TILLAGE SYSTEM AND CEREAL RYE RESIDUE AFFECTS PIGWEED ESTABLISHMENT AND COMPETITIVENESS IN COTTON

Andrew J. Price
Kipling S. Balkcom
Francisco J. Arriaga
Jason S. Bergtold
Randy L. Raper
Ted S. Kornecki
USDA-ARS
Auburn, AL

Abstract

An integral component of conservation-agriculture systems in cotton (*Gossypium hirusutum* L.) is the use of a winter cover crop; however, managing problematic weeds in such systems is a challenge. To evaluate pigweed (*Amaranthus* spp.) dynamics in conventional vs. conservation systems, a rye (*Secale cereale* L.) winter cover crop was established at the E.V. Smith Research and Extension Center located near Shorter, AL in the fall of 2006 and at the Tennessee Valley Research and Extension Center near Bella Mina, AL. Horizontal strips consisted of four conservation-tillage treatments: high, medium, and low amounts of cereal rye plus a winter fallow treatment, as well as a conventional tillage treatment that was left fallow prior to tillage. Additionally, vertical strips consisted of four herbicide regimes: 1) S-metolachlor at 1.12 kg/ha applied broadcast preemergence (PRE) application followed by (fb) glyphosate at 1.12 kg ae/ha applied postemergence (POST) fb a LAYBY application of diuron at 1.12 kg ai/ha plus MSMA at 2.24 kg ai/ha plus 0.25% (v/v) NIS, 2) S-metolachlor at 1.12 kg/ha applied banded PRE fb glyphosate at 1.12 kg/ha POST fb a LAYBY application of diuron at 1.12 kg /ha plus MSMA at 2.24 kg/ha plus 0.25% (v/v) NIS, 3) glyphosate applied at 1.12 kg/ha POST fb a LAYBY application of diuron at 1.12 kg/ha plus MSMA at 2.24 kg/ha plus 0.25% (v/v) NIS, and 4) a non-treated control. Cotton was then established after within-row sub-soiling at E.V. Smith and no-till at Tennessee Valley. At both locations, the highest rye biomass was attained following the earliest planting date and the lowest rye biomass was attained following the latest planting date. At both locations, the highest pigweed density was attained following the winter fallow conservation-tillage treatment; the second highest densities were attained following the conventional-tillage and third planting date conservation-tillage treatments; pigweed density decreased as winter cover residue increased. Also at both locations, cotton yield was not dependent on pigweed density or pigweed biomass. Additionally, all conservation-tillage treatments regardless of winter cover yielded more seed cotton lint than the conventional tillage treatment.

Introduction

Conservation-tillage systems are primarily used to address concerns about soil erosion, soil quality, and water availability (Blevins et al. 1971, Reeves 1997, Kaspar et al. 2001). Cotton acreage in conservation tillage systems is estimated to be 30% in the U.S. and approaches 60% in the southeastern U.S. (Anonymous 2003). The use of cover crops in conservation tillage offers many advantages, one of which is weed suppression through physical as well as chemical allelopathic effects (Nagabhushana et al. 2001). Cereal rye (*Secale cereale* L.) is one of the most common winter cover crops recommended for cotton production in the U.S.

Recently, glyphosate resistant Palmer amaranth (*Amaranthus palmerii*) has been discovered in Arkansas, Georgia, North Carolina, South Carolina, and Tennessee and populations in Alabama may also be resistance. Current resistant Palmer amaranth control recommendations in Georgia rely on soil applied herbicides (Cullpepper 2007). However, conservation tillage systems are disadvantaged due to herbicide interception by winter cover residue. An alternative method may be to band herbicides over the drill, thus protecting cotton yield while reducing inputs. Previous research has also shown that high amounts of residue can inhibit weed germination and emergence (Reeves at al. 2005, Price et al. 2006, Saini et al. 2006). We hypothesize that pigweed control will be higher in high-residue systems vs. low residue systems and at control levels equivalent to conventional tillage systems utilizing soil applied herbicides. Therefore, field studies were conducted evaluating pigweed density, biomass, and cotton yield provided by two tillage systems containing four winter residue amounts in the conservation tillage system and four herbicide systems.

