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**ADVANTAGE**

Continuing Education  
Self-Study Course

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# WEED MANAGEMENT

Management plans that do not contain herbicides with residual activity allow for weed emergence after the final scheduled treatment. The adoption of one- or two-pass herbicide programs that rely on glyphosate provides no residual control for late-emerging plants. Weed flushes can occur throughout the growing season, depending on environmental and seed dormancy conditions. These late-emerging weeds may reduce crop yields through competition, remain green to interfere with harvest, and/or produce high seed numbers that will increase soil seed bank reserves and future infestation problems.

Aggressive weed species, such as common waterhemp (*Amaranthus rudis Sauer*) and Palmer amaranth (*A. palmeri* S. Wats.), may warrant late-season control measures. Common waterhemp can contribute several thousands of seed to the soil seed bank and reduce crop yield. In addition, these weeds may be difficult to control in subsequent years due to the occurrence of herbicide resistance to many herbicide modes of action.

Late-emerging weeds, however, are less competitive with crops and have less biomass and fecundity (seed productivity) than weeds that emerge before or at crop emergence. If weeds remain small, minimal impacts on crop yield and seed bank additions are expected. In these cases, control may not be needed. In fact, some biologists support leaving late-emerging weeds as a food source to benefit arthropod and bird productivity.

Limited data are available on the weed species and the timing of emergence that may result in minimal agronomic impact, i.e., few or no weed seeds produced and little or no

crop yield loss. Plant fecundity and level of competition are influenced by weed species, crop, row spacing, time of emergence, weed placement (in or between rows), and soil fertility. The objective of this study was to determine growth, fecundity, and yield loss potential of eight weed species common to the western region of the Midwestern United States Corn Belt sown into corn and soybean at four times during the growing season.

## SITE DESCRIPTION AND PLOT MAINTENANCE

The experiment was conducted in 2002 and 2003 at the Aurora Experiment Farm, Aurora, S.D. Before plot establishment each year, the field was chiseled in the fall and field-cultivated in the spring. Urea and mono-ammonium phosphate (MAP) were broadcast-applied to both crops in the spring before planting at rates of 192 kg N ha<sup>-1</sup> (171 lbs/A) and 42 kg P ha<sup>-1</sup> (37 lbs/A).

## TREATMENTS, SAMPLING, EXPERIMENTAL DESIGN AND DATA ANALYSES

Barnyardgrass, woolly cupgrass [*Eriochloa villosa* (Thunb.) Kunth], green foxtail [*Setaria viridis* (L.) Beauv.], yellow foxtail [*Setaria pumila* (Poir.) Roem. & Schult.], velvetleaf, common lambsquarters (*Chenopodium album* L.), redroot pigweed, and common ragweed (*Ambrosia artemisiifolia* L.) were sown in 2002. In 2003, barnyardgrass, velvetleaf, redroot pigweed, and common sunflower (*Helianthus annuus* L.) were sown. Seeds were obtained commercially and stored dry at about 2°C (36°F) before planting.

An individual plot consisted of all weed species planted at a single planting

time and had the dimensions of four rows wide by 12 m (39 ft) long in 2002 and four rows wide by 8 m (26 ft) long in 2003. The position of each weed species within each plot was randomized. About 20 to 30 weed seeds per species were planted about 1.5 cm (0.5 in) deep, in the interrow area between Rows 2 and 3, 10 cm (4 in) from the crop row at 1-m (3.3 ft) intervals at four crop growth stages: before crop emergence, at crop emergence, and at V-1 and V-2 stages of crop growth. Plots were maintained weed-free except for the species of interest using a combination of glyphosate application and hand weeding.

Weed growth was monitored at 7- to 14-d intervals from emergence. Weeds were measured for plant height at all sampling dates. Canopy area was determined by measuring the broadest part of the plant in two directions and multiplying these dimensions.

Plant characteristics, such as number of seed capsules (velvetleaf), branches (redroot pigweed), or tillers (barnyardgrass), of weeds that survived and produced seed were recorded in 2003 at harvest. No evidence of seed loss (shattered capsules, partially shattered panicles, or spikes) was observed at harvest. The corn plant closest to and the three soybean plants adjacent to the weed were harvested for biomass in 2002 and grain yield in 2002 and 2003. The number of weed seeds per plant were determined after seeds were threshed and cleaned.

