

Breeding Winter Cereals for Mulch Cover Proves Transformational

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Roller-crimper with research plots for winter cereal mulching at AAFC Lethbridge (Photo credit: Agriculture and Agri-Food Canada)

AAFC crop breeders are making a dramatic shift in breeding objectives for fall rye and winter triticale. No longer is the emphasis on crop yield. The breeding program is targeting cover crop characteristics that support weed management and tillage reduction as part of a sustainable cropping system.

This important research could lead to a transformational shift in organic production practices, in the way that the introduction of herbicide resistant crops changed conventional agriculture.

With the support of industry partners, Drs. Raja Ragapathy (AAFC Lethbridge), Jamie Larsen (AAFC Harrow) and technician Jordan Harvie have established a research program under Organic Science Cluster 3 to develop cultivars of cover crops that are adapted to a roller/crimper production system.

"With the example of rye and triticale, we had to shift our thinking about cultivar development from producing high grain yield to producing early flowering, high biomass, weed suppressing cover crops that suit the organic production system," Dr. Jamie Larsen explains.

TOO MUCH TILLAGE IN ORGANIC AGRICULTURE?

Organic agriculture has long been criticized for relying on tillage for weed control, incorporating cover crops or soil amendments, and seed-bed preparation. While Organic Science Cluster 3 evaluates the impacts of tillage within organic cropping systems, it also supports a project that turns conventional breeding programs upside down.

Intensive and frequent tillage can lead to losses of soil organic matter, degradation of soil structure, higher erosion susceptibility and overall declines in soil quality and health. The impacts of tillage can vary widely depending on the depth, level of disturbance and frequency of tillage. Tillage practices can also vary widely in organic agriculture. For example, ploughs and heavy disks which may invert the soil to a depth of 20+ cm, while rotary hoes disturb only the surface of the soil for weed control, leaving residue and cash crops (if present) in place.

The impacts of tillage can also be mitigated through use of cover crops, crop rotations, and soil building practices such

as growing perennial forages. Drs. Caroline Halde (Université Laval) and Derek Lynch (Dalhousie University) are studying the net impacts of tillage within cropping systems on soil health on farms in Quebec through their project within Organic Science Cluster 3.

Some annual weeds rely on soil disturbance to stimulate germination; by tilling the soil, weed seeds are exposed to a flash of light, the seed coat is scratched to allow water penetration, or higher nitrate availability may trigger germination.

Tillage also disrupts the development of mycorrhizal networks that may establish associations with crop plants. The benefits of these associations, such as enhancing water and nutrient uptake, can therefore be lost.

Frequent cultivation within a growing season, even with low disturbance intensity, is a time-consuming and fuel intensive operation for organic farmers. Thus, organic farmers and researchers are still looking for ways to reduce tillage in cropping systems while minimizing weed pressure.



Winter cereal mulch after roller-crimper pass (Photo credit: Agriculture and Agri-Food Canada)

THE SEARCH FOR A NO-TILL ORGANIC SYSTEM

The most extreme form of no-till grain cropping would involve the development perennial cultivars of cereal crops. These perennial crops would eliminate the need for soil disturbance with planting, produce much more root biomass (sequestering carbon) and have a competitive advantage over annual weeds. This system of production would need to establish effective ways of minimizing problems with perennial weeds, deal with a potential dwindling crop stand over several years, and provide adequate nutrients to support an acceptable yield with good quality.

While progress is being made in these breeding and research programs in the U.S. (visit for example The Land Institute), there is limited research occurring in Canada in this production system, and it is still not close to becoming a commercially viable option.

Fall rye has long been recognized as a great option for providing fall/winter cover while also suppressing weeds through its competitiveness and allelopathic effects. Fall rye should be grown at least to heading

stage to maximize its weed control benefits. Unfortunately, fall rye has limited value as a food crop and thus growing it to the heading stage results in a low value crop displacing a potentially high value crop.

Enter the Rodale Institute which has introduced paradigm-shifting work to the U.S. and Canada in reduced tillage production systems. They have found that a combination of rolling the crop down while simultaneously crimping, but not cutting the stem, will terminate the plant and leave a flat smooth surface to plant into.

The classic model is to plant soybeans or other pulses in wide rows into the rolled down rye, as the legumes will be able to provide their own nitrogen, while the rye mulch suppresses weeds and slows nitrogen cycling. The catch here is that fall rye must be rolled/crimped no earlier than the late flowering stage which, in many cooler parts of Canada, does not occur until early June. This substantially delays planting of the soybeans which requires heat and a long growing season.

There are two solutions to this: a) select a short season cultivar of soybean and take a considerable yield loss, or b) develop fall cover crops that can be rolled/crimped

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—Dr. Raja Ragapathy (AAFC Lethbridge)

earlier, either through earlier flowering or without regrowth when crimping at an earlier stage.

In any case, the cover crop must produce enough biomass to leave a mulch that suppresses weeds. Researchers involved with the Natural Systems Agriculture project at the University of Manitoba suggest that 6-8 t/ha of mulch biomass needs to be in place at the time of cash crop planting.

