Innovative Weed Management Strategies for Organic Cereal Crops with Dr. Ellen Mallory

Introduction:

Dr. Eric Gallandt (Associate Professor of Weed Ecology and Management at the University of Maine), Lauren Cole (graduate student) and Tom Mallow (research technician) worked on this research with Dr. Ellen Mallory, whose background is in soil fertility.

This project looking into weed management strategies for organic cereal crops in Maine is a relatively new. Given the similarities between Maine and the Maritime provinces, there is an opportunity for information and research results to be shared across the region. Generally farmers in the Maritimes have more experience growing food grain than farmers in Maine, who have only recently begun growing these crops.

Background Information:
Cereal production was relatively non-existent in Maine ten years ago. Originally, interest in growing organic stemmed out of the need to provide feed for organic dairy operations. Maine is the state with the highest percentage of organic dairies in the USA. In order for these dairy farms to remain profitable they needed to be able to produce their own feed. If not producing their own feeds, farmers were spending about 40% of their gross revenue on feed, the majority of which was being shipped in from the mid-western states of the Canadian prairies. These bought feeds were also generally lower quality feed because highest quality feeds were generally sold within the region in which they were grown.

In 2005 a collaborative research project focusing on organic dairies was started by the University of Maine, the University of New Hampshire, the USDA-ARS and dairy farmer groups. The project involved researching grain production for feed, crop rotations, appropriate varieties and feeding trials and starting a farmer network (the Maine Organic Milk Producers Association).

Since the time that producers started growing organic feed grains there has been an increase in demand for locally produced products (including grains). Dairy farmers saw an opportunity to be a part of that growing “local food” market. Due to the higher prices paid for food grade grains, they could potentially sell grains they were growing at twice the price and then buy in feed. However, the quality requirements for food grade grain are higher than for feed grain and so different management approaches and more research into this field were required.

In 2008, Ellen Mallory wrote a grant proposal to start up the Northern New England Local Bread Wheat Project and received funding to do research into bread wheat

production, to create tools for farmers interested in producing this crop and to start up networks and educational opportunities for those farmers.

Farmers in Maine have a lot of experience growing small grains as part of a crop rotation with potatoes. Over 40,000 acres of small grains were grown in 2007, most of which were conventional grains in rotation with potatoes and were not food grade grains. There is little experience in the state with organic grain production.

Weed management is an important part of growing organic cereals. Weeds that germinate at the same time as grains are the most competitive with the crop. Using larger sized seeds when planting can results in grain plants that have a competitive advantage over weeds.

Some preventative measures that can be taken to control weed pressure include appropriate crop rotations, timely planting and good soil quality. Reactive measure that are used to deal with weeds that are present include using a tine harrow to dislodge germinated weed seeds from the soil causing them to dry out and die. This method can be very effective under the right conditions (sunny and dry to ensure the dislodges weeds die and don't re-root). The tine harrow can be used repeatedly as more weed seeds germinate and emerge.

The first opportunity to use the tine harrow comes before the germinating crop seed emerges from the soil, about 7 to 10 days after seeding. After the crop comes up it is very susceptible to damage so you would want to wait until it is between the 2 and 4 leaf stage before doing post-emergence harrowing. That's a fairly large window in which you can do post-emergence harrowing but you want to keep in mind that if the weeds get too large they become harder to dislodge and the more forceful harrowing required could result in a lot of crop damage.

Harrowing is most effective at control very small weeds so a good time to harrow is when the weeds are in the white stage. In white thread stage harrowing can result in 90% weed control, when the weeds have two or three leaves harrowing kills 70-80% weeds and when the weeds have three or more leaves, harrowing becomes a lot less effective.

Overall, you need to time harrowing quite precisely.

As was mentioned above, ideally you need dry conditions when harrowing so weed desiccates and doesn't re-root. Note that if your soil has a lot of clods, it is harder for a harrow to dislodge weeds to seed bed preparation is important.

