Evaluating Cover Crop Options after Winter Wheat and in Standing Corn

(St Clair SCIA Regional Partner Grant)
(Interim Report)

Purpose:

Cover crops can provide many benefits and interest in them has been growing in recent years. They protect the soil from erosion, add organic matter, stimulate soil life, provide nitrogen, scavenge or retain nitrogen, reduce compaction and improve water holding capacity and infiltration. Planting a cover crop after winter wheat is the easiest way to start including cover crops in most typical field crop rotations. Red clover establishment in winter wheat has been variable in recent years; many farmers end up with a poor stand of red clover after wheat harvest, while others have abandoned the practice all together. There is still a desire to reap some of the benefits of red clover so farmers are looking to other cover crops to provide some or all of these benefits. There are a number of different cover crops options to choose from.

Planting date, managing cover crop growth and control afterwards are just a few of the things growers must consider when planting a cover crop. Depending on species selected, the seed is relatively expensive so it is important to get the most out of the seeding. After winter wheat harvest the soil conditions are often not optimal for establishment, principally dry. Planting a mixture may reduce establishment risk. The purpose of this project is to optimize cover crop establishment and provide the most benefit following winter wheat.

Some growers are looking for ways to plant cover crops in other parts of their rotation. Establishing cover crops after grain corn is difficult as there is little or no growing season remaining in Ontario. There is interest in exploring the seeding of cover crops into standing corn. A research project is currently underway where various cover crops are seeded into seed corn. There are a couple of planting units capable of broadcast seeding cover crops into corn. There is potential to link with the seed corn project and explore seeding cover crops into standing grain corn. This will be explored as a small sub project of this partner project. Several cover crops and mixtures (based on the results of the seed corn project) would be seeded into standing corn and evaluated for stand establishment. A second purpose of the project is to evaluate options for establishing cover crops in standing corn.

Methods:

Cover crops were seeded following winter wheat harvest but generally not before the beginning of August. Management of volunteer winter wheat was investigated including comparisons of leaving it untouched, light tillage and herbicide control. In 2012 a commercially available mixture, TillageMax Dover™ (Tillage Radish + seed oats), was used and another commercial mixture, TillageMax Daytona™ (Tillage Radish™ + crimson clover), plus feed oats were compared for establishment and other benefits. In 2013 two similar mixtures were used by combining the radish, variety Tillage, with locally sourced oats and similarly for the three way mixture of radish, var. Tillage, crimson clover and oats. A third treatment, a mixture of six cover crops (radish var. Tillage, oats, crimson clover, Austrian Winter peas, sorghum sudan and sunflowers), was added to a number of plots in 2013 (see figure 1). In 2012 the Dover mixture was seeded at 25

lbs/ac and the Daytona + oats was seeded 25 lbs/ac (5 lbs/ac Daytona + 20 lbs oats). In 2013 the radish/oat mixture was seeded at 30 lbs/ac, the radish/oat/crimson clover mixture at 35 lbs/ac and the six way mixture at 40 lbs/ac. Cover crop mixtures may help to ensure cover crop establishment success. The cover crops chosen provide different benefits. The oats provide a fibrous root to improve soil structure, take up nitrogen in the soil and produce significant biomass to return to the soil. The radish provides a deep tap root to open up the soil and takes up nitrogen. The crimson clover also has a tap root, fibrous roots and produces some nitrogen. The six way mixture was to provide multiple benefits. A check strip with no cover crop planted was left for comparison. There were three replications of each treatment. The treatment strips were 15' or 30' wide and most were 500" long. At several sites different other cover crop treatments were included. A soil nitrate test occurred prior to seeding to assess soil N levels. Nitrogen was applied (50 lbs N/ac) to ensure adequate cover crop growth. In 2013, nitrogen was applied to only three quarters of the plot, at most sites, leaving about a quarter of the plot without additional nitrogen. Cover crop biomass measurements were taken at two times, one in the middle of the growth period and one late fall. The above ground plant material was removed from four 0.25 m^2 areas in each replication of each cover crop strip.

In 2012, four cover crops: common annual ryegrass, Tillage RootMax™ annual ryegrass, feed oats and TillageMax Daytona™ blend (Tillage Radish and crimson clover) were hand seeded into standing grain corn in plots that were four rows wide by 10 m long and replicated three times. One plot was seeded after silage harvest. Visual observations were made of cover crop growth in late fall. In 2013, at one site three cover crops (annual ryegrass, red clover and an annual ryegrass/crimson clover mix) were seeded at the six leaf stage of corn and then again just following tasseling. At another site two cover crops (annual ryegrass at 20 lbs/ac and red clover 10 lbs/ac) were seeded during corn tasseling.

