NC STATE UNIVERSITY

DEPARTMENT of SOIL SCIENCE

Residue Management Approaches in Conservation Tillage: Adaptive Research Directed Toward Cotton and Soybean Production in the Southeast

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RATIONALE

Winter annual cover crops improve the rooting environment for the following cash crop, build up soil organic matter, and improve water infiltration while moderating soil temperature and moisture through a protective residue layer. These changes support more consistent crop establishment, reduced weed pressure, and broader environmental benefits such as reduced erosion and improved water quality. Realizing these benefits depends on preserving residue at termination, since methods that destroy or incorporate the residue forfeit much of its protective value. The mechanical roller-crimper is one such tool designed to manage cover crop residues non-destructively so producers can achieve those benefits.

Producers in the southern Brazilian subtropical states of Rio Grande do Sul and Paraná are using the mechanical roller-crimper to manage high-density cover crop residues under zero tillage systems (Derpsch, 1984; 1998; Derpsch et al., 1991). The tool depends on the weight of a cylindrical roller to flatten and crimp standing residue, leaving behind a pressed, soil-protective, and weed-suppressive mulch layer into which the principal crop may be planted. The tool has only recently been introduced in North America, and many questions remain about its efficacy in killing or suppressing cover crop growth, timing constraints, and herbicide tradeoffs.

OBJECTIVES

- Evaluate the physical effect of surface pressed, intact residue and residue orientation on weed suppression using different weed control programs
- Determine the relationship between residue decomposition and incident weed pressure
- Evaluate the effect of residue management on cotton and soybean stand establishment, growth, and yield

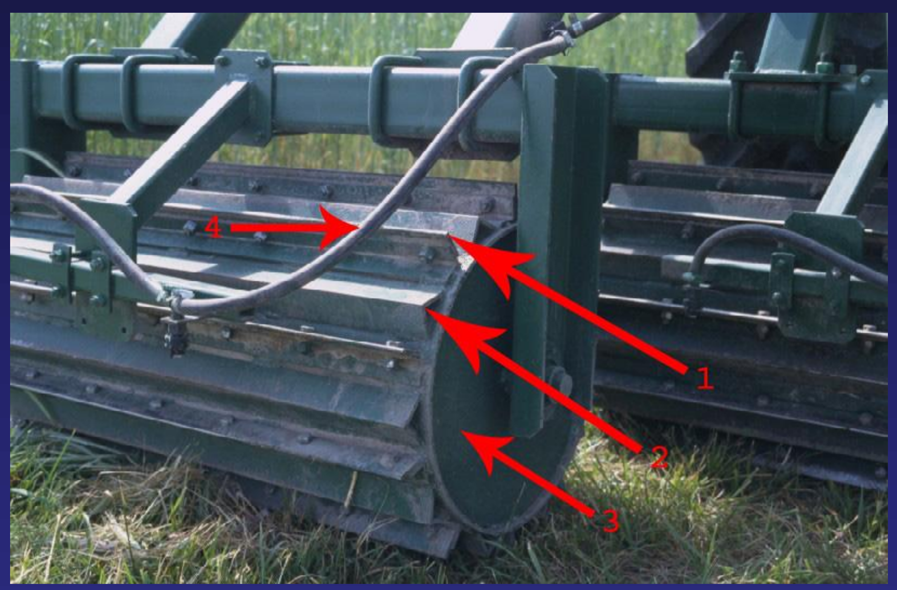
METHODS

In Fall 2003, an annual rye (cv. 'Abruzzi') winter cover crop was seeded at two field sites with similar weed management history at the NCDA Cherry Farm Research Unit in Goldsboro, NC. Soils at both sites were nearly level, well-drained and moderately permeable Wickham sandy loam. Prior to rye growth termination, biomass production was estimated using 0.5-m^2 quadrats. Rye growth was terminated mechanically or with glyphosate (1.75 L ha^{-1}), and the standing rye residue flattened using one pass of the roller-crimper.