## PLANT GROWTH AND DEVELOPMENT

Seed germination was not tested before planting. However, seeds of each weed species were viable because at least one seedling emerged in each of the planted areas at each planting

# MENT

## Growth and fecundity of several weed species in corn and soybean



date. Common ragweed, common lambsquarters, and woolly cupgrass died a few days after germination regardless of date sown. Yellow and green foxtail in both crops survived from 2 to 8 weeks but did not produce seed from any of the plantings. The cause(s) of the poor establishment and growth of these species is not known. Barnyardgrass in soybean grew and was present until harvest in each year but failed to produce seed, most likely due to competition stresses (light, water, and/or nutrient) imposed by the soybean. Based on 2002 results, barnyardgrass, velvetleaf, and redroot pigweed were planted in 2003. In addition, sunflower was included; however, an infestation of head-clipping weevil (*Haploryhynchites aeneus Boheman*) cut the stem just below the flower head in August, and plants failed to produce seed.

Seedling emergence from barnyardgrass, redroot pigweed, and velvetleaf seed sown pre-emergence to the crop in 2002 occurred when the respective crop was in the V-1 growth stage, 29 May for both crops. Plants from weed seed sown at V-2 stage of crop growth emerged when the respective crop was in the V-3 growth stage. In 2003, weed seed sown pre-emergence to corn emerged from 6 d before corn emergence (velvetleaf) to 2 d after corn emergence (redroot pigweed) whereas all weeds in soybean emerged 2 d before soybean emergence. Weeds emerged from the late-sown weed seeds at V-4 of corn and V-3 of soybean. Seedlings from seed sown in noncrop areas in 2003 emerged at the same time as seedlings in the crop.

The development of barnyardgrass, redroot pigweed, and velvetleaf differed among species, planting dates, and the type of crop interference. Generally, plants that developed from seed sown before crop emergence had a larger canopy than plants that developed from seed sown at later dates. In 2003, it was evident that both corn and soybean greatly reduced the canopy area of each weed species when compared with plants grown without crop interference.

The maximum canopy area of barnyardgrass in corn was 500 cm<sup>2</sup> plant<sup>-1</sup> (0.54 ft<sup>2</sup>) (conversion to ft<sup>2</sup> is about 929 cm<sup>2</sup>/ft<sup>2</sup>) and 6000 cm<sup>2</sup> plant<sup>-1</sup> (6.45 ft<sup>2</sup>) in 2002 and 2003, respectively, when seeds were sown pre-emergence to corn. Barnyardgrass in soybean had canopy areas of < 300 cm<sup>2</sup> plant<sup>-1</sup> (0.32 ft<sup>2</sup>) in 2002 for plants from the four planting dates. In 2003, the largest plants in soybean were from seed sown pre-emergence that had an average canopy area of 1,000 cm<sup>2</sup> plant<sup>-1</sup> (1.1 ft<sup>2</sup>). The differences between the canopies of barnyardgrass in soybean may have been due to the narrow- vs. wide-row soybean planting in 2002 and 2003, respectively. In contrast to the plants grown with each crop, barnyardgrass from seed sown before crop emergence and grown alone in 2003 had a maximum canopy area of 12,000 cm<sup>2</sup> plant<sup>-1</sup> (12.9 ft<sup>2</sup>). Tillering accounted for the large canopy area of barnyardgrass, with individual plants having an average of 15 tillers plant<sup>-1</sup> in corn and up to 35 tillers plant<sup>-1</sup> when grown alone. Barnyardgrass plants from seed sown at the V-1 and V-2 stages of corn produced an average of 2 tillers plant<sup>-1</sup> in corn and

5 tillers plant<sup>-1</sup> when grown alone.

Redroot pigweed plants from the pre-emergence seeding had the greatest canopy area when compared with other seeding dates. In 2002, plants grown in corn and soybean averaged about 1,200 cm<sup>2</sup> plant<sup>-1</sup> (1.2 ft<sup>2</sup>) from the pre-emergence planting and < 200 cm<sup>2</sup> plant<sup>-1</sup> (0.22 ft<sup>2</sup>) for plants from the V-2 planting. In 2003, plants from seed sown at emergence had maximum canopy areas of 3,000 cm<sup>2</sup> plant<sup>-1</sup> (3.2 ft<sup>2</sup>), 1,000 cm<sup>2</sup> plant<sup>-1</sup> (1.1 ft<sup>2</sup>), and 5,500 cm<sup>2</sup> plant<sup>-1</sup> (5.9 ft<sup>2</sup>) for plants grown with corn, with soybean, and alone, respectively. Redroot pigweed plants from later-sown seeds in the crops remained small, with canopies of < 500 cm<sup>2</sup> plant<sup>-1</sup> (0.54 ft<sup>2</sup>).