Results:

2012 was the start-up year for this project. Like many start-ups, the project was delayed. As a result cover crop planting following winter wheat did not occur until August 27th and was completed by August 31st. Seven sites were planted: three in Lambton county, two in Chatham-Kent and two in Essex county. A variety of drills and planters were used. No-till drills with and without small seed boxes and an air seeder were used. Generally all did an adequate job of planting. There was concern that the three way mix would separate out in the drill so in a couple of cases the Daytona (radish/clover) seed was put through the small seed box. The oats are a relatively large seed, radish a small to medium sized seed and crimson clover is a small seed. Surprisingly, the seed did not appear to separate out. Stand establishment was equally as good when planted with and without using the small seed box. The real challenge came with seeding depth. In a few cases the cover crop seed was planted 2.5 cm (one inch) or deeper. In those cases the oats came up fine, the radish emergence was delayed or it did not emerge. The nitrogen applied produced good growth. Soil samples taken at the Amhertsburg and FlorenceW sites had low nitrate levels in the 5 to7 ppm range. Nitrate levels were higher at the Kingsville, Thamesville and FlorenceV sites in the 10 to 15ppm range.

Figure 1. Seeds of the cover crop mixtures.

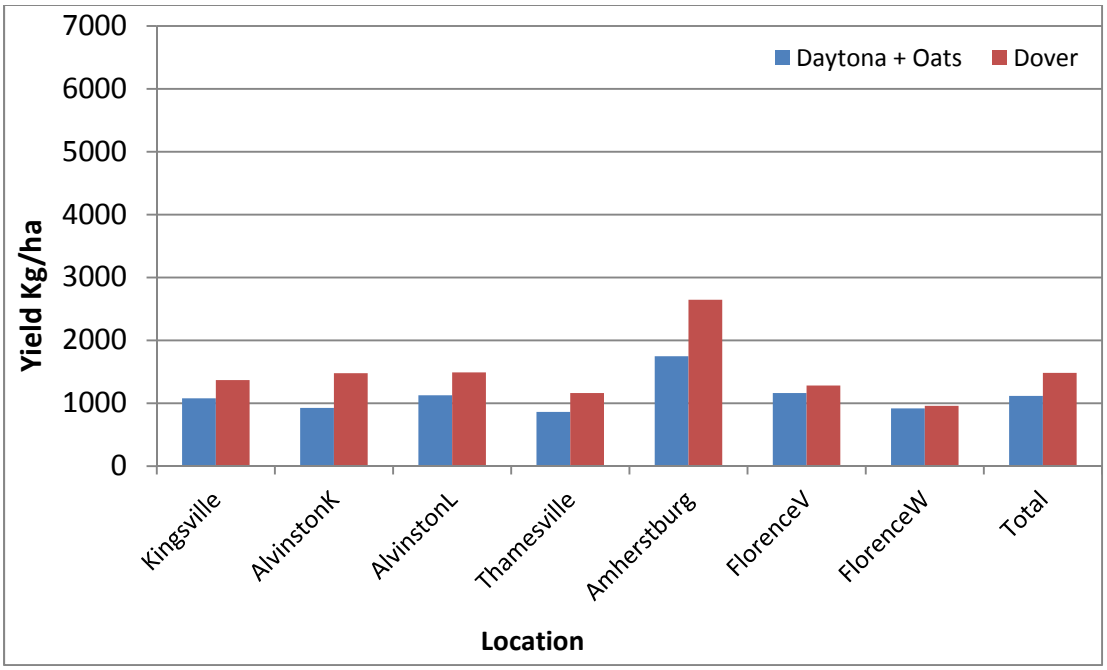
Six way mixture top left, oats/ radish top right and oats/radish/crimson clover bottom photo.