When talking about the aggressiveness with which you should be harrowing, some say "you can just go like hell and it will be fine" but you can do a lot of damage. Under ideal conditions and appropriate harrowing you could expect to lose around 5% of your crop but it is possible to lose a lot more.

(See slide for take-home points about harrowing)

Improving weed management: Two strategies

1. Increase competitive ability of the crop
2. Improve physical weed control

A lot of the strategies discussed in this section of the presentation come from Denmark, where there is a lot of experience with organic grain production. In 1987, Denmark was the first country to legislate money particularly for organic crop research. In Denmark they use harrows for physical weed control but are also looking for alternatives.

1.a. Competitive Varieties
Bo Melander looking at different varieties of winter wheat and their ability to compete with weeds. Some variety plots had up to 25% more weeds than others. So, varieties can be used to your advantage! There appears to be a large difference in the ability of different varities to compete with weeds.

1.b. Increased Seeding Rate
An experiement at Washington State University looked at increasing seeding rates by 25-50% seeding rates to compete with weeds. You can see that higher seeding rate under high weed pressure makes a difference. Weeds had greater effect at lower crop seeding density than higher crop seeding density

(Question: Were these trials drill seeded? Answer: Yes)

If using the crop to compete with weeds, we need the overall population we want but we also need to be good at getting the density we want. Farmers talk of seeding in bushels or pounds per acre but grain seeds vary in weight (can seen in a table in the slideshow). Seed weights can differ by up to 75% so if you put out 2 bushel you don't necessarily know what plant density will be, unless you know your seed weight before hand and/or have calibrated your drill and know how many seeds it will plant per length in each row. Corn and soybeans are planted by density and wheat should be done that way too.

(Comment from Dr. Andrew Hammermeister: Most farmers in Nova Scotia set their seed drill for the varieties they usually use. I have also been looking into seed vigour into order to improve a farmers ability to plant the density that he or she wants.)

1.c. Fertility Placement
In Denmark research has been conducted looking at fertility placement, involving slurry injection, that may provide an advantage for crops and not weeds. In Washington state, fertilizer placement has been considered crucial in grain production for many years, however when using organic nutrient sources we may not be able to have as much precision as in conventional agriculture. However, in Denmark they looked at injection slurry closer to the crop seed and not weed seeds. Overall, they found a combination of injecting the slurry, so the crop had more access to nutrients, and harrowing resulted in the best weed control.

1.d. Uniform Pattern Planting

Jacob Weiner is a weed ecologist with really theoretical background. At one point he asked "Why do we seed in rows? Doesn't that just increase competition between crop plants?" Generally he thought weeds between rows don't compete with crop plants but, if sown differently, crop plants could compete with weed and not with each other. Overall his idea was that we should use the competitive ability of crop to its fullest potential when trying to control weeds.

His experimental results showed that wheat seeded so that each plant was equidistant from its neighbouring plants results in higher yields and reduced weed pressure then wheat seeded in rows. A special precision drill was required to seed the wheat at equidistance spacing but you could broadcast the seed or use two drill passes to get similar results.

However, in a experiment with barley at the University of Maine, seeds that were broadcast did not establish very well and seeds from two drill passes had uniform seed depth and variable emergence due to the wheel tracks pressing down on seeds during the second pass. So they brought in air seeder with 4.5 inch spacing and have had more success with that seeder.

Other alternatives include seeding the crop in narrower rows to increase the crop's competitiveness or seeding wider rows and relying more on physical control. The latter option involves growing a cereal as row crop and using hoeing instead of harrowing for physical weed control.

3.Improving Physical Weed control

A wide row crop configuration allows for a wider window of opportunity for using physical weed control but there is also the potential to do a lot of damage unless the hoeing implements are controlled precisely.

(See presentation slide for advantages and disadvantages)

Inter-row hoeing is thought to stimulate nitrogen mineralization. This could be useful for the production of bread wheats which needs to have high protein contents. If nitrogen could be made available later in season, it could help increase the protein content of the crop. But more research is required to see if this would actually happen.

