

# ROLLER VS. HERBICIDES: AN ALTERNATIVE KILL METHOD FOR COVER CROPS

D.L. Ashford<sup>1</sup>, D.W. Reeves<sup>2</sup>, M.G. Patterson<sup>1</sup>, G.R. Wehtje<sup>1</sup>, and M.S. Miller-Goodman<sup>1</sup>

---

AUTHORS: <sup>1</sup>Agronomy and Soils Dept., USDA-ARS NSDL, 411 S. Donahue Dr., Auburn University, Auburn, AL 36832 and <sup>2</sup>USDA-ARS National Soil Dynamics Laboratory, Auburn, AL 36832. Corresponding author: D.L. Ashford (dashford@acesag.auburn.edu).

---

## ABSTRACT

Identifying more cost effective and perceived environmentally friendly techniques for cover crop management can increase their use. This study was conducted to determine the effectiveness and economic viability of using a mechanical roller-crimper as an alternative kill method for cover crops. Three cover crops, rye (*Secale cereale* L.), wheat (*Triticum aestivum* L.), and black oat (*Avena strigosa* Schreb.) were evaluated in terms of ease of kill and optimum time of kill using a roller-crimper, two herbicides (paraquat and glyphosate), and two reduced chemical rate (half label rate) combinations with the roller. During 1998-1999, the study took place at two locations in east-central Alabama, using a split-split plot experimental design with four replications. Three Feekes' scale growth stages were used to determine optimum time of kill: 8.0 (flag leaf), 10.51 (anthesis), and 11.2 (soft dough). Percent kill measurements were taken 14 d after treatment application. Black oat reached maximum biomass at anthesis (7660 lb/A), while rye and wheat continued to increase biomass significantly through soft dough (8480 and 9340 lb/A, respectively). There was a significant interaction between growth stage and kill method; by soft dough, kill methods were equally effective due to accelerating plant senescence (95% mean kill across kill methods). The label rate of glyphosate and 1/2 label rate+roller combination produced the best kill mean, 91 and 89%, respectively, at all growth stage levels across all cover crops. However, at anthesis, the label rate of paraquat and 1/2 label rate+roller combination were as effective (mean 89% kill) as glyphosate.

This study shows that it is possible to reduce the use of herbicides and implement effective alternative kill methods for cover crops.

## INTRODUCTION

Cereal cover crops are useful to growers in many ways (Reeves, 1994); however, growers must have an effective and cost efficient way to kill covers when they are ready to plant their cash crop. Mechanical rollers have been used effectively on millions of acres of conservation tilled land in southern Brazil and Paraguay (Derpsch et al., 1991). In the United States, the roller is a relatively new cover crop kill method but there is growing producer, as well as commercial, interest in this implement. The objectives of this study were three-fold: 1) determine the effectiveness and economic viability of the roller compared with herbicides as a cover crop kill method; 2) determine the optimum kill time for three cover crops in terms of growth stage; and 3) identify any differences in ease of kill for three cover crops using the roller.

## MATERIALS AND METHODS

The study was conducted at two locations in east-central Alabama on a Compass loamy sand (coarse-loamy, siliceous, subactive, thermic Plinthic Paleudults) and a Cahaba sandy loam (fine-loamy, siliceous, semiactive, thermic Typic Hapludults) using a split-split plot experimental design with four replications. Whole plots were three small grain cover crops: rye (*Secale cereale* L.), wheat (*Triticum aestivum* L.), and black oat (*Avena*

*strigosa* Schreb.). Three easily identifiable Feekes growth stages (Large, 1954) were the subplots: 8 (flag leaf), 10.51 (anthesis), and 11.2 (soft dough). Sub-subplots were five kill methods: roller only, glyphosate at 3 pt/A (label rate), paraquat at 1 qt/A (label rate), roller+glyphosate at 1.5 pt/A (half label rate), and roller+paraquat at 0.5 qt/A (half label rate). Herbicide treatments were applied first, immediately followed by rolling on specified plots. The roller used was a drum roller with horizontal welded blunt steel metal strips, which made it possible to crush the cover crop, facilitating kill by leaving plant stems intact yet discouraging regrowth (see photo).

Cover crops were planted into a stale seedbed at a rate of 90 lb/A on November 18, 1998, using an 8-ft grain drill. 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, we took two biomass samples equivalent to a total of 5.4 ft<sup>2</sup> within each subplot for each cover crop. Percent kill measurements were taken using a visual rating method at 7, 14, 21, and 28 days after treatment (DAT). Visual measurements were made using a 0-10 scale, with 0 being no kill and 10 being complete kill. In addition, plant moisture content was determined to backup the visual percent kill measurements. Gravimetric soil water content measurements (Gardner, 1986) were taken 28 DAT to determine the amount of soil water available to a cash crop planted after the cover crop. Soil samples were taken in the top 3 inches of soil (cash crop seed zone) in each sub-subplot using a hand-held soil probe.

There were no significant location interactions observed, so data were averaged over locations. All data were analyzed using an analysis of variance (ANOVA) with SAS (SAS Inst., 1988); means were separated using the least significant difference (LSD) test at  $P \leq 0.10$ .

