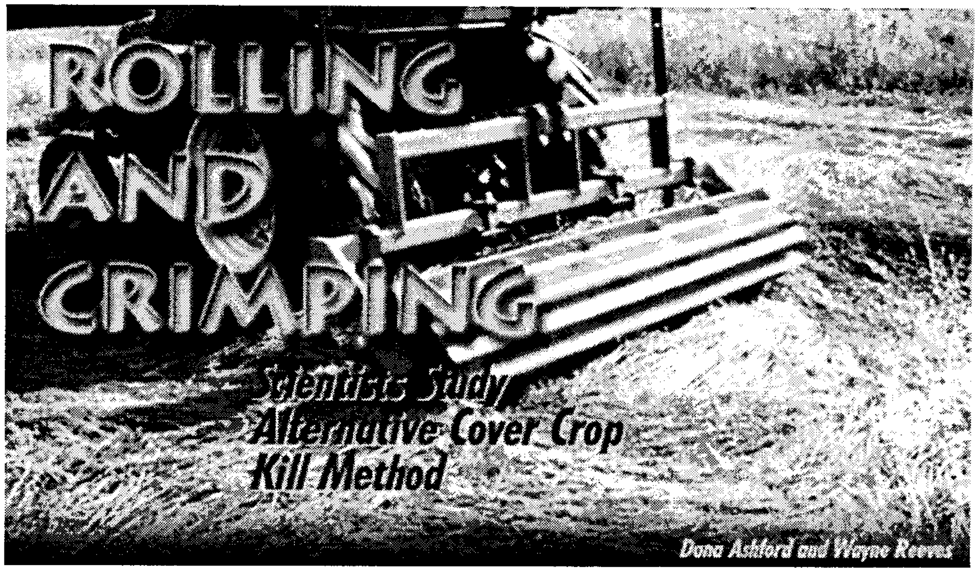
AAES HIGHLIGHTS
A Magazine of Research from the Alabama Agricultural Experiment Station at Auburn University



Alabama is a major leader in conservation tillage adoption, increasing acreage 400% since 1996. Growers are constantly looking for ways to reduce input costs and more effectively manage cover crops used in these systems. AAES and USDA-ARS researchers investigated a popular Brazilian cover crop management concept, i.e., using a mechanized roller-crimper to kill cover crops, for use by Alabama farmers. The roller-crimper provides additional benefits compared to herbicides used alone, as it lays residue flat on the soil surface, providing maximum soil coverage, preventing erosion, decreasing soil water loss, enhancing weed control, and facilitating no-till planting.

Cover crops have long been recognized as a beneficial part of many cropping systems. Planted in the fall or winter on fallow land, the crops help control soil erosion and often add nutrients to the soil as they grow. Before planting the spring and summer cash crops, however, cover crops must be killed so they don't compete with the following crop. Traditionally, small grain cover crops have been killed using non-selective desiccant or systemic herbicides, usually paraquat or glyphosate. However, herbicide cost can add expense for a farmer, and there is increased concern by the public, both founded and unfounded, about the use of agricultural chemicals. These concerns, along with increasing input costs, have lead some farmers to look for alternative ways to terminate cover crops.

Rolling cover crops as a mechanical method of kill has been used effectively on millions of acres in southern Brazil and Paraguay as a part of conservation tillage systems, but has not been evaluated in the United States. The objectives of this research project were to determine the effectiveness of the roller-crimper as a cover crop kill method and the optimum time for its use with three small grain cover crops in terms of an easily identifiable growth stage.

The project was performed over three site-years at the Field Crops and Plant Breeding Units of the E. V. Smith Research Center in Shorter. Five cover crop kill methods were evaluated for three small grain cover crops at four growth stages. The cover crops used were 'Elbon' rye (*Secale cereale* L.), 'Coker 9803' wheat (*Triticum aestivum* L.), and 'SoilSaver' black oat (*Avena strigosa*

Schreb.). SoilSaver black oat is a promising cover crop recently developed and released for use in the lower Coastal Plain by the AAES in cooperation with the Conservation Systems Research Team at the USDA-ARS Soil Dynamics Research Unit.

Four easily identifiable growth stages for each small grain were evaluated: flag leaf, anthesis (flowering), early milk, and soft dough. The five kill methods investigated were: roller-crimper alone, glyphosate at full label rate (three pints per acre), paraquat at full label rate (one quart per acre), half the label rate of glyphosate (1.5 pints per acre) + roller-crimper, and half the label rate of paraquat (0.5 quarts per acre) + roller-crimper. For combination treatments the herbicide was applied and the cover immediately rolled. The roller-crimper used was a drum roller with horizontal blunt steel metal strips, which crushed the cover crop, leaving plant stems intact (**see picture above**).

Cover crops were drilled into stale seed beds at a rate of 90 pounds per acre in November 1998 and 1999. Kill treatments were applied when at least 65% of the plot was at the desired growth stage. At each growth stage, prior to kill treatment application, samples of each cover crop were taken to measure biomass and carbon to nitrogen ratio (C:N). Percent kill visual rating were made 28 days after treatment. The 1999 data indicated the critical termination period lay between anthesis and soft dough growth stages. Therefore during 2000, the last growth stage tested was changed to early milk. Soil water content measurements were also taken 28 days after treatment in 1999 to determine the amount of soil water available to a following cash crop.

In 1999, maximum biomass for rye (8,480 pounds per acre) and wheat (9,380 pounds per acre) occurred at soft dough, while SoilSaver black oat reached maximum biomass (7,680 pounds per acre) at anthesis. Attaining maximum biomass at an early growth stage is beneficial, as it allows greater residue production for an earlier planting date for a cash crop. Biomass production by black oat was reduced by extremely cold temperatures during early development; early January temperatures were as low as 14 $^{\circ}$ Fahrenheit.

