Sustainable Agriculture

Relative emergence sequence for weeds of corn and soybeans

Weed emergence timing: a new tool for managing weeds in crop fields

The success of integrated weed management relies on matching control strategies to the specific weed problem in a field. Managers must know not only which weed species (and how many) are present in a field; they also must understand the distribution and development stages of these weeds throughout the field.

Weed control recommendations typically provide information on appropriate tillage methods and herbicide selection. But the weed infestation information on which these recommendations are based typically is not sufficiently detailed to make the best use of these strategies.

Information on weed populations can be improved by increasing the time spent scouting fields. However, time is a constraint during the busy spring crop season. With an improved understanding of how environmental influences affect weed emergence and growth, growers and consultants could better predict when best to invest time in scouting. Better information on weed development and populations could help growers determine the optimum time for tillage and crop planting to reduce weed populations, maximize the effectiveness of mechanical weed control operations, and strategically time burndown and postemergence herbicide applications. Although considerable research and modeling of weed emergence has been conducted in recent years, little effort has been directed toward developing emergence information for the individuals most directly involved in weed management.

This publication describes how weed emergence timing influences weed management systems. Included are preliminary rankings of relative emergence for important weed species in the Midwest. The Leopold Center for Sustainable Agriculture is supporting efforts to develop more precise ways to predict emergence that will aid the development of more efficient weed management systems.

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Weed life cycles

Weed life cycles are important to understanding emergence sequences. Weed species with different life cycles also have different requirements for seedling establishment, growth, and reproduction. Weeds can be classified by life cycle as follows:

1. **Annual species** complete their life cycle from seed to seed in less than 12 months.
   - *Summer annual species* emerge in the spring or early summer and produce seed during the same growing season (for example, giant foxtail and velvetleaf). These species, which closely mimic the life cycle of corn and soybeans, represent the most troublesome weeds in these crops.
   - *Winter annual species* emerge in the late summer or fall, survive the winter, and produce seed during late spring or early summer of the following year (for example, downy brome and field pennycress). Some of these species also may behave as summer annuals (for example, wild oat and horseweed). Winter annuals require undisturbed soil from late summer or fall through early summer the following year; no-tillage systems provide precisely these conditions.
2. **Biennial species** complete their life cycle in two years (for example, musk thistle). In the first year they remain vegetative, store food in their roots, and overwinter. They flower, produce seed, and die during the second growing season. Because they need undisturbed soil for two consecutive growing seasons, biennial weeds are most frequently found in fields that have been under no-tillage for several years. Depending on weather and soil fertility, biennials sometimes behave as annuals or short-lived perennials.
3. **Herbaceous perennial species** live for more than two years. Usually, top growth dies each winter with below-ground structures persisting and initiating new growth in successive years.
   - *Simple perennials* usually produce a taproot without root buds or rhizomes and spread only by seed (for example, dandelion).
   - *Creeping and bulbous perennial species* have roots with buds, rhizomes, or bulbs, which produce new plants and seed (for example, field bindweed, quackgrass, and nutsedges). The occurrence and intensity of perennial species generally increase as tillage is reduced.

Weed emergence timing and weed management

Most weed seed banks in agricultural lands contain many species. Knowledge of when these species are likely to emerge is important in planning effective weed control programs. Each weed species has one or more periods of high emergence; while the initial emergence date varies widely from year to year, the *order* of emergence for different species remains relatively constant. In a 1995 study evaluating the emergence profile of four summer annual species, velvetleaf was the first to emerge, followed by woolly cupgrass, giant foxtail, and waterhemp (Table 1). There was more than a three-week difference between initial velvetleaf and waterhemp emergence.

The *rate* of emergence also varied among species. Woolly cupgrass reached 78 percent emergence by May 18, compared with only 21 percent emergence for giant foxtail. Results were similar when the same experiment was conducted in 1996.

Table 1. Emergence profiles of four weed species at Ames, Iowa during 1995.