The challenges are not just limited to early flowering and good crimping characteristics. "One of the key challenges is producing winter-hardy cultivars of these cover crops with the traits we desire. If we have thin or patchy stands of rye or triticale, then weeds are likely to become a problem and the benefits of this system are lost." says Dr. Ragapathy.

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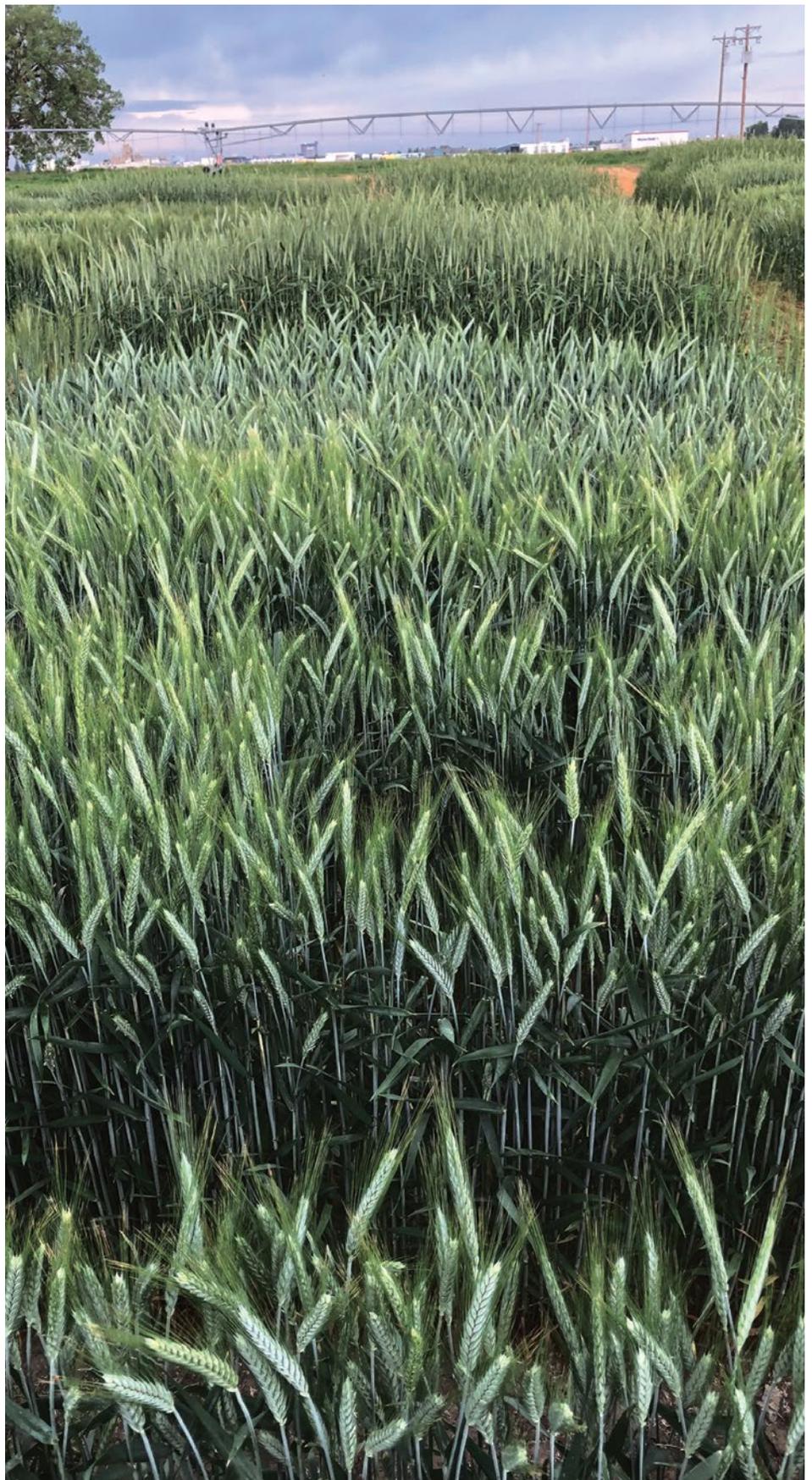
—Dr. Jamie Larsen

The breeding program will emphasize early heading, thin stems, and low regrowth potential for better rolling and crimping as well.

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The program will also evaluate triticale as an alternative to fall rye in this system. Winter triticale provides a number of similar benefits as fall rye and may even have some key advantages as explained by Dr. Larsen, “Triticale regularly produces more biomass per unit area than rye (in the prairies). Although the heading date of triticale is slightly later than rye, it is self-pollinated making variety height and flowering date more uniform. The inherent variability in open-pollinated rye, means that flowering can extend over a longer period making termination via roller crimping more difficult.”

Organic agriculture sees a future with significantly reduced labour and energy inputs while controlling weeds and increasing soil carbon content. This future will be achieved through collaborations among AAFC, universities, and industry. There is a convergence of breeding programs specifically targeting organic production systems, for yield and pest resistance among our economic crops, and for weed suppression and biomass among our cover crops.



Winter cereal test plots at AAFC Lethbridge are being evaluated for their potential as a mulch in no-till organic farming systems. (Photo credit: AAFC)