Materials and Methods

Identical field experiments were established at the E.V. Smith Research and Extension Center located near Shorter, AL and at the Tennessee Valley Research and Extension Center near Bella Mina, AL in the fall of 2006. The experimental design was a randomized complete block, having a split block restriction on randomization, with three treatment replicates. Native populations of Palmer amaranth and redroot pigweed (*Amaranthus hybridus*) were present at E. V. Smith and Tennessee Valley locations, respectively. However, an additional 120,000 seed of each respective pigweed species was broadcast early spring over each plot at each location, to assure an adequate seedbank.

The experiment involved two tillage systems, four winter residue amounts in the conservation-tillage system, and four herbicide regimes. Parallel strips consisted of four conservation-tillage treatments: high (PD1), medium (PD2), and low (PD3) amounts of cereal rye plus a winter fallow treatment, as well as a conventional tillage treatment that was left fallow prior to spring tillage. The three cereal rye residue amounts were generated by utilizing three fall planting dates: 2 and 4 wks prior to and on the historical average first frost. The rye was established with a no-till drill at a seeding rate was 100 kg/ha; 56 kg of nitrogen (N) as ammonium nitrate was applied to rye in fall after establishment. Additionally, perpendicular strips consisted of four herbicide regimes: 1) S-metolachlor at 1.12 kg/ha applied broadcast preemergence (PRE) application followed by (fb) glyphosate at 1.12 kg ae/ha applied postemergence (POST) fb a LAYBY application of diuron at 1.12 kg ai/ha plus MSMA at 2.24 kg ai/ha plus 0.25% (v/v) NIS, 2) S-metolachlor at 1.12 kg/ha applied banded PRE fb glyphosate at 1.12 kg/ha POST fb a LAYBY application of diuron at 1.12 kg /ha plus MSMA at 2.24 kg/ha plus 0.25% (v/v) NIS, 3) glyphosate applied at 1.12 kg/ha POST fb a LAYBY application of diuron at 1.12 kg/ha plus MSMA at 2.24 kg/ha plus 0.25% (v/v) NIS, and 4) a non-treated control.

In the spring, the rye cover crop as well as weeds in the winter fallow treatment were terminated using glyphosate at 1.12 kg ae/ha and flattened prior to cotton seeding with a mechanical roller-crimper to form a dense residue mat on the soil surface. Cover biomass from each plot was measured immediately before termination; the above-ground portion of the rye cover was clipped from one randomly-selected 0.25-m^2 section in each plot, dried and weighed.

The cotton variety DP 555 BG/RR was seeded at E.V. Smith following within-row subsoiling all plots with a narrow-shanked parabolic subsoiler, equipped with pneumatic tires to close the subsoil channel. Subsoiling was necessary because this location had a well-developed hardpan. The cotton variety DP 444 BG/RR was direct-seeded at Tennessee Valley. The conventional tillage treatment was prepared with multiple disk passes and cotton was seeded with a four-row planter equipped with row cleaners and double-disk openers at both locations. Both experimental areas were exposed to extreme drought, and the experimental area at E.V. Smith received minimal supplemental irrigation so that the experiment was not terminated. Plot size was four-rows (102 cm row spacing) wide at both locations by 6 m in length.

Evaluations also included pigweed density, dry weight and fresh weight before and after POST and LAYBY herbicide applications, cotton stand establishment and height, and cotton seed lint yields were determined by machine-harvesting the middle two rows of each plot with a spindle picker. Due to recommended manuscript limits, results from the herbicide regimes have been omitted.

Results and Discussion

Winter Cover Crop Biomass and Weed Density

At both locations, the highest rye biomass was attained following the earliest planting date (PD1) and the lowest biomass was attained following the latest planning date (PD3) (Figures 1 and 2). At Tennessee Valley, biomass yields of 8,680, 7,390 and 6,430 kg/ha were attained for planting dates one, two and three, respectively (Figure 1). At Tennessee Valley, the highest pigweed density (1,073,000 plants/ha) was observed following the winter fallow conservation-tillage (WF) treatment. The second highest densities were observed following the third planning date (493,000 plants/ha) and the conventional-tillage (CT) (560,000 plants/ha) treatments. The lowest densities followed the first (90,000 plants/ha) and second planting dates (123,000 plants/ha). At E.V. Smith, biomass yields of 8,430, 6,050 and 4,170 kg/ha were attained for planning dates one, two and three respectively (Figure 2). At E.V. Smith, the highest pigweed density again followed the winter fallow conservation-tillage treatment (797,000 plants/ha). The second highest density followed the conventional-tillage treatment (580,000). All three conservation-tillage systems provided lower densities ranging between 210,000 and 230,000 plants/ha compared to both the winter fallow conservation tillage and conventional tillage treatments.