In the spring of 2013 some additional measurements were taken to try to identify cover crop benefits for the soil. Earthworm counts were done on an area 0.25m^2 by shovel depth. On a sandy loam soil there were on average 20% more earthworms on the knolls where there was a cover crop compared to no cover crop. In the depression areas of the field there were almost twice as many earthworms. Some limited infiltration measurements were taken where there were cover crops versus no cover crop. In some situations the cover crop improved water infiltration into the soil. Cover crop residue in the spring was not as much as some growers thought it would be. Several cooperators

no-tilled the next crop into the residue without any problem. The crimson clover that survived the winter on sandy loam soils produced a very nice fibrous root system. Corn was planted following the cover crops on five of the sites. There were a number of issues with the plots including corn rows not lining up with the cover plots and stand issues due to equipment and weather. So it was difficult to draw any conclusions on the impact of the cover crop on corn yield.

The first cover crop biomass harvest took place during the third and fourth weeks of October. Biomass weights were highest at the Amherstburg site and similar at the rest of the sites. The Daytona + oats averaged 1100 kg/ha and the Dover mixture was higher at 1500 kg/ha, see figure 2. The lower amount of biomass with the Daytona + oats could be due to the feed oats in this mixture either having a lower germination rate and lower vigour than the seed quality oats in the Dover mixture. Some of the treatments with feed oats had mustard or canola in them. As these came from the west it is possible that the canola could be Roundup Ready and may be difficult to control in the following crop if glyphosate is the only herbicide to be used.

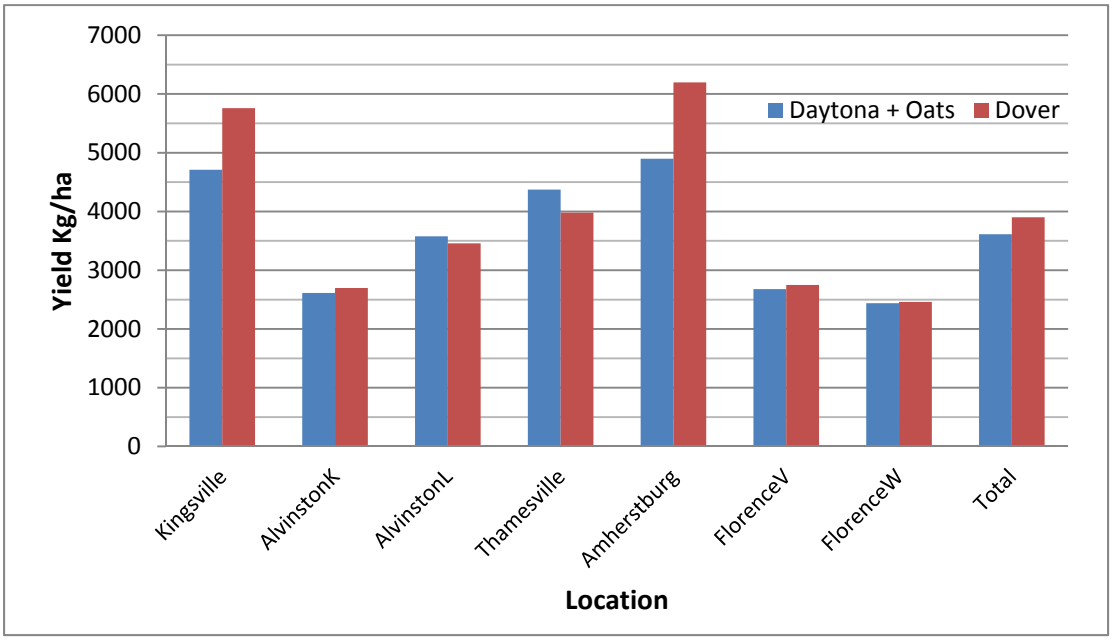
Figure 2. Cover Crop Biomass October 2012 Harvest



The cover crop biomass increased significantly at the second harvest which was completed the second and third week of November. The Kingsville, Bothwell and Amherstburg sites had higher growth than the other sites. The first two sites were on sandy soils and the Amherstburg site is on a clay loam soil. Average biomass for the Daytona + plus oats was 3600 kg/ha and the Dover mix was higher at 3900 kg/ha, see Figure 3. There was not as much of a difference between the two mixtures at this harvest. The growth at the two Alvinston sites may lag behind some of the others because the nitrogen was applied as ESN nitrogen which would have delayed the availability of the nitrogen. The FlorenceV site received the nitrogen a few weeks after the others and it was planted deeper delaying the Tillage Radish emergence so that may

help explain the reduced growth. The FlorenceW site was tilled prior to planting and the soil was dry so that may explain the reduced growth there.