## RESULTS AND DISCUSSION

### Cover Crop Biomass Production

A significant cover crop by growth stage interaction was observed ( $P \leq 0.05$ ). Black oat reached maximum biomass at anthesis (7660 lb/A), while rye and wheat continued to increase biomass significantly through soft dough (8480 and 9340 lb/A, respectively). The early maturity of black oat may be beneficial to growers as it allows for a larger planting window for cash crops.

### Percent Kill

A strong linear relationship between plant moisture content and visual percent kill ratings was observed ( $R^2=0.58$ ). The visual ratings will be presented here. Percent kill measurements were taken at 7, 14, 21, and 28 DAT; however, after 14 DAT, there were no significant increases in percent kill ( $P \leq 0.05$ ). Consequently, only the 14 DAT measurements are presented.

There was a significant cover crop by growth stage by kill method interaction ( $P \leq 0.01$ ); by soft dough, kill methods were equally effective due to accelerated plant senescence (95% mean kill across cover crops and all kill methods). The label rate of glyphosate and 1/2 label rate+roller combination produced the best kill mean, 91 and 89%, respectively, at all growth stage levels across all cover crops (Fig. 1). At anthesis, the label rate of paraquat and 1/2 label rate+roller combination were as effective (mean 89% kill) as glyphosate.

At flag leaf, the label rate of paraquat and the 1/2 label rate+roller had a significantly lower kill mean (41 and 42%, respectively), especially on black oat (24 and 27%, respectively). Cover crop plant height was relatively low and plant stems were still elongating at flag leaf, contributing to the low termination rate by the roller alone at this growth stage. The roller was not able to effectively crimp the plants at flag leaf, leading to the low kill mean

(12%) by the roller alone for all covers. Roller efficacy increased at anthesis to 47%, but this was not enough to be a suitable kill method at this growth stage.

### Soil Moisture

The soil moisture content measured at 28 DAT is indicative of the amount of soil water available at cash crop planting. The soils at the two locations were different types, a sandy loam and loamy sand. However, since there were no significant location interactions, results were averaged across locations. For reference, the average field capacity of the two soil types is about 14.7% and the average permanent wilting point (PWP) is about 5% (Miller and Donahue, 1990).

A significant cover crop by growth stage by kill method interaction was observed ( $P \leq 0.01$ ). Soil water content measurements at the flag leaf growth stage were directly related to efficacy of kill method. Ineffective kill methods resulted in depletion of soil water by still-growing cover crops. Glyphosate treatments, which resulted in the best kill, had the highest soil water content for all cover crops 28 DAT at flag leaf (11%). However, in wheat, soil water following paraquat treatments (9.5%) were not significantly different than wheat treated with glyphosate treatments (11.5%).

Paraquat treatments were especially ineffective at terminating black oat, resulting in soil water depletion significant enough to likely affect emergence of a cash crop if planted. At flag leaf, the roller only treatment was the least effective kill method and, therefore, resulted in the lowest soil water content in all cover crops (5%). Considering an average PWP of 5%, soil at this water content would not be adequately moist to plant a cash crop.

There were no significant differences in soil water 28 DAT of any cover crop as a result of kill method at anthesis or soft dough. However, soil water content was affected by cover crop, as a result

of straw biomass at both growth stages. A significant but poor linear relationship was observed between cover crop growth (biomass production) and soil water content ( $P \leq 0.01$ ,  $R^2=0.10$ ). At anthesis, rye resulted in greater soil water content (12%) than either black oat or wheat (10 and 9%, respectively). At soft dough, soil water content within wheat (10%) was less than under rye or black oat (12 and 11%, respectively). These soil water contents would all be moist enough to plant a cash crop.

### CONCLUSIONS

This study shows it is possible to effectively terminate cover crops using reduced herbicide inputs, especially when the cover crop is at an optimum growth stage. Farmers may be able to decrease the use of herbicides when implementing alternative kill methods for cover crops. At anthesis, it would be possible to use the combination methods and still get an effective kill (88% with roller+paraquat and 91% with roller+glyphosate), while reducing the amount of chemical used, thereby decreasing costs. The average reduction in chemical costs when using half rates and the roller rather than full label rates would be \$5.25/A (reflecting current commercial prices). The cost of using the roller alone can be estimated as \$1.50/A, which is the cost of running a cultipacker (Prevatt et al., 1998). Use of the roller provides benefits when killing cover crops as it lays residue flat on the soil surface, providing maximum soil coverage, thereby preventing erosion, decreasing soil water evaporation, and providing weed control. The use of a roller also facilitates planting by reducing hairpinning of residue when the planter runs parallel to the roller.

When termination occurs as late as soft dough, which in most cases is not practical due to cash crop planting windows, the use of herbicides may even be eliminated. At this late growth stage, all kill methods were equally effective (94% across all cover crops). The optimum kill time, when using

the roller alone, is some point after anthesis prior to soft dough, possibly the early milk stage (Feekes growth stage 10.54). There were no significant differences between the cover crops in terms of percent lull when the roller was used. The main determining factors were plant height and maturity, which are directly related to growth stage.