Velvetleaf plants in 2002 had the greatest canopy area when planted before crop emergence. Maximum plant canopies ranged from two to six times less when seed was sown after the pre-emergence timing. Maximum velvetleaf canopy cover in corn was 1.5 times greater than the canopy produced in soybean. In 2003, the canopy areas of velvetleaf plants emerging from seeds sown pre-emergence to either corn or soybean were similar and averaged 3,900 (4.2 ft<sup>2</sup>) cm<sup>2</sup> plant<sup>-1</sup>. Velvetleaf plant canopies from V-1 or V-2 seedings were 2 to 20 times less than the canopies of plants from the pre-emergence seeding. Velvetleaf plants grown without crop interference (2003) had canopies two to four times larger than plants grown with crop interference. The largest velvetleaf canopy area was observed in plants that developed from seed sown at crop emergence.

The canopy area of barnyardgrass from seed sown before corn emergence

in 2003 was greater than the velvetleaf canopy area. Barnyardgrass produced many tillers that laterally spread into both row and interrow areas. Velvetleaf had one main stem and remained upright, limiting the area covered.

## HARVEST DATA

Corn yield averaged about 190 g plant<sup>-1</sup> (about 140 bu/A) and 160 g plant<sup>-1</sup> (about 120 bu/A) in 2002 and 2003, respectively. Soybean yield averaged about 40 g plant<sup>-1</sup> (about 40 bu/A) and 21 g plant<sup>-1</sup> (about 32 bu/A) in 2002 and 2003, respectively. Yield was reduced most often by plants that developed from seed sown before crop emergence.

No barnyardgrass survived in soybean to produce seed in either year although row spacing differed between years. In contrast, 50 percent of barnyardgrass plants from all planting times in corn survived and produced corn seed in 2002. There were no differences in barnyardgrass canopy area, biomass, or fecundity among these plants. The average number of seeds produced was 380 seeds plant<sup>-1</sup>. Corn grain yield was not influenced by barnyardgrass planting times. In 2003, about 85 percent of the barnyardgrass plants from seed sown from pre-emergence to V-1 and 30 percent of plants from seed sown at V-2 survived to produce seed. Barnyardgrass plants from seed sown before corn emergence had greater canopy area, were taller, and reduced corn yield 30 percent although the barnyardgrass biomass and seed number per plant were similar to plants from the other planting dates. Barnyardgrass fecundity when grown alone was 5 to 15 times greater than plants that developed from seed sown before or at crop emergence.

About 66 and 30 percent of the redroot pigweed plants in corn produced seed in 2002 and 2003, respectively. Plants produced from seed sown before

crop emergence in 2002 produced more seed than plants developing from seed sown at V-2 stage of crop growth in both crops. In 2003, plants from the earliest sowing produced many more seeds than the other plants, but due to high seed production variability among treatments, this value was not different than seed production of plants sown at other planting times. Redroot pigweed plants grown without interference generally had higher seed production than those grown in either crop. Corn yield across all planting times was similar to the weed-free control in 2002 whereas yield was reduced an average of 14 percent in 2003 regardless of planting date. Only plants that developed from the earliest-planted seed reduced soybean yield in 2002.

Velvetleaf plants had higher survival rates in corn than soybean. Seed capsule production in 2003 ranged from 0 on velvetleaf plants from seed sown at V-2 to 75 on plants from seed sown before crop emergence in both corn and soybean (data not shown). Similar numbers of velvetleaf seed were produced by plants from each planting time when compared across crops. Velvetleaf seed numbers were larger for plants grown without crop interference. Velvetleaf interference reduced corn yield by 10 percent except where plants developed from seed sown at V-2 stage. Soybean yield was reduced in both years only by velvetleaf plants that developed from seed sown before emergence. Yield reductions were 33 percent in 2002 and 47 percent in 2003.

Nitrogen fertilizer was applied to the soybean area, and all plots were irrigated. These conditions should have been optimal for both crop and weed growth, so that time of planting was the major influence of this study. Plants that emerged later in the crop cycle produced less seed than early emerged plants.

