Residue-Management Practice Effects on Soybean Establishment and Growth in a Young Wheat-Soybean Double-Cropped System

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BACKGROUND INFORMATION AND RESEARCH PROBLEM

Long-term sustainability of farmland and escalating production costs are increasing concerns of today's growers. Alternative soybean [*Glycine max* (Merr.) L.] management systems, such as double-crop production, can serve to promote sustainability and increase farm earnings.

Wheat (*Triticum aestivum* L.) is typically harvested in late spring, and soybean yield loss commonly occurs if planting is delayed beyond June 15 (UACES, 2000); thus expeditious planting of soybean after wheat harvest is imperative. Many growers burn wheat residue directly after wheat harvest to improve seedbed preparation and eliminate possible sites for insect pests and plant pathogens. Aside from these advantages, NeSmith et al. (1987) concluded that burning residue was a matter of convenience and was of no agronomic benefit.

Though residue burning is popular, some growers have adopted alternative post-wheat harvest operations such as conservation tillage or no-tillage (NT). New and improved equipment has made planting more feasible in high-residue conditions (Kelley and Sweeney, 1998). New methods produce comparable yields to conventional tillage (CT) and reduce production costs (Touchton and Johnson, 1982).

Many studies have addressed the effect of NT on soybean yield, but few have dealt with the effect of burning on soybean production in a wheat-soybean double-crop system in the mid-South. Therefore, the objective of this study was to evaluate the effects of alternative wheat residue-management practices (i.e., CT vs. NT, burn vs. no burn, and high vs. low wheat residue levels) on soybean establishment, growth, and grain yield within the first two cycles of a wheat-soybean double-crop production system.

PROCEDURES

Research was conducted on silt-loam Alfisols at the Pine Tree Branch (PTBS) and Cotton Branch (CBES) Experiment Stations. Prior to the initiation of this study, both study locations were cropped under CT; thus the results of this study represent a short-term NT history. Previous crops were sorghum (*Sorghum bicolor* L.) and soybean at PTBS and CBES, respectively. The research area was established at both locations in Spring 2002 and repeated in Spring 2003.

In Fall 2001 and 2002, 'Coker 9663' wheat was drill-seeded with a 7.5-inch row spacing at both locations. In Spring 2002, 48 10-ft by 20-ft plots were established at both locations. In 2003, the exact same plots as in 2002 were used again. All plots were fertilized with a 90 lb/acre broadcast application of N as urea (46% N) in early March 2002 and 2003. To obtain different levels of wheat residue, one half of the plots were fertilized with an additional 90 lb N/acre broadcast application as urea during the late-jointing stage in late March 2002 and 2003.

After wheat harvest in early June 2002 and 2003, the residue-burning treatment was imposed on half of the plots. Following burning each year, the CT treatment was imposed. Glyphosate-resistant soybean, 'Pioneer 95B32', maturity group 5.3, was drill-seeded with a 7-in row spacing at both locations each year. Soybeans were harvested in early November 2002 by hand due to wet soil conditions, but were harvested using a plot combine in late October 2003. Soybean yields from 2002 and 2003 were adjusted and reported on a 13% moisture basis. To capture potential effects of tillage, burning, and wheat-residue level throughout the growing season in addition to final yield, plant populations were measured early in the growing season (i.e., 8 to 10 and 30 days after planting) and at mid-season growth and development were evaluated by measuring soybean leaf-area index (LAI) at roughly the R6 stage.

Due to dissimilar cropping histories between locations and the recent establishment of the NT production system, year was not explicitly tested as a factor affecting any soybean measurement in this study. Similarly, due to dissimilar fertilization schemes prior to the initial wheat crop and dissimilar soybean seeding rates between locations and years, location was also not explicitly tested as a factor affecting soybean response to tillage, burning, or residue level. Therefore, for each year-location combination, an analysis of variance was conducted to determine the effects of burning, tillage, residue level, and their interactions on early-season plant population, mid-season LAI, and soybean yield using SAS (Version 8.1, SAS Institute, Cary, N.C.).

RESULTS AND DISCUSSION

Burning, tillage, and wheat-residue level each affected early-season soybean plant population at some point during the two-year study. By 8 days after planting (DAP) in 2002, the soybean population was higher ($P = 0.0125$) under the burn (2.2 plants/m) than no-burn treatment (1.1 plants/m) at CBES. Neither tillage nor wheat-residue level affected soybean plant populations by 8 DAP at CBES in 2002. In contrast, the soybean population was higher ($P = 0.0069$) under the low (3.5 plants/m) than high wheat-residue-level treatment (2.0 plants/m) by 8 DAP at PTBS in 2002. Neither tillage nor burning affected soybean plant populations by 8 DAP at PTBS in 2002.

