Cover Cropping Strategies for Organic Weed Management: Lessons Learned from Organic Annual Grain Systems

John Wallace, Bill Curran, Clair Keene, Matt Ryan, Steven Mirsky, Dave Mortensen
Pennsylvania State University, University Park PA

Improving soil quality and maintaining adequate weed control are primary goals of organic crop production. In practice, however, management activities directed toward one of these goals may inhibit the other. Most notably, frequent and intensive tillage is often the primary weed management practice in organic systems, which has the potential to reduce soil quality. Cover crop-based, no-till strategies aim to combine the soil health-building benefits of cover cropping practices with the soil conserving and labor-energy saving benefits of no-till practices. This strategy involves growing high-biomass cover crops and terminating them with a roller-crimper prior to no-till planting cash crops. In organic annual grain systems, soybean is typically no-till planted into rolled cereal rye and corn is no-till planted into a rolled hairy vetch – triticale mixture. Experimental trials have also evaluated this no-till strategy, as well as using strip-tillage in combination with high-residue rolled cover crops, for a variety of vegetables including sweet corn, snap beans, pumpkins and other cucurbits.

High-residue, rolled cover crops can produce effective weed control by inhibiting weed germination and suppressing emerged weed seedlings via actively growing cover crops or rolled cover crop mulches. Cover crop biomass accumulation determines the level of physical weed suppression. Consequently, agronomic practices that promote high cover crop growth rates should be prioritized. High levels of cover crop biomass accumulation also contribute to the persistence of mulch through the critical period of weed control, a period of time during a given crop's growing season in which weed control is necessary to prevent crop yield loss. Weed emergence patterns also affect the level of weed suppression from rolled cover crop mulch. Early-emerging summer annual weeds may be particularly susceptible to rolled cover crop strategies, whereas later-emerging summer annuals that emerge in the cash crop may persist as the cover crop mulch begins to degrade.

Many agronomic practices influence the weed suppressive potential of high-residue, rolled cover crop systems. Lengthening the cover crop growing season window by planting earlier or delaying termination can significantly increase biomass accumulation of cereal rye, thereby increasing its weed suppression potential. At a Pennsylvania site (USDA Hardiness Zone 6), delaying cereal rye termination from May 1 to May 30 resulted in a 3 tn ac^{-1} dry matter increase irrespective of planting dates, which ranged from late-August to mid-October. Depending on geography, at least 3 tn ac^{-1} of cereal rye dry matter is generally needed to produce consistent levels of weed suppression.

Effective termination of cover crops with the roller-crimper is critical to the success of organic systems employing high-residue, rolled cover crop mulches. Previous studies have demonstrated that cereal rye and hairy vetch control with a roller-crimper is a direct function of growth stage phenology. Effective cereal rye control can be achieved by delaying termination until anthesis, or the flowering growth stage (Zadoks Growth Stage 61). Further delay in termination, beyond the anthesis stage, also results in high levels of control. However, delaying termination until after

seed begins to develop (medium milk; Zadoks 75) increases the likelihood that terminated plants will produce viable seed, resulting in volunteer cereal rye in subsequent cash crops. Cereal rye biomass accumulation peaks by anthesis, so weed suppressive potential and termination efficacy can be maximized by targeting this growth stage. Cereal rye termination prior to anthesis is likely to result in the persistence of uncontrolled tillers, which will produce mature seed and also lead to volunteer cereal rye in subsequent cash crops.

Effective hairy vetch control can be achieved by targeting the early pod set growth stage. This stage is characterized by flower production on the upper five nodes, with the fourth and fifth nodes beginning to form reproductive pods. Similar to cereal rye, there is little benefit to delaying termination beyond the early pod stage and termination at earlier vegetative stages is likely to result in significant re-growth, leading to volunteer hairy vetch in subsequent phases of the rotation. Field research has demonstrated that cereal rye and hairy vetch termination can also be improved by rolling twice, approximately 3 to 5 days apart. Finally, rolling perpendicular to the direction of cereal rye planting creates more uniform, weed suppressive cover crop mulch. This planting strategy is not necessary for hairy vetch because of its vine-like growth habit.

Cover crop biomass accumulation can vary year to year, leading to inconsistent levels of weed suppressive mulch. Consequently, multi-tactic approaches may be necessary to achieve adequate levels of weed control. Several studies have evaluated the integration of high-residue inter-row cultivation in rolled cover crop mulch systems. High-residue cultivators for no-till systems typically have dual-gauge wheels in front of a residue-slicing coulter, which is followed by a single wide flat sweep. The sweep cuts through the soil at a 1-2 in depth, slicing off the root systems of plants while leaving the surface residue mostly intact. High residue cultivator sweeps are available in different widths to allow for use in a variety of row crops. A recent study found that the use of high-residue cultivation decreased total weed biomass by over 60% in no-till soybean planted into rolled cereal rye and no-till field corn planted into a rolled hairy vetch – triticale mixture. In this study, two high-residue cultivation passes were typically made approximately 7 to10 days apart. In practice, the use of high-residue cultivation in rolled cover crop mulch systems should be based on an in-season assessment of weed pressure. Intact cereal rye mulch can help maintain adequate soil moisture for early-season soybean growth. High residue cultivation fractures the soil surface and displaces the mulch toward the crop row, which can negate the soil moisture retention benefits of the mulch. Consequently, this practice should be avoided when weed pressure is low.

In summary, high-residue rolled cover crop strategies have the potential to provide adequate weed control in a variety of organic vegetable systems. However, it is necessary to prioritize management practices that maximize the weed suppression potential of the cover crop mulch. High priority should also be given to terminating cover crops at the correct phenological growth stage in order to avoid the risk of volunteer cover crops in later rotational phases. Multi-tactic weed management approaches will also likely necessary to maintain adequate in-season weed control.