Soybean interference at either row

spacing generally reduced weed growth more than corn. Barnyardgrass plants did not produce seed in soybean, and redroot pigweed and velvetleaf plants that developed from seed sown at V-1 and V-2 produced no or very small amounts of seed. These three species at all planting times in corn survived and had greater fecundity than in soybean. However, the fecundity of these plants was low when plants emerged at or after the V-1 growth stage in either crop, and most likely, the seeds produced would have little impact on the soil seed bank. Nevertheless, control measures still may be needed. For example, if velvetleaf is not widespread in a field, just a few seeds from late-emerging plants may be cause for concern, whereas small additions of new seed from a more widely distributed species, like barnyardgrass, may not warrant control.

Further research should be conducted with higher weed densities to understand the balance between crop growth and the consequences of the late-emerging weeds. High densities of late-emerging plants may result in yield loss or lower fecundity of individual plants due to both intraplant and interplant competition for light, water, and nutrients. These changes may increase the return of seed to the seed bank due to more individuals producing seed in an area. In contrast, higher crop densities and more rapid and complete crop canopy coverage may counteract seed production of late-emerging weeds.

Whatever the case, the current results suggest that seed production from weeds that escape control by nonresidual burn-down herbicides may be more of a problem in corn than soybean. Managers should recognize this difference between crops and plan control strategies accordingly; e.g., split glyphosate applications or soil-residual plus post-emergence glyphosate in glyphosate-tolerant corn.



# Weed management: Growth and fecundity of several weed species in corn and soybean

## June Self-Study Examination

- 1. Considerations with late-emerging weeds include all of the following EXCEPT that they**
- a. are generally less of a concern when a herbicide with no residual activity is used.
  - b. can be the result of weed seed germination occurring throughout the growing season.
  - c. often remain green and interfere with harvest.
  - d. may produce high seed numbers that increase soil seed bank reserves.
- 2. As compared to earlier emerging weeds, a characteristic of late-emerging weeds is that they**
- a. are more competitive with the crop.
  - b. tend to produce more seeds.
  - c. have less biomass.
  - d. can be detrimental to wildlife populations.
- 3. An objective of this study was to**
- a. determine the yield loss potential of common weed species.
  - b. study weed biotypes common in Midwest crop rotations.
  - c. determine dominant weed species in corn and soybean ecosystems.
  - d. assess how weeds affect grain quality.
- 4. Plot management for this study included**
- a. DAP application.
  - b. different weed planting dates.
  - c. weed growth monitored twice weekly.
  - d. six-row plots.
- 5. A weed characteristic that was monitored included**
- a. weed branches or tillers.
  - b. number of leaves.
  - c. herbicide resistance tendencies.
  - d. weed seed dormancy.
- 6. Weed species that did not produce seed in any of the plots in any year included**
- a. yellow nutsedge.
  - b. barnyardgrass.
  - c. yellow and green foxtail.
  - d. velvetleaf.
- 7. A weed species where tillering accounted for a large part of the canopy area was**
- a. barnyardgrass.
  - b. yellow foxtail.
  - c. redroot pigweed.
  - d. yellow nutsedge.
- 8. As compared to their canopy in soybeans, maximum velvetleaf canopy in corn was**
- a. 3 times less.
  - b. 1.5 times less.
  - c. 1.5 times greater.
  - d. 3 times greater.
- 9. Factors that influenced weed canopy size included all of the following EXCEPT**
- a. crop row spacing.
  - b. time of weed planting as compared to time of crop emergence.
  - c. crop interference.
  - d. source of nitrogen fertilizer.
- 10. As a result of this study, one of the conclusions of the authors was that**
- a. late-emerging weeds may be more of a problem in corn than in soybeans.
  - b. barnyardgrass is an extremely competitive weed in soybeans.
  - c. due to lower canopy height, weed seed production is usually greater in soybeans.
  - d. it is difficult to control late-emerging weeds with herbicides.

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2. Answer the questions by clearly marking an "X" in the box next to the best answer for each question.
3. Complete the self-study exam registration form on the back of this page.
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**Rating Scale: 1=Poor 5=Excellent**

Information presented will be useful in my daily crop advising activities: 1 2 3 4 5

Information was organized and logical: 1 2 3 4 5

Graphics/tables were appropriate and enhanced my learning: 1 2 3 4 5

I was stimulated to think how to use and apply the information presented: 1 2 3 4 5

This article addressed the stated competency area and performance objective(s): 1 2 3 4 5

Briefly explain any "1" ratings: \_\_\_\_\_

Topics you would like to see addressed in future self-study materials: \_\_\_\_\_

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