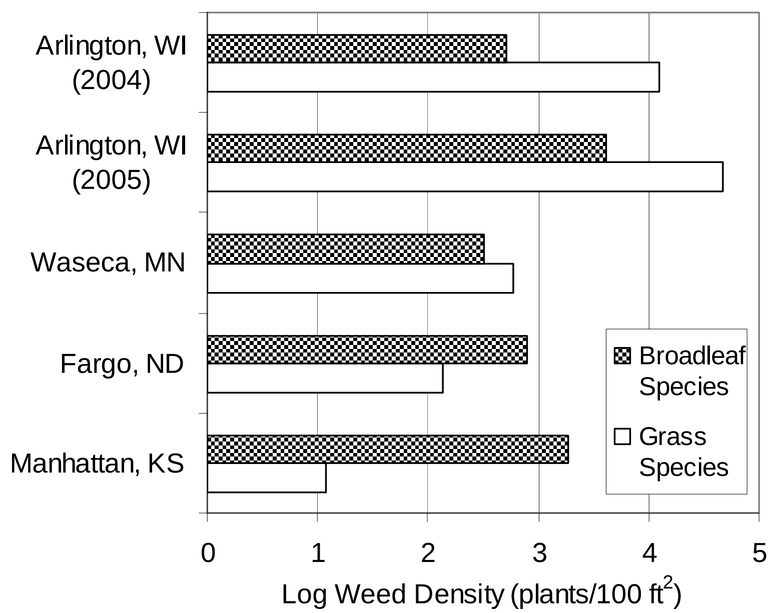

Figure 1. Grass and broadleaf weed communities in corn.

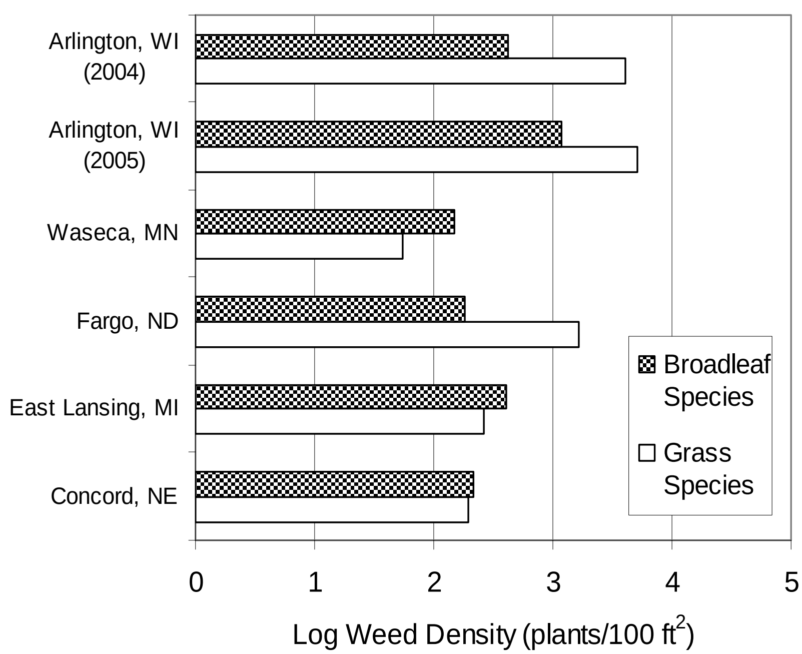

Figure 2. Grass and broadleaf weed communities in soybean.

Table 4. Corn weed-free yield and yield-loss associated with four weed cohorts.

Site	Weed-free yield	Weed cohort effect				
		p-value	Cohort[a]			
	bu/A		1	2	3	4
Arlington, WI (2004)	212	<0.0001	*			
Arlington, WI (2005)	194	<0.0001	*			
Waseca, MN	232	<0.0001	*			
Fargo, ND	100	<0.0001	*			
Manhattan, KS	212	<0.0001	*	*		

[a] An asterisk (*) denotes yield-loss relative to the weed-free yield.

Table 5. Soybean weed-free yield and yield-loss associated with four weed cohorts.

Site	Weed-free yield	Weed Cohort Effect				
		p-value	Cohort[a]			
	bu/A		1	2	3	4
Arlington, WI (2004)	57.3	0.1255				
Arlington, WI (2005)	61.0	<0.0001	*			
Waseca, MN	54.2	<0.0001	*	*		
Fargo, ND	20.7	0.8776				
East Lansing, MI	62.5	<0.0001	*			
Concord, NE	46.3	<0.0001	*			

[a] An asterisk (*) denotes yield-loss relative to the weed-free yield.