In 2000, all cover crops reached maximum biomass at the early milk growth stage. Rye and black oat achieved higher biomass (9,560 and 9,640 pounds per acre, respectively) than wheat (6,880 pounds per acre). These two crops reached high biomass by anthesis, which as previously noted would allow for earlier termination and an earlier summer cash crop planting. SoilSaver black oat was specifically bred for use as a cover crop and forage, while rye and especially wheat have been bred as grain crops. Thus, wheat produces a greater percentage of its biomass as grain, not as stems that become soil and water-conserving residue.

The carbon to nitrogen ratio (C:N) of the residue provided by these cover crops is an important indicator of how long it covers the soil. A high ratio slows residue breakdown, which is beneficial, however, a high ratio can be a disadvantage when nitrogen is immobilized. Rye had the greatest C:N of 56:1, while black oat and wheat had similar ratios (40:1), consistently lower than rye. SoilSaver black oat provided a large amount of residue, resistant to decomposition, but with less nitrogen immobilization potential than rye.

During 1999, at flag leaf, the label rate of paraquat and the half-label rate paraquat + roller-crimper combination had a significantly lower kill, especially on black oat (26 and 28%, respectively), than glyphosate treatments (**Figure 1**). The roller-crimper alone did not effectively kill plants at flag leaf (13%, 16%, and 26% termination for black oat, rye, and wheat, respectively). At flag leaf, cover crop stems were relatively short, which hindered kill by the roller-crimper alone. At anthesis, the label rate of paraquat and the half-label rate paraquat + roller-crimper combination were as effective as the glyphosate treatments. Roller-crimper efficacy increased at anthesis to an average of 81%, but this is still significantly less than chemical and combination treatments at this growth stage. At anthesis, the roller-crimper was most effective on black oat (88%) compared to wheat (81%) and rye (74%). By soft dough, all kill methods were equally effective due to accelerating plant maturity (95% mean kill across all cover crops and methods). At anthesis and soft dough, a combination of the roller-crimper and a half rate of either herbicide performed just as well as the herbicides alone at the label rate.

The 1999 data indicated the critical period lay between anthesis and soft dough growth stages. Therefore during 2000, the last growth stage tested was changed to the early milk stage. The full rate of glyphosate had equal kill effectiveness on all cover crops at all growth stages, averaging 95%. Paraquat at the full label rate was more effective at the flag leaf stage on rye (94%) compared to wheat (81%) and black oat (80%). Similar results were seen with the half-label rate paraquat + roller-crimper combination, it was more effective on rye (88%) than on black oat (61%) and wheat (51%). At the flag leaf growth stage, the effectiveness of the roller-crimper was low with a kill mean of only 16% across all covers (**Figure 2**), similar to the 1999 results. Roller-crimper efficacy increased at anthesis to 85%. However, waiting until early milk (usually only seven to 10 days after anthesis) resulted in 93% effectiveness by the roller-crimper; the average effectiveness of all other treatments was 95% averaged over cover crops.

There were a few distinguishable similarities across all site-years. The flag leaf stage was too early to get an effective kill when using the roller-crimper alone. By anthesis, the half-label rate + roller-crimper combinations were as effective as the label rate of either chemical used alone. By waiting the additional seven to 10 days after anthesis to early milk (or later to the soft dough growth stage), kill of all three cover crop species was very good with the roller-crimper alone.

Soil water content was measured 28 days after treatment to determine the amount of soil water which would be available to a cash crop planted after the cover crop. The soils at the two sites varied in texture from sandy loam to loamy sand. For reference, water content for these soils types is typically 11.2% at field capacity and 5.4% at the permanent wilting point.

Ineffective kill methods resulted in depletion of soil water by still-growing cover crops and soil water increased with percent kill. Glyphosate treatments, which resulted in the best kill, had the highest soil water content for all cover crops at flag leaf (11.0%). At flag leaf, the roller-crimper alone was the least effective kill method and therefore resulted in the lowest soil water content in all cover crops (5.0%), which not adequate to plant a cash crop. There were no significant differences in soil water for any cover crop as a result of kill method at anthesis or soft dough (soil water averaged 10.3%), as a result of the high kill efficacy at these growth stages.

This study shows it is possible using a roller-crimper to effectively terminate cereal cover crops. When termination occurs at early milk or later, the use of herbicides may be eliminated; at this stage, all kill methods were equally effective (94% across all cover crops). Researchers observed that no-till planting in the same direction as the cover crop is rolled lays residue flat on the soil surface, facilitates seed-soil contact, and maximizes soil coverage, thereby preventing erosion, decreasing soil water evaporation, and enhancing weed control.

The variable cost of using a roller-crimper (based on data for a similar implement in the 2001 ACES Budgets for Crop Enterprises in Alabama) is estimated to be $1.51 per acre. Standard herbicide applications costs, at current prices and label rates, are $12.00 per acre for glyphosate and $10.19 per acre for paraquat. Risk averse farmers could use half-label rate + roller-crimper combinations after anthesis, while organic farmers may benefit by delaying kill until early milk or later and eliminating herbicides. Producers should note, however, that usage of a herbicide in a manner inconsistent with the label is technically a federal violation. Therefore, it will be necessary for herbicide manufacturers to adjust labels to address use with roller-crimpers.

Ashford is USDA-ARS Soil Dynamics Research Unit Agronomist (formerly Graduate Research Assistant of Agronomy and Soils) and Reeves is USDA-ARS Soil Dynamics Research Unit Research Agronomist and Affiliate Professor of Agronomy and Soils.

Top **Table of Contents**