Figure 3. Cover Crop Biomass (kg/ha) November 2012 Harvest



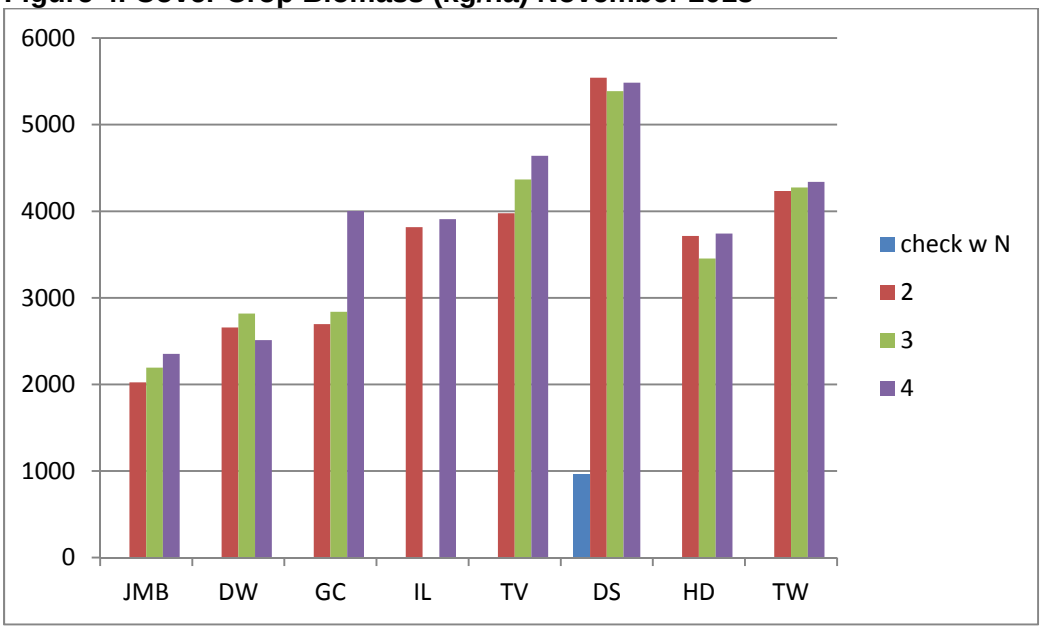
Cover Crops in Corn The cover crops were hand seeded into four grain corn fields and after silage harvest at another site from the last week of August to the middle of September. The cover crop establishment was sparse at all four sites. The plants that did establish had minimal growth. The annual ryegrass had the best growth and establishment of the cover crops tested. Overall the growth was reasonable considering the late planting. The cover crops planted after corn silage had reasonable growth.

2013 Cover crop planting did not begin until the second half of August to mitigate concerns the radish would get into tile drains. The first plot was planted on August 20th and most of the rest were planted by the end of August with the last two planted the second week of September. Twelve sites were planted: five in Lambton county, three in Chatham-Kent and four in Essex county. Five other cover crop sites were also monitored as part of this project. Many of the observations were similar to 2012. Cover crop growth was very good on most of the cover crop plots. The area of the plots where no nitrogen was applied showed poor growth at soil nitrate levels of 5ppm or less, about half the biomass. Moderate growth was seen at the 8 to 10ppm level where one site had equal growth and the two others about 70% of the biomass with nitrogen. Growth was similar to where the 50 lbs/ac of nitrogen was applied where soil nitrate levels where 20ppm. The checks were put in to evaluate what happens if there is no cover crop planted in a field. There was a range of what was seen in the checks at the various sites. Some sites had very little growth of volunteer wheat or weeds. A few had significant growth of weeds. All but three had very little growth of volunteer wheat. The site with the most volunteer wheat growth only produced about 1000 kg/ha of above ground biomass whereas the cover crops beside it produced over 5000 kg/ha of biomass by mid-November. Not only did the cover crop produce a lot more organic material to feed the

soil it also suppressed weed growth. Volunteer wheat is not going to put on a lot of growth until it is vernalized with cold temperatures so it doesn't provide much growth as a summer cover crop. Winter came early this fall and temperatures dipped to -5C or lower in the second half of November. This terminated the growth of all of the cover crops except the crimson clover and the Austrian winter peas. The sorghum sudan and the sunflowers were terminated by earlier frosts. In one or two fields the cover crops provided feed for the wildlife. The deer ate the buds off the sunflowers and there was some nibbling on the above ground radish.