WeedSOFT tended to over-predict yield loss in both corn and soybean, with substantial yield loss predicted in many cases where none was observed (Figures 3 and 4). Yield loss was overestimated particularly for weed cohort 2, with an average over-prediction of 31% in corn and 35% in soybean across sites. The greatest over-predictions of yield loss were associated with weed communities composed largely of grasses, indicating that WeedSOFT overestimated the competitiveness of these species at later crop growth stages. In several instances, grass-dominated weed communities were associated with large yield losses for cohort 1, but no yield loss for later cohorts.

Summary

WeedSOFT tended to over-predict both corn and soybean yield losses associated with later weed cohorts (Figures 3 and 4), particularly for weed communities that consisted mostly of grass species (Figures 1 and 2). Different relative competitiveness among weed species is accounted for in WeedSOFT by the use of unique competitive index (CI) values. However, a single set of CI modifier (CIM) values is used for all weed species to account for time of emergence (cohort) effect on competitiveness (Table 2). The accuracy of WeedSOFT crop yield loss predictions may be improved if CIM values were adjusted to account for the apparent differential cohort effect among weed species.

Reference

Neeser, C., J. A. Dille, G. Krishnan, D. A. Mortensen, J. T. Rawlinson, A. R. Martin, and L. B. Bills. 2004. WeedSOFT: A weed management decision support system. Weed Sci. 52:115-122.

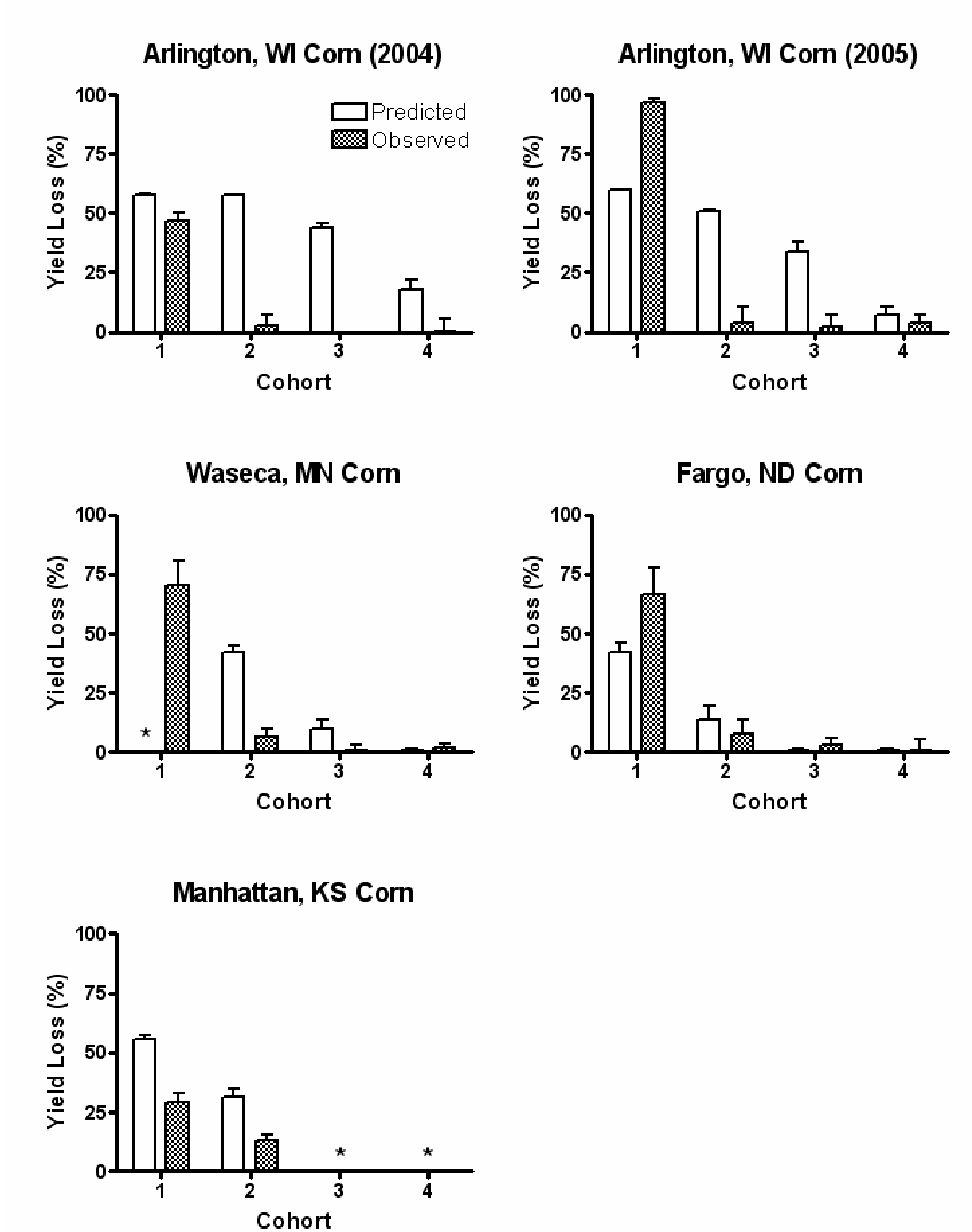

Figure 3. Predicted (WeedSOFT) and observed corn yield loss (± SE) associated with four weed cohorts (emergence times) and five site-years. Corn growth stage for each cohort establishment time is shown in Table 3. An asterisk (*) denotes data not collected.