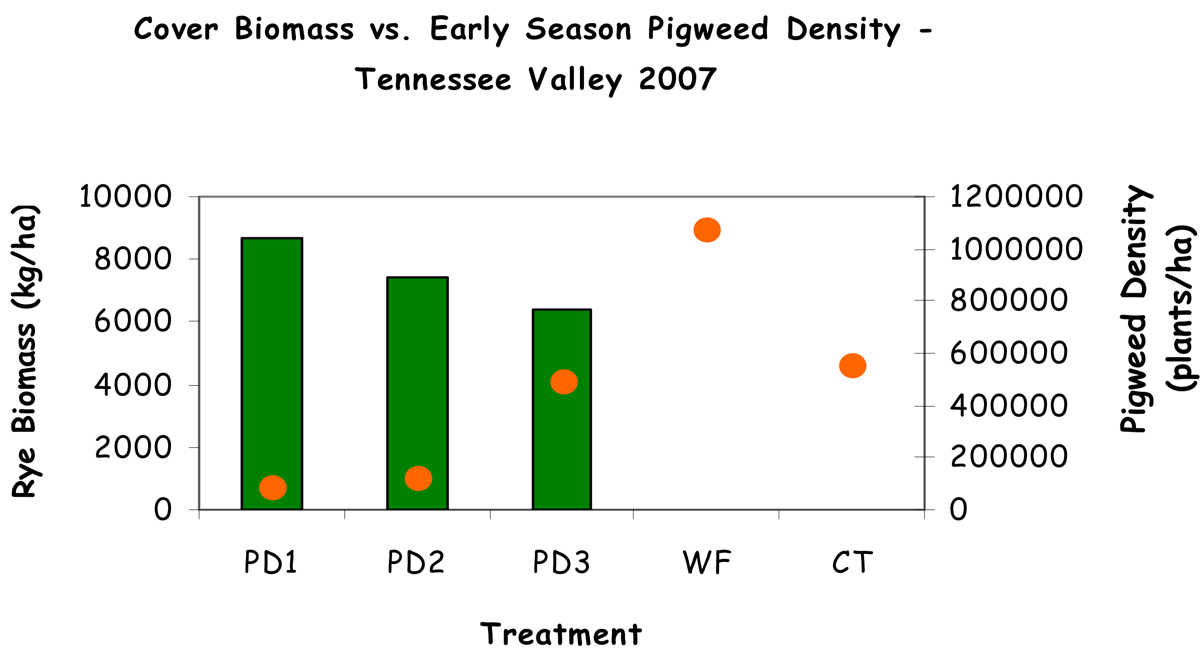

Figure 1. Bars represent rye biomass, dots represent pigweed density.