The average biomass harvested in October for the oats/radish mixture was 1800 kg/ha, 1850 kg/ha for the oats/radish/crimson clover mixture and 2000 kg/ha for the six way mixture. Rain delayed the biomass harvest until later in November. Cold temperatures set in early. A few sites were harvested closer to the middle of the month but six of the sites were harvested at or near freezing temperatures. Snow began to fall preventing the biomass harvest of the remaining three sites. Again this year the biomass increased significantly in the November sampling. The oats/radish and the oats/radish/crimson clover mixtures averaged 3600 kg/ha and the six way mixture averaged 3900 kg/ha see figure 4. A couple of the sites included the commercially available mixtures. The oats in those mixtures grew more rapidly than the oats in the main plots. Beside one of the plots there was an excellent stand of red clover. 3900 kg/ha of biomass was harvested mid-October compared to 1500 kg/ha biomass harvested from the cover crop mixtures. One of the additional plots evaluated seeding rate of a commercial oat/radish mixture. Seeding rates of 25, 30, 40, and 50 lbs/ac were planted. The seeding rate we used in the plots was the best at 30 lbs/ac.

Figure 4. Cover Crop Biomass (kg/ha) November 2013



Cover Crops in Corn At one site three cover crop treatments were set up. The cover crops were broadcast into grain corn at the six leaf stage and again just after tasseling. The three treatments were annual ryegrass, red clover and an annual ryegrass/ crimson clover mix in the last one. Cover establishment and crop growth for all three was good in the early seeding but was nonexistent for the later seeding. The annual ryegrass and the

clover/ryegrass mixture were about 15cm tall by early September and the red clover was at the 6 leaf stage see figure 5. At another site similar cover crops were seeded after tasseling with disappointing results.

Figure 5. Annual Ryegrass Growth September 3 (seeded in to corn June 24, 2013)

The cost per acre in 2012 of the Dover mixture was $37.50 and the Daytona plus oats mixture was $16.90 per acre. In 2013 the seed cost for the radish + oats was $19/ac, radish + oats + crimson clover $32/ac, and the six way mixture $37.50/ac. The cost of 50 lbs of urea per acre was $34.50/ acre in 2012 and custom application $10 per acre. Approximately $10 per acre worth of herbicide will control the crimson clover.

Summary:

Cover crops planted in the second half of August can produce a significant amount of biomass by the middle to end of November. October biomass averaged 1500 to 2000 kg/ha over the two years and 3600 to 3900 kg/ha in November. Looking at the mixtures there is no biomass advantage to adding the crimson clover to the oats and radish but the clover would provide a little nitrogen. The crimson clover in the Daytona mixture without the oats added would have less competition and the opportunity for more growth and a bit more nitrogen. Planting the cover crop at the correct depth is important to ensure the cover crop germinates rapidly. When the mixtures in a plot were planted too deep the crimson clover did not emerge and the radish was delayed so the oats grew to begin providing cover and helped fill in where the other species growth was poor or missing. The type of drill or planter does not seem to matter as anything from drills without a small seed box to 30’ air seeders were able to successfully plant the cover crops.

The Dover mixture is killed by cold temperatures. The crimson clover will have to be killed with a herbicide in the spring. Cover crops increased the number of earthworms compared to no cover crops. Volunteer winter wheat does not provide as much growth as a planted cover crop in August.

After one year of evaluating soil nitrate levels and cover crop growth it appears that soil nitrate levels at 5ppm or below require the 50 lbs N/ac to provide good cover crop growth. Nitrate levels around 10 ppm do not provide as much growth as the 50 lbs of nitrogen did but produced what could be called adequate growth. Cover crops grown in soil with nitrate levels around 20ppm of nitrogen do not require additional nitrogen to achieve good growth.

Cover crops will grow when inter seeded in grain corn. Not all cover crops will tolerate the shade well or germinate well on the soil surface. Dry soil conditions limited cover crop germination in 2013. Annual ryegrass and clovers seem to tolerate the shade well. Seeding these cover crops at the six leaf stage of corn shows promise.

Next Steps:

Earthworm counts, infiltration measurements and the cover provided by each mixture will be assessed in the spring. The corn yields following the cover crops will be measured where possible. The mixtures will be assessed to determine their performance and other cover crops will be evaluated to see if they should be included in 2014 trials. Further evaluation of cover crops that will establish well in corn will be completed. An attempt will be made to rent a seeder to inter seed cover crops into standing corn mid-season for field scale evaluations.

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