Reduced tillage and cover cropping systems for sweet corn in Michigan

Daniel Brainard, Erin Haramoto, and Carolyn Lowry
Department of Horticulture, Michigan State University
A440A Plant and Soil Sciences Building, East Lansing, MI 48824
email: brainar9@msu.edu phone: 517-355-5191 ext 1417

Reduced-tillage, cover crop intensive production systems have several important potential benefits for sweet corn growers including: fuel and labor savings; reduced equipment wear and tear; more timely planting under wet conditions; and improvements in soil physical, chemical and biological properties. Since sweet corn is an important rotational crop for many high value vegetables, improvements in soil properties during sweet corn production may also have long-term payoffs for growers. Anticipated increases in the cost of energy and the incidence of extreme weather events suggest that reduced tillage will become increasingly important in vegetable cropping systems of the future. However, concerns about reduced stand establishment, delays in crop maturity, and pest problems (especially weeds) under reduced tillage need to be addressed before growers are likely to invest the time and money required to transition to this practice. Research underway in Michigan is aimed at developing cover crop and strip-tillage systems to address grower concerns in order to improve profits while enhancing environmental stewardship.

Potential direct benefits of strip-tilled sweet corn. Reports from strip-tilled sweet corn trials from across the country generally show comparable yields to conventional tillage, with lower input costs, and reduced susceptibility of crops and soils to damage from wind and rain. For example, in 20 on-farm trials conducted in Oregon, strip-tilled sweet corn yields were reported to be equivalent to conventional tillage, with an average savings in tillage costs of $15/acre (http://extension.oregonstate.edu/catalog/pdf/em/em8824.pdf). Similarly, in NY state, Dr. Rangarajan of Cornell University reports that strip-tillage saved growers $39/acre in production costs while maintaining crop yields. The primary benefits cited by growers adopting strip tillage are: fuel and labor savings, reduced equipment wear and tear, and more timely planting under wet conditions. In addition to these direct benefits, strip-tillage systems may indirectly benefit both sweet corn and subsequent crops in the rotation through improvements in soil physical, chemical and biological characteristics.

Potential problems with strip-tilled sweet corn. Although strip-tillage has important potential benefits related primarily to cost savings and soil conservation, this practice has not been widely adopted by sweet corn growers in MI. A recent survey of MI sweet corn growers conducted by MSU graduate student Ben Henshaw revealed that several important concerns need to be addressed before growers are likely to invest the time and money required to transition to strip-tillage. Among the primary concerns commonly raised were: 1) more difficult weed management (80% cited); 2) reductions in yield due to weaker stand establishment and delayed soil warming (50%); 3) increased costs associated with new equipment purchases (40%); and 4) uncertainty about potential effects on insects and diseases (25%).

Weeds in strip-tillage systems. Weeds can be more problematic in reduced tillage systems since: 1) tillage is not used to uproot, sever or bury weeds; 2) efficacy of certain herbicides is reduced; and 3) crop residue left on the soil surface may reduce the efficacy of cultivation. These complications mean that growers adopting strip-tillage need to adjust their weed management practices. This may mean changes in herbicide products or rates; investment in high-residue cultivation equipment; or increased reliance on cover cropping for weed suppression.

Cover crop management in strip-tilled sweet corn. Cover crops in combination with strip-tillage can leave a surface residue that protects soil from erosion, improves moisture retention, and suppresses weeds (Figure 1). In trials in Michigan, strip-tillage without cover-cropping resulted in a 2-fold increase in crabgrass populations compared to conventional tillage. However, when a winter rye cover crop was grown in combination with strip tillage, crabgrass densities were equivalent to those found in conventional tillage systems (Figure 2). Although cover crops like winter rye can improve weed suppression in strip-tilled sweet corn, heavy residues sometimes interfere with sweet corn establishment, and may reduce growth by tying up nitrogen.

Figure 1. Winter rye residues in reduced-tillage sweet corn help suppress weeds, retain moisture, and protect the soil.

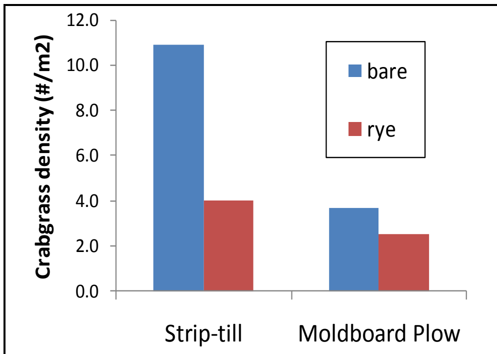

Figure 2. Effects of tillage and winter rye cover crops on crabgrass in strip-tilled sweet corn.

Targeting cover crops to specific zones. One approach to avoiding possible negative effects of cover crops on the establishment of sweet corn is to grow them only in the zones where they are most beneficial. For example, winter rye can be targeted to the zone *between* future sweet corn rows to maximize weed suppression while avoiding interference with crop establishment (Figure 3). This can be accomplished by blocking the opening of every third or fourth drop-tube (depending on drill and corn planter spacing) before planting. If a small seed-box is available on the grain drill, this approach can be further improved by planting a small-seeded cover crop into the in-row zone at the same time that rye is being planted. Experiments are underway to determine what cover crops might work best in this in-row environment. Legume cover crops (e.g. red clover or hairy vetch) along with various mustard species (e.g. yellow mustard or oilseed radish) are being tested. Sowing legumes in-row has the potential to save on expensive seeds while providing nitrogen where it is needed most.