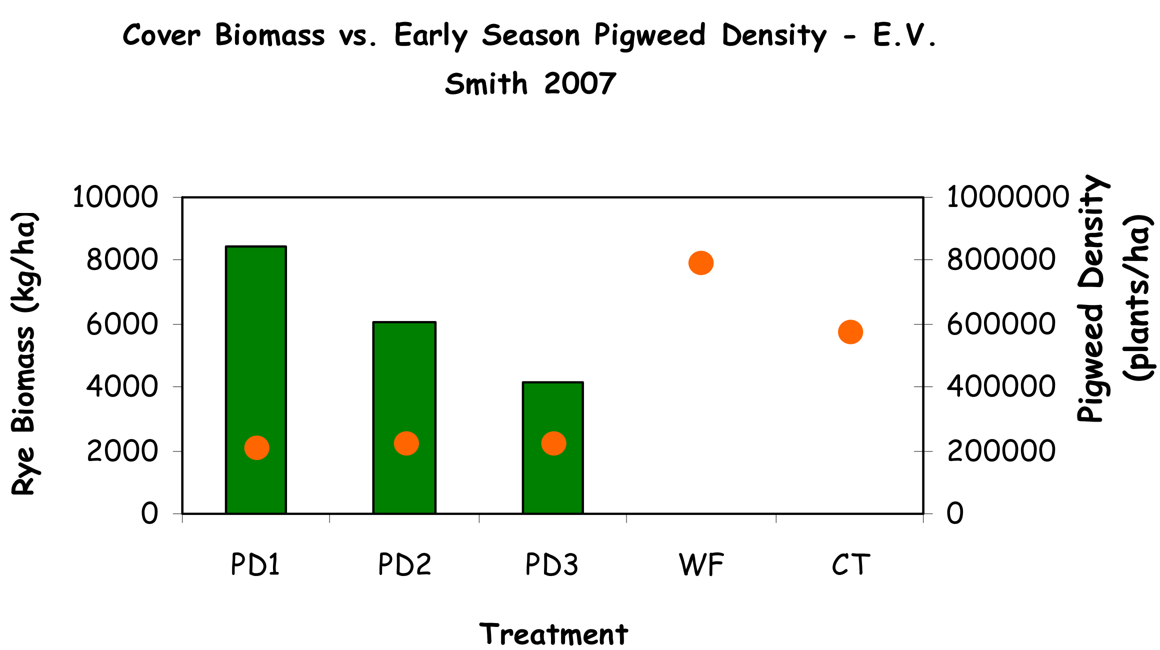

Figure 2. Bars represent rye biomass, dots represent pigweed density.

Winter Cover Crop Biomass and Pigweed Biomass

Differences between location, and thus pigweed species biomass response, were significant. At Tennessee Valley, redroot pigweed biomass generally reflected pigweed density, with the highest pigweed biomass (270 kg/ha) attained in winter fallow conservation tillage and conventional tillage (200 kg/ha) treatments (Figure 3). Planting date three resulted in 20 kg biomass/ha while planting dates one and two resulted in < 3kg biomass/ha. At E.V. Smith, similar Palmer amaranth biomasses were observed in the winter fallow conservation tillage (85 kg/ha) and conventional tillage treatments (95 kg/ha) (Figure 4). Densities of 60 kg/ha and 55 kg/ha were observed in planting date treatments one and two, respectively. However, the third planning date which provided similar pigweed density compared to planning dates one and two provided the lowest pigweed biomass (25 kg/ha). Because the experimental area experienced severe drought stress throughout the season, the larger pigweed in the earlier planting dates may be due to increased moisture conservation provided by the higher mulch residue attained in these treatments, resulting in larger plants.

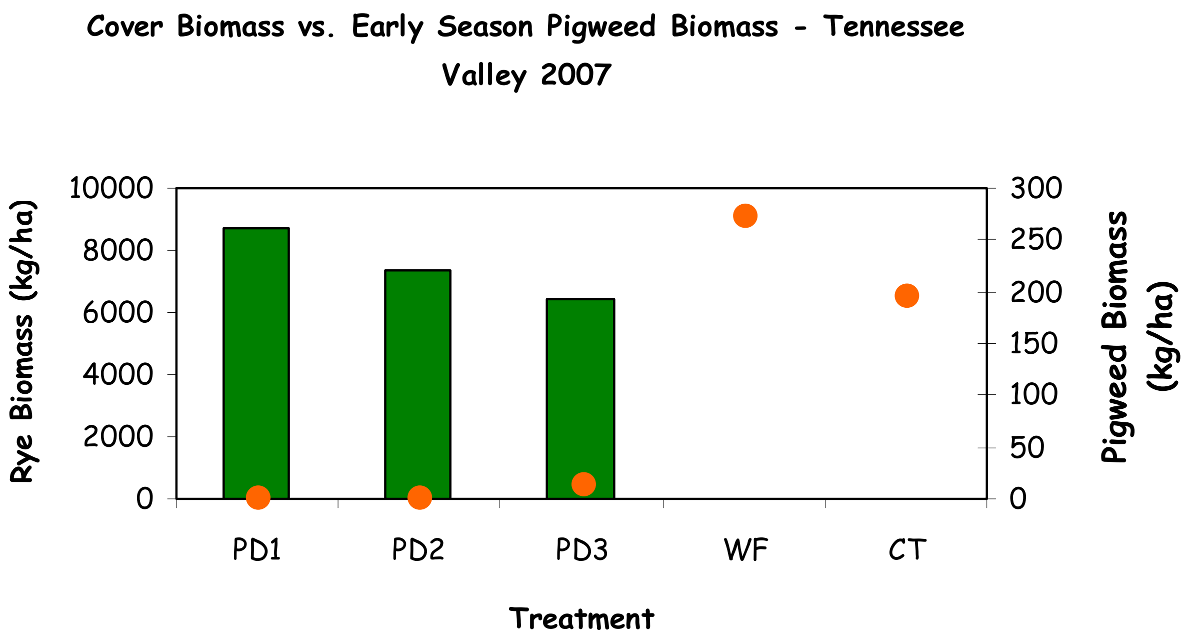

Figure 3. Bars represent rye biomass, dots represent pigweed biomass.

