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The Knife Roller (Crimper): An Alternative Kill Method for Cover Crops

Background: Learning from our southern neighbors

Farmers in Paraguay and Brazil have become very successful in utilizing a systems approach to conserving and improving the soil resource. By effectively using cover crops, crop rotations, and such tools as the knife roller, they have achieved no-till rates on 45-60% of all agricultural lands. In contrast, no-till systems are used on only about 17.5% of the cropland in the United States (Derpsch, 2002). The South Americans have learned the value and importance of no-till systems. Annual primary tillage results in bare soils unprotected from rains and heat. Over time, tillage can increase erosion rates, induce the excess oxidation of organic matter, and thus reduce the performance and productivity of the soil.

Cover crops are especially important in keeping no-till systems healthy. In any system, cover crops provide valuable erosion control, increase the amount of organic matter in the soil, reduce nitrate leaching, improve soil fertility, keep the soil cooler, improve water infiltration and storage in the soil, and suppress weeds. Rolf Derpsch, a researcher and consultant in Brazil and Paraguay, says that green manure cover crops are the missing element in the no-till system in many regions of the world. Derpsch adds that cover crops are an economically viable option and "are indispensable to reduce weed infestation and herbicide costs, reduce diseases and pests, produce the permanent cover needed in the no-till system and increase organic matter content of the soil" (Derpsch, 2002). (For more information about the benefits of cover crops, see NRCS, 1996.)

One component of cover crop management is choosing how to kill the cover crop before the cash crop is planted. This technical note examines one promising technology for killing cover crops—the knife roller (crimper). Roller technology is used with the taller grass cover crops (cereals) and with the shorter cover crops that have flowered.

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This is the thirteenth in a series of technical notes about the effects of land management on soil quality.

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Chemical and mechanical kill methods

Cereal cover crops are traditionally killed by contact or systemic herbicides. Herbicides are highly effective and can be relatively quick, but their high cost is a disadvantage. Also, there are concerns associated with the use of agricultural chemicals, including potential contamination of surface and ground water, soil contamination, and the potential for weed resistance to herbicides (Ashford and Reeves, in press).

In response to these concerns and to the successes in South America, farmers and researchers in the U.S. have started working with mechanical kill methods for cover crops in no-till systems. Modified stalk choppers and rotary mowers have been used on a limited basis, but the finely chopped residues rot too quickly in humid environments to provide good soil cover. Furthermore, the mowers do not distribute the cover evenly over the field.

The roller equipment

Knife rollers or rolling drums have been used for many years on millions of acres in Brazil and Paraguay (Derpsch et al., 1991; Ashford and Reeves, in press). The rolling drums were developed because of the difficulty with planting no-till crops into a heavy cover. Dr. Wayne Reeves, Research Agronomist with the USDA Agricultural Research Service (ARS), has worked with farmers and researchers from South America to adapt this technology for handling high amounts of cover crop residue.

Knife rollers are hollow steel drums, generally 2 to 3 feet in diameter and no wider than 6½ feet, that adjust to soil surface irregularities. More than one can be pulled side-by-side to achieve greater operating width. Approximately 10 blunt knives are along the length of the drum. These knives are 3 to 4 inches tall and are spaced 7 to 8 inches apart (Derpsch et al., 1991; Grooms, 2002). The blunt knives do not cut or chop the stems of the cover crops but crimp or crush them. The drums generally weigh over 800 pounds when empty and can weigh in excess of 1,700 pounds when filled with water. The water is helpful as the height and amount of biomass increase.

The energy required for a knife roller (up to 2.4 kW•hr ha^{-1}) is very similar to that required for a land roller or cultipacker and is tenfold less than the energy required for a rotary mower (up to 24 kW•hr ha^{-1}). The knife roller is especially useful in no-till systems because the roller provides a unidirectional mat, facilitating planting operations and improving seed-soil contact and plant emergence (Ashford and Reeves, in press).

Figure 1.—ARS adaptation of the knife roller (top). Farmer adaptation of the knife roller (bottom).

Research

Kill rates and timing of kill.—One concern for farmers using mechanical rollers is deciding when to terminate the cover crop. Recent ARS research in Alabama aimed to determine the effectiveness and economic viability of using a knife roller as an alternative kill method for cover crops in a no-till cropping system (Ashford and Reeves, in press). The objectives of the experiment were to evaluate the ease of kill and optimum time of kill for three cover crops (rye, wheat, and black oats) when the knife roller is used with two herbicides at their labeled rates and when the roller is used with the same chemicals at half the labeled rates.

Four growth stages were used to determine the optimum time to kill: flag leaf, anthesis (flowering), early milk, and soft dough. At the flag stage, the knife roller alone provided poor kill: only 19% across all covers during the 2 years of the study. After plants reached the early milk stage, the mechanical roller with half the labeled rate of herbicides equaled the effectiveness of the herbicides alone at their labeled rate. Both had 94% kill rates. By the soft dough growth stage, all kill methods were equally effective because of the accelerating plant senescence; a 95% kill rate was achieved across all kill methods. The researchers found that using the knife roller alone could reduce the cost of chemicals as much as $10.64 per acre.

Although the early milk stage or a later stage of a cover crop is the most effective time to kill with a mechanical roller, most farmers base the time they kill cover crops on the time they plant the cash crop, e.g., 2 to 3 weeks prior to planting. Thus, farmers growing organic or late-planted crops will be most likely to take advantage of the later maturity required for terminating cover crops without herbicides. More research and practical use by farmers will determine the balance between planting dates and growth stages of cover crops.

Weed control.—At the 10th National No-tillage Conference sponsored by *No-Till Farmer*, Rolf Derpsch stated that no-till soybeans following mechanically rolled black oats had much less weed pressure than no-till soybeans after a fallow period with no cover crop (Grooms, 2002). The agronomist measured amounts of weed dry matter 96 days after soybeans had been no-till planted. The weeds collected from the fallow plot totaled 6,400 pounds of dry matter per acre, whereas those collected from the plot where the black oats were previously rolled totaled only 82 pounds per acre. Reeves et al. (1997) showed similar results in a study in Alabama. In another study, Derpsch examined weed growth in a continuous wheat-soybean double crop system. He compared sunflower and sunn hemp* cover crops killed with a knife roller to a field fallowed with herbicides. The fallow treatment required five applications of herbicide for a total of $42.49 per acre to control weeds. Where a cover crop, such as sunn hemp, is grown in a no-till system, herbicides are not needed and production costs can be trimmed to $25.00 per acre (Grooms, 2002). Patterson et al. (1996) showed that weed control is better in cotton fields with cover crops of black oats and rye that were terminated with a modified stalk chopper than in cotton planted in fallow ground.

Soil temperature.— Derpsch found that in warm climates a cover crop mat that is rolled protects cotton from extremely high temperatures. If the cotton is grown after a cover crop rather than after traditional fallow, the yield is about 39% higher (Derpsch and Florentin, 1992).

Summary

The use of a knife roller with properly managed cover crops provides a thick, flat residue cover on the soil surface that reduces soil erosion, decreases evaporation rates, and helps to control weeds. Use of the roller reduces the extent to which residue prevents seed-to-soil contact when the planter runs in the same direction as the roller. Also, it allows good stands of a cash crop in heavy residue. When cover crops are terminated after flowering, the rate of herbicide application can be reduced. When the cover crops are terminated after the early milk stage, the use of herbicides may be eliminated.

* For more information about sunn hemp, see NRCS, 1999.

FURTHER READING

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