Species	Date Of First Emergence	% Emerged on May 18	% Emerged on May 31	% Emerged on June 8
Giant foxtail	May 15	21	36	85
Woolly cupgrass	May 2	78	83	95
Velvetleaf	April 28	50	75	88
Waterhemp	May 22	0	23	53

The time of weed emergence influences which species will be the most serious weeds in a given crop production practice or the ones most susceptible to certain control measures.

The time of weed emergence influences which species will be the most serious weeds in a given crop production practice or the ones most susceptible to certain control measures. For example, weed species that complete most of their emergence early are killed when the seedbed is prepared or when burndown herbicide is applied prior to planting corn or soybean. In one Minnesota study, delaying soybean planting reduced weed populations and improved weed control when rotary hoeing and cultivation were used. Reductions in weed densities due to delayed planting varied by species, with a 25 percent reduction for pigweed species and nearly 80 percent for common lambsquarters (Table 2). These values directly reflect the timing of emergence of these two species, with common lambsquarters emerging much earlier than pigweed. In the case of giant foxtail and velvetleaf, both emergence timing and the influence of planting date on their control were intermediate between common lambsquarters and pigweed.

The better weed control attained with mechanical strategies (two rotary hoeings plus two cultivations) with late planting also resulted in higher soybean yields than with the same control strategies following early planting. In this study, neither weed control *nor* soybean yields were influenced by planting date in management systems that relied on herbicides.

Table 2. Reduction in weed populations due to delaying soybean planting from mid-May until early-June in east central Minnesota in 1989-1991.

Weed species	Weed population reduction due to delayed planting (%)
Common lambsquarters	80
Giant foxtail	66
Pigweeds	25
Velvetleaf	69

These examples illustrate that knowledge of the timing of weeds' emergence (relative to each other and to crop emergence)—*and* of the influence of tillage and other cultural practices—can be useful in developing integrated weed management systems.

Relative emergence sequence of common weeds

The wide range of weed species present in corn and soybean complicates prediction of weed emergence patterns. Many factors, such as tillage system, crop rotation, weed control history, and weather patterns, regulate the weed population of a given field. However, general emergence trends among species are predictable.

The rankings presented below were developed from research data and observations of weed scientists in the North Central region. These rankings are estimates of emergence sequence, and a species could easily shift one category in either direction, depending on environmental and management factors. Rankings are based primarily on differences in initial emergence (first flush, about 5 percent of total emergence). Differences in the length of the emergence period are not considered in these rankings.

Relative emergence of common weeds of summer annual crops

Previous fall (Winter annuals & biennials)	Early spring →						Late spring
GROUP 0	**GROUP 1**	**GROUP 2**	**GROUP 3**	**GROUP 4**	**GROUP 5**	**GROUP 6**	**GROUP 7**
Horseweed/marestail	Foxtail barley	Quackgrass	Smooth brome	Canada thistle	Green foxtail	Black Nightshade	Fall panicum
Downy brome	Kochia	Orchardgrass	C. ragweed	Giant foxtail	C. milkweed	Shattercane	Crabgrasses
Field pennycress	Prostrata knotweed	Giant ragweed	Wooly cupgrass	C. cocklebur	Hemp dogbane	Venice mallow	Morningglories
Shepherd's purse	Wild mustard	P. smartweed	Velvetleaf	Yellow nutsedge	Barnyardgrass	Waterhemp	Jimsonweed
Biennial thistles	Dandelion	Ladysthumb	Wild buckwheat	Redroot pigweed	Yellow foxtail	S. groundcherry	Witchgrass
Wild carrot	Russian thistle	C. lambsquarters			Wild proso millet	J. artichoke	
Dandelion (from seed)	White cockle	Wild oats			Field sandbur		
		Hairy nightshade					
	Prior to crop planting		About the time of crop planting			After crop planting	

This publication is a first step to present user-friendly information on weed emergence and growth. The weed management issue team of the Leopold Center for Sustainable Agriculture, in cooperation with other state and regional groups, is working to develop more precise and sophisticated methods for predicting weed emergence and growth. These include methods based on heat unit accumulation and precipitation information, biological indicators, and real-time computer models.

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