Full-season soybean (Pioneer 95B97) was planted at a rate of 344,300 seeds ha^{-1} on 76-cm rows. Cotton (DP 451) was planted at 119,170 seeds ha^{-1} on 96-cm rows. Weed management programs included: (1) rye residue + no herbicide; (2) rye + glyphosate only for burndown; (3) rye + glyphosate + pre-emergent herbicide; (4) rye + glyphosate + pre & post-emergent herbicide. All plots were planted no-till except in cotton, where a subsoil-strip till treatment was included. A conventional tillage treatment and one no-till treatment that excluded the roller was used for comparison in both studies.

Weed counts were made at planting and at 2- and 6-weeks post-emergence using 0.5-m^2 quadrats at three points along a diagonal transect in each plot. Residue decomposition was evaluated by placing folded, intact residue in 2-mm nylon mesh bags at rates equivalent to field conditions and retrieved at 2, 4, 6, 8, and 16 weeks after planting. Cotton and soybean were machine harvested on 22 October and 10 November 2004, respectively, and yield determined.

Mechanical roller-crimper manufactured by Kelley Manufacturing Company (KMC) of Tifton, GA. These units are inexpensive to build and operate. Roller may be front or rear mounted; front mounting allows for rolling, spraying, and planting in one pass.



Arrows point to principal parts of the mechanical roller: (1) crimper blade; (2) damping iron to reduce vibration; (3) drum roller w/end plug (not shown) allows user to fill drum with water to increase down pressure on crimper blade; (4) plumbing assembly to apply burndown herbicide.

Cover crop rye after one pass with the mechanical roller. Residue pressed on the surface and oriented in the direction of planting may aid growers in managing higher residue loads.

Detail of crimped rye stem. Crimping action aids in termination of cover crop growth and can reduce by *50%* the amount of herbicide needed for burndown.

Non-inversion tillage can be integrated into high residue conservation systems. Shown here is a Precision Agricultural Tillage System (PATS) rig subsoiling in small grain residue after rolling. Note the minimal disturbance of surface residue.

Cotton early post-emergence in rolled and strip-tilled rye residue. *25 May 2005*

Mid-season view of strip-tilled cotton. *07 July 2005*

Soybean directly planted in mechanically rolled cover crop rye.