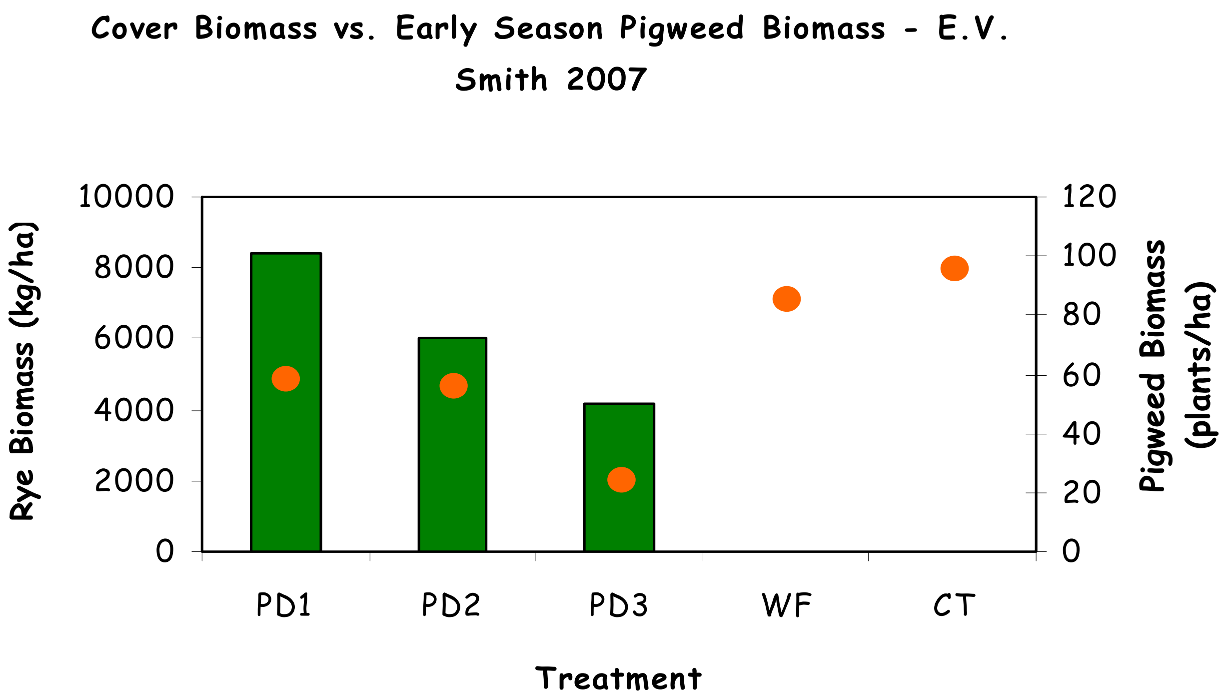

Figure 4. Bars represent rye biomass, dots represent pigweed biomass.

Cotton Yield

At Tennessee Valley and E.V. Smith, cotton yield was not dependent on pigweed density (Figures 5 and 6) or pigweed biomass (data not shown). Additionally, all conservation-tillage treatments yielded more seed cotton lint than the conventional tillage treatment.