By 10 DAP in 2003, only tillage affected soybean population at CBES, where the soybean population under NT (10.0 plants/m) was higher ($P = 0.0053$) than under CT (7.3 plants/m). Neither burning nor wheat-residue level affected soybean populations by 10 DAP at CBES in 2003. Similarly, neither tillage, burning, nor wheat-residue level affected soybean populations by 10 DAP at PTBS in 2003.

By 30 DAP, it is not unreasonable to expect similar effects on soybean populations as were evident earlier in the growing season (i.e., at 8 or 10 DAP). However, there were no consistent effects on soybean population by 30 DAP as existed at 8 DAP in 2002 at either location. Neither tillage, burning, nor wheat-residue level affected soybean populations at CBES by 30 DAP in 2002. In contrast to the effects on soybean populations by 30 DAP at CBES in 2002, only tillage affected soybean populations by 30 DAP at PTBS in 2002, where soybean populations were higher ($P = 0.0143$) under NT (13.3 plants/m) than under CT (3.7 plants/m).

Similar to 10 DAP, neither tillage, burning, nor wheat-residue level affected soybean populations by 30 DAP at PTBS. However, similar to the results at 10 DAP, tillage also affected soybean population by 30 DAP at CBES, such that soybean planted under NT had a higher ($P = 0.0075$) population (11.0 plants/m) than soybean planted under CT (8.1 plants/m). In addition to a significant tillage effect, wheat-residue level affected soybean population by 30 DAP at CBES in 2003, such that soybean planted into the high wheat-residue treatment resulted in a higher ($P = 0.0037$) population (10.9 plants/m) than soybean planted in the low wheat-residue treatment (8.2 plants/m).

Neither burning nor wheat-residue level affected soybean LAI approximately 90 DAP at either location in 2002 or 2003. However, tillage significantly ($P < 0.03$) affected soybean LAI at PTBS in both years. In 2002, soybean LAI was significantly higher under NT (4.7 m^2/m^2) than CT (2.1 m^2/m^2) at PTBS. Similar to 2002, soybean LAI was significantly higher under NT (3.2 m^2/m^2) than CT (2.7 m^2/m^2) at PTBS in 2003. Neither tillage, burning, nor wheat-residue level affected soybean LAI at CBES in 2003.

Early- and mid-season soybean establishment, growth, and development patterns would be expected to manifest themselves by the end of the growing season in soybean yield. Soybean plant population by 30 DAP at CBES in 2003 ($P = 0.006$ and $r = 0.39$) and mid-season LAI at both locations in 2003 ($P = 0.041$ and $r = 0.30$ at CBES; $P = 0.001$ and $r = 0.46$ at PTBS) were significantly, though weakly, correlated with soybean yield. However, despite significantly higher soybean LAI under NT than CT in both years at PTBS and a significant correlation between LAI and yield in 2003 at both locations, neither tillage, residue burning, nor wheat-residue level affected soybean yield at either location in either year. Soybean yield averaged 62.5 [standard error (SE) = 3.0] bu/acre [4.2 (SE = 0.2) Mg/ha] at CBES and 46.1 (SE = 3.0) bu/acre [3.1 (SE = 0.2) Mg/ha] at PTBS in 2002. In 2003, soybean yield decreased somewhat from that in 2002, averaging 54.6 (SE = 1.5) bu/acre [3.6 (SE = 0.1) Mg/ha] at CBES and 34.2 (SE = 1.5) bu/acre [2.3 (SE = 0.1) Mg/ha] at PTBS.

PRACTICAL APPLICATIONS

The lack of significant tillage and burning effects on soybean yield are important results indicating that soybean grown under NT performed equally as well as soybean grown under CT. Similarly, soybean grown without burning wheat residue performed equally as well as soybean grown following residue burning. In the case of tillage, fewer passes across a field under NT than CT likely results in lower on-farm expenses to prepare for soybean planting in the wheat-soybean double-crop production system. Results of this study indicate no consistent advantage of wheat-residue burning over non-burning and that the combination of NT and non-burning wheat residue can be sound management alternatives that can maintain agricultural production at a high level.

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