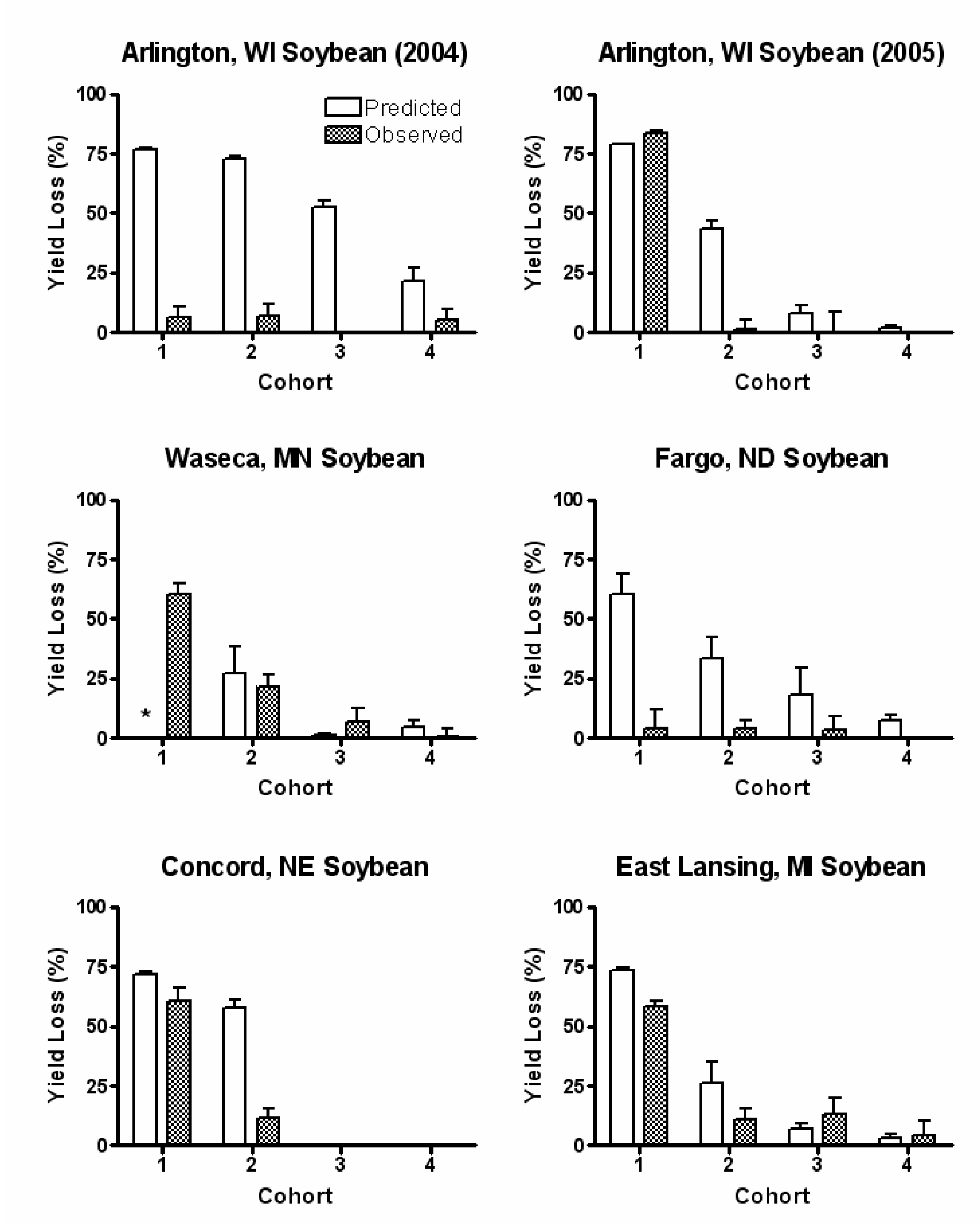

Figure 4. Predicted (WeedSOFT) and observed soybean yield loss (± SE) associated with four weed cohorts (emergence times) and six site-years. Soybean growth stage for each cohort establishment time is shown in Table 3. An asterisk (*) denotes data not collected.