Lauren Cole's project at the University of Maine involved investigating the effects of different row spacings and harrowing for barley. ("+" in the graph indicates that tine row harrowing was used). Ida gold mustard was used as surrogate weed in the experiment.

Note that in 2007 weed pressure was high while in 2008 weed pressure was lower. Also, in the bar graphs, bars with different letters are statistically different from one another. In 2007, narrow spacing with harrowing resulted in significantly lower weed biomass than the other treatments. In 2008, narrow spacing with harrowing still had the lowest biomass but it was not significantly different than the wide row spacing. In 2007, the wide spacing

resulted in the highest yield while in 2008 the narrow and standard spacings both with harrowing has the highest yields. However in both years, the yields of standard spacing with harrowing, wide spacing and narrow spacing with harrowing were not significantly different.

(See slide for study conclusions and cost analysis)

The higher cost of narrow spacing was largely due to the high cost of seeds at higher densities.

However the results of a similar experiment involving wheat and the relative advantages of each treatment with wheat could be different.

Question period:

Q: When seed was broadcast did you do anything after?
A: We ran over the seed with a harrow but not sure if they packed it.
Comment: When broadcast seeding contact between the seed and soil is crucial. It's a good idea to harrow once, broadcast seed, harrow second time, then pack it. Depth of cultivation is also crucial.

Q: Did the last experiment involve 2 row or 6 row barley?
A: I don't know…

Comment: Crop with more straw could be more competive

Q: Why are spacing the way they are?
A: There are lots of factors that contributed to current drill configurations but it's also interesting to remember that current drills were developed for conventional agriculture. Also, we need to think about a lot of factors in drill design including how stubble from previous crops will pass through the drill. If the row spacing in very very close this stubble could get stuck in the drill and cause problems.

Comment: Inoculants for winter wheat and winter rye are being developed.

Q: How close to emergence can you do pre-emergence harrowing?
A: It depends on where your seed is and how deep you're harrowing. Usually 3-5 days after planting is safe. You could cultivate a week before planting, pack to simulate weed germination then harrow then seed. But overall, it's all about designing your own system. Weed control varies a lot from farm to farm.

Comment: Competition between plants below ground is also important, not just shading of planst above ground. This was shown in a recent study at the OACC. (Ask Dr. Andrew Hammermeister for more details)

Comment: Cereals are more competitive with early planting. Plant in the beginning of May. You could do harrowing and leveling a week before planting, the use a packer, then do pre-emergence harrowing, then harrow again when the crop is at the 3 or 4 leaf stage. Caution, crops in lighter soils can more easily be buried during harrowing.

Comment: When you increase the aggressivness of your harrowing you lower your weed pressure weeds but past a certain point, you reduce your crop's yield potential due to damage.

Comment: Wide rows could be an advantage in areas that are coming out of sod.

More about the wheat project:
No we can' compete with Kansas but now demand is for local…so the equation has really changed. Retired potato farmers may be interested in growing grains. The project is currently looking into trialing as many varities as possible. They're also looking at the using of top dressings used later in the season to increase the crops protein content. An enterprise budget developed as part of the project will be available online and can adjusted to model our own farm (in Maine).

Some folks in Maine are currently growing heritage varieties at a small scale largely for home use/local communities. Others like Jim Amaral uses 35 to 40 acres of wheat are looking to expand that to 100s of acres of grains.

Q: What variety works on those 40 acres?
A: AC berry and Maxine. Jim Amaral doesn't have the capacity to blend wheats so he grows "self-bakers."

Q: Wondering about fusarium.
A: We just did a workshop about that. The last two years have brought that issue to forefront. Last year winter wheat was hit, year before spring wheat was hit. Fusarium is high on the list of issues to be addressed with varieties and making sure farmers know management strategies. You can manage for moderate years with rotations (don't follow corn or grain), making sure residue tilled in and using multiple planting dates. But in epidemic years, fusarium can't really be managed.