#### LITERATURE CITED

- Derpsch, R., C.H. Roth, N. Sidiras, and U. Kopke (com a colaboracao de R. Krause e J Blanken). 1991. Controle da erosao no Parana, Brasil: Sistemas de cobertura do solo, plantio directo e preparo conservacionista do solo. Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH, Eschborn, Germany.
- Gardner, W.H. 1986. Water content. p. 493-505. *In:* A. Klute (ed.) Methods of soil analysis: Part 1. Physical and mineralogical methods (2nd Edition). ASA and SSSA, Madison, WI.
- Large, E.C. 1954. Growth stages in cereals. Illustrations of the Feekes Scale. *Plant Pathol.* 3:128-129.
- Miller, R.W. and R.L. Donahue. 1990. Soils: An introduction to soils and plant growth. p. 122-123. (6<sup>th</sup> Edition). Prentice Hall, Englewood Cliffs, NJ.
- Prevatt, J.W., M. Runge, and J. Marshall. 1998. 1998/99 Budgets for fall/winter forage crops and wheat in Alabama. Dept. of Agric. Econ. And Rural Sociology. AEC BUD **1-3**. Auburn University, Auburn, AL.
- Reeves, D.W. 1994. Cover crops and **rotations**. p. 125-172. *In:* J.L.Hatfield and B.A. Stewart (eds.) Crops residue management. Advances in Soil Science, Lewis Publishers, Boca Raton, FL.
- SAS Institute. 1988. SAS/STAT user's guide. Version 6.03 ed. SAS Inst., Cary, NC.

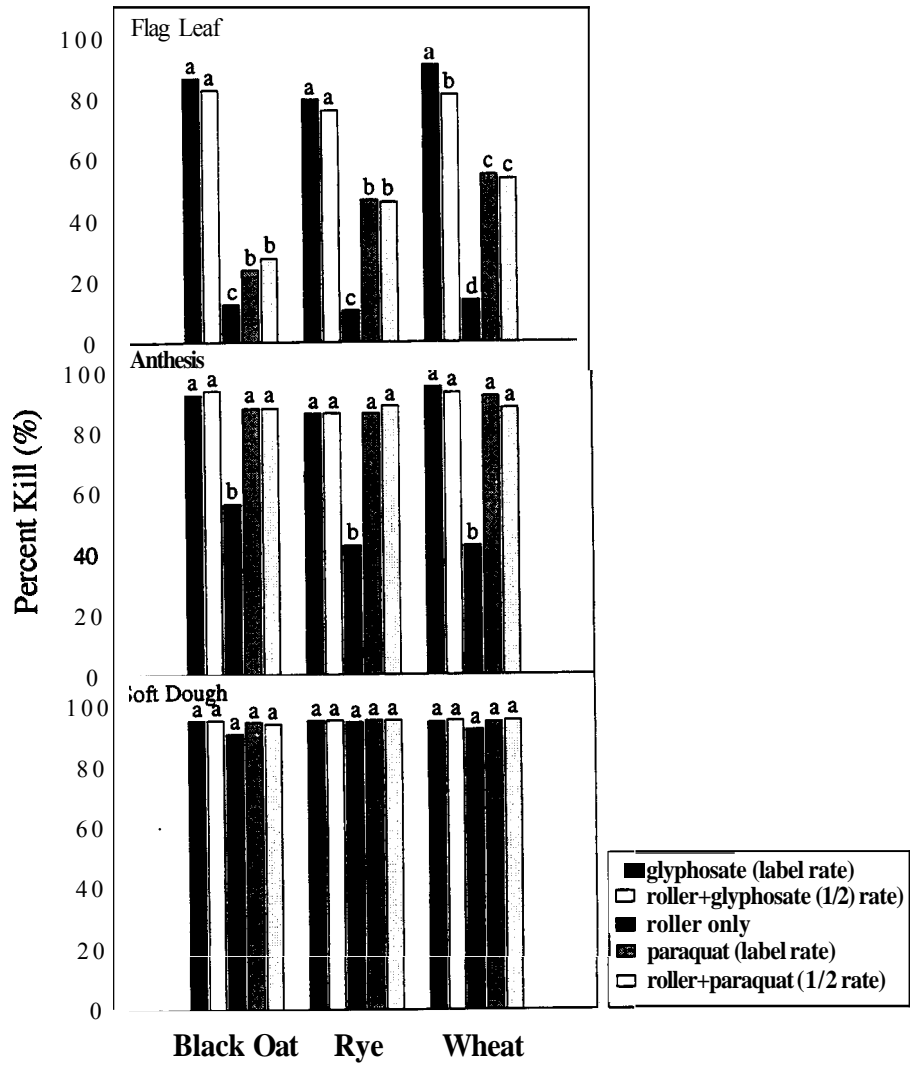


Fig. 1. Percent kill by cover crop and growth stage. Means within a growth stage and cover crop with the same letter are not significantly different (P<0.10).