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RESULTS

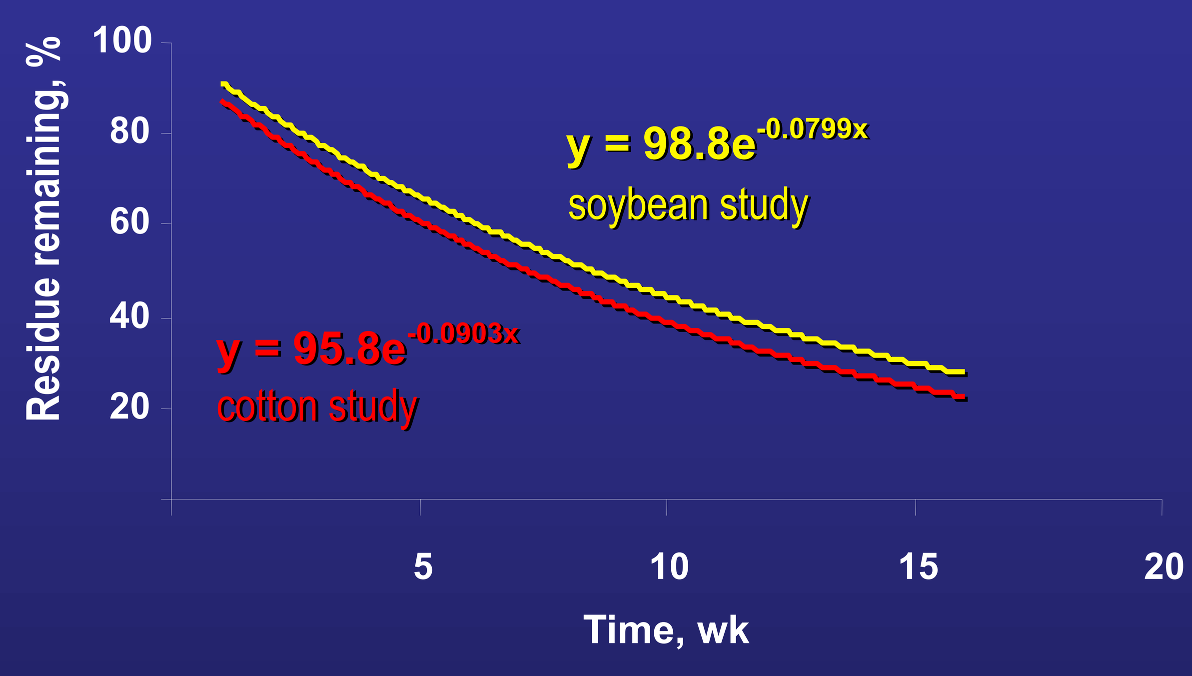
Cotton and soybean stands were successfully established in the rolled rye residue. Stand counts for both crops were slightly less in the rolled residue mainly due to lifting of the planter's gauge wheels where residue was unevenly distributed (Table 1). Rye biomass production averaged 4.5 Mg ha^{-1} for cotton and 6.7 Mg ha^{-1} for soybean. Mechanical rolling was not as effective at terminating rye growth as glyphosate. Yields for soybean and cotton lint in rolled treatments were about equal to conventional tillage (Table 1). However, reducing herbicide inputs resulted in a yield penalty (Table 1). Post-emergence weed counts revealed a steady increase in weed density where herbicides were reduced despite the heavy mulch cover and minimal soil disturbance. Dominant weeds included pigweed (*Amaranthus* spp.), lambs quarters (*Chenopodium album*), eclipta (*Eclipta alba*), signal grass (*Brachiaria platyphylla*). Decomposition of the rye residue followed an exponential decay function with approximately 70% of the original residue decomposed at 16 weeks after planting (Fig.1).

Table 1.

TREATMENT	COTTON LINT YIELD (kg ha^{-1})	SOYBEAN GRAIN YIELD (Mg ha^{-1})	COTTON STAND (Plants m^{-1})	SOYBEAN STAND (Plants m^{-1})
ROLL NO HERB NT*	467	2.42	6.03	16.41
ROLL NO HERB RST**	487	----	5.38	----
ROLL+GLY § ONLY NT	662	2.76	8.46	17.00
ROLL+GLY ONLY RST	865	----	7.05	----
ROLL+GLY+PRE HERB NT	810	3.56	7.91	10.43
ROLL+GLY+PRE HERB RST	983	----	8.00	----
ROLL+GLY+PRE+POST HERB NT	1063	3.76	8.86	16.96
ROLL+GLY+PRE+POST HERB RST	1312	----	8.40	----
NO ROLL+GLY+PRE+POST HERB NT	1027	3.56	8.40	17.00
GLY+PRE+POST HERB CT***	1045	3.76	9.91	21.39

* NO-TILLAGE; ** RIP-STRIP TILLAGE; *** CONVENTIONAL TILLAGE; § GLYPHOSATE

Fig. 1. Rye Residue Decomposition



INTERPRETIVE SUMMARY

- Row crops can be successfully adapted to high-residue conservation tillage using the mechanical roller-crimper.
- Overall, high residue density (6.7 Mg ha^{-1}) and residue orientation did not suppress early-season annual weeds enough to counteract the need for supplementary weed management with herbicides.
- Mechanical rolling alone was not as effective at terminating rye growth as glyphosate.
- Further work is needed to assess the effect of high-residue conservation tillage on long-term annual and perennial weed suppression, soil C sequestration, moisture balance, crop yield and quality.