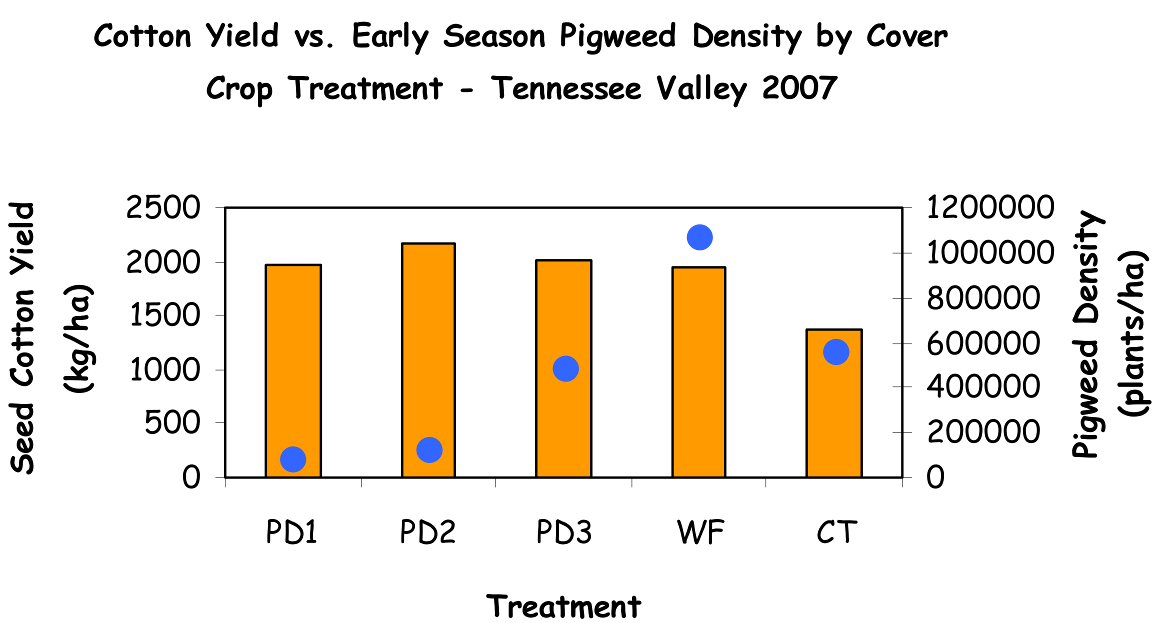

Figure 5. Bars represent cotton yield, dots represent pigweed density.

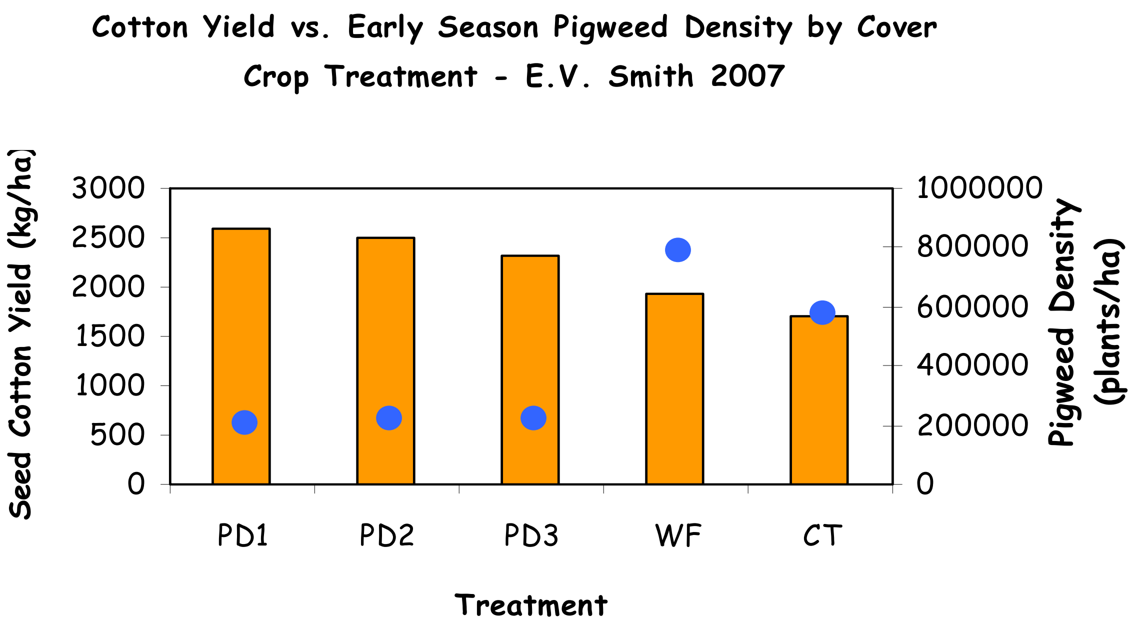

Figure 6. Bars represent cotton yield, dots represent pigweed density

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Conclusions

- Increasing amounts of winter cover biomass can decrease early season pigweed density in conservation-agriculture systems, thus allowing for a size differential between pigweed and crop for future herbicide applications.
- Conservation-agriculture systems that do not utilize high-residue winter cover crops may have increased pigweed densities.
- Weed control provided by shallow tillage is similar to conservation-agriculture systems that have moderate amounts of residue; systems with maximum levels of residue will have fewer pigweed.

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