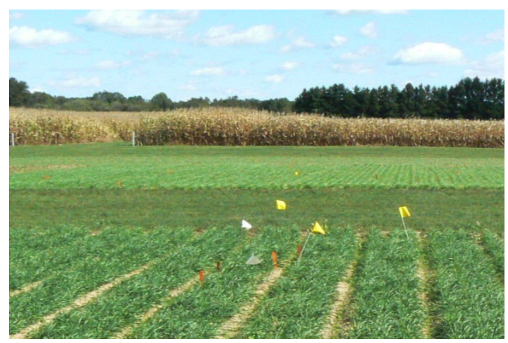

Figure 3. Alternating strips of winter rye with legumes or mustards may provide weed suppression and mulch between sweet corn rows, without interfering with sweet corn planting.

Trials (and tribulations) with hairy vetch. Hairy vetch (*Vicia villosa*) is a potentially useful legume cover crop because it can be sown in late August and still produces considerable N before late plantings of sweet corn or other crops the following spring. For example, in field trials on sandy soils in Holt, MI, hairy vetch and rye-vetch mixtures sown in August produced 70-140 kg N/ha in shoot tissue prior to sweet corn planting. Of this, approximately 30-80 kg N/ha was fixed from atmospheric N, with the remainder soaked up from soil N that may otherwise have been lost to leaching in the fall and early spring. Strip-tilled sweet corn grown following these cover crops produced the same yield as sweet corn grown with 120 lbs/A of N and no cover crops.

However, hairy vetch has some potential downsides. First, it can be a problematic weed in winter annual crops (e.g. wheat) and perennial crops (e.g. asparagus). Second, the seed is expensive. Third, it is sometimes difficult to kill in the spring when tillage is not used, resulting in regrowth. To address some of these issues, ongoing studies have 1) evaluated vetch varieties for differences in overwinter survival, biomass production, N fixation, flowering timing and regrowth following mechanical kill; 2) examined different mixture-proportions of hairy vetch with winter rye; and 3) assessed targeted placement of vetch in the zone where sweet corn is planted. Variety trials have demonstrated that some early-flowering varieties (e.g. Purple Bounty and Purple Prosperity) developed at USDA-ARS in Beltsville, MD, have comparable overwinter survival and N fixation capacity as more commonly used VNS varieties used in Michigan, but flower 1 – 2 weeks earlier (Figure 4). Early flowering is desirable because it reduces the risk of re-growth following mechanical termination in preparation for sweet corn planting. When grown in mixtures with winter rye, flowering is sometimes induced to occur even earlier (Figure 4). Mixtures of vetch with rye also have several other benefits compared to monoculture including: 1) lower C:N ratio of residue resulting in better synchrony of N supply with sweet corn N demand; and 2) lower seed costs per unit of nitrogen fixed. Preliminary studies evaluating the potential benefits of segregated strips of hairy vetch and winter rye prior to strip-tilled sweet corn suggest that this approach may lower seed costs and reduce the risk of vetch re-growth. However, the resulting effects of this approach on weed management and N use efficiency are not yet known.

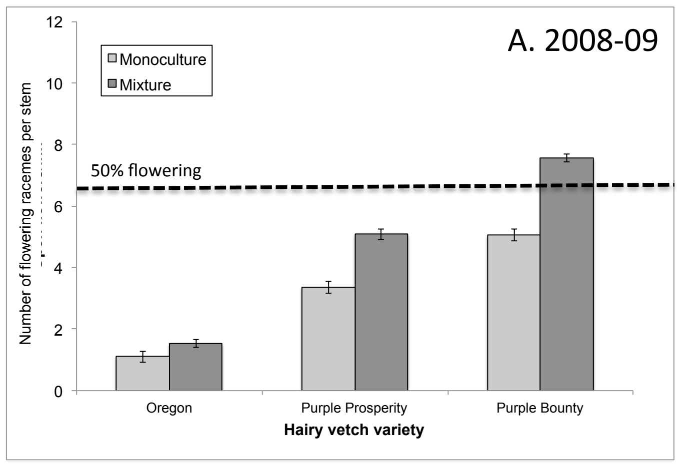

Figure 4. Extent of flowering (number of flowering racemes per stem) in mid May of three varieties of hairy vetch grown alone or in mixture with winter rye. Hairy vetch which has reached 50% flowering can be mowed with minimal risk of regrowth.

Long term effects of strip tillage in sweet corn and rotational crops. The long-term effects of strip tillage on vegetable rotations have not been extensively studied. While strip tillage is likely to bring gradual improvements in soil health, it may also bring increases in problematic weeds. For example, in long-term trials comparing strip tillage to conventional tillage in MI we have observed gradual increases in creeping perennial species including horsenettle and quackgrass, as well as increases in weed seedbanks of some annual species including large crabgrass. Strategies to avoid long-term increases in weed management costs are being studied including more intensive use of cover crops, changes in herbicide strategies, and targeted shifts in strip locations from one year to the next.

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