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NO-TILL CORN YIELD COMPARISONS USING WINTER PEAS/OILSEED RADISH AND NITROGEN FERTILIZER

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ABSTRACT

A replicated no-till corn experiment used Austrian winter peas plus oilseed radish and Windham winter peas plus oil seed radish planted on two dates compared to no covers and three rates of nitrogen fertilizer (0, 140, 220). Mean soil nitrate levels ranged from 15-23 ppm. The September plantings of Austrian and Windham winter pea mix with zero nitrogen fertilizer had significantly higher nitrate levels (25-47% higher) than the no cover crop treatments. Winter pea plus oilseed radish corn yields averaged 134 bushels with zero nitrogen fertilizer and were significantly higher than the no cover zero fertilizer treatments (108.1 bushels). In the absence of nitrogen, the addition of cover crops significantly increased yield compared to no cover crop.

INTRODUCTION

High nitrogen prices are encouraging agricultural producers to plant cover crops to tie up carryover nitrogen or to supplement nitrogen fertilizer with organic nitrogen. Hoorman et al. (2010) reported at the Ohio Conservation Tillage & Technology Conference that cover crops were being extensively used to decrease soil erosion, increase nutrient recycling, improve water quality and increase farm profitability. Speakers at this conference reported how winter peas plus oilseed radish in no-till corn decreased nitrogen fertilizer application.

Flanary and Crawford (2012) found that no-till corn yields were maximized yearly by optimal nitrogen rates based on climate. The optimal nitrogen rate varied from 120 to 300 pound/acre with generally more nitrogen fertilizer needed in wet or extremely wet years and less nitrogen needed in dry years.

Angimma et al. (2010) found that moisture and shallow planted no-till corn played a significant role in producing high producing corn but starter fertilizer and reducing soil compaction also played a role in producing high yielding corn. Nottingham and Armentrout (2011) found that drilling the cover crops, especially the legumes, produced higher biomass than light incorporation and broadcasting the legume cover crop seed. Sundermeier (2010) found that oil seed radish planted in wheat stubble tied up 70% of the nitrogen from manure compared to no cover.

This experiment uses two varieties of winter peas (Austrian and Windham) plus oilseed radish to document the impact of a fall planted legume cover crop to produce organic nitrogen for corn production the following year. Preliminary reference materials from the new Cover Crop Field Guide and the Managing Cover Crops Profitably were used to manage these plots.

MATERIALS AND METHODS

This research was conducted at the Ohio Agricultural Research and Development Center's (OARDC) Northwest Agricultural Research Station located near Custar, Ohio. The soil type is Hoytville clay with subsurface drainage systematically installed. Each plot was 10 x 70 feet with four replications in a randomized complete block design. On July 20, 2010; all plots were tilled to incorporate residue straw after wheat harvest.

On August 18, 2010, a White splitter planter seeded inoculated Austrian winter pea at 30 pounds per acre and oilseed radish at 4 pounds per acre. Row alignment had radish placed where corn was planted the following spring and winter pea planted 15 inches over from the radish rows. The second planting of cover crops was on September 14, 2010, with both inoculated Austrian and Windham winter peas varieties planted with the oilseed radish in separate rows. Due to space limitations, Windham was not planted in August. The Windham winter pea variety is promoted as a late planted legume for winter survival.

Corn was no-till planted nearly a month late on June 4, 2011 due to an extremely wet spring. Herbicides were applied on June 6, 2011 to kill the cover crop and weeds. On June 27, 2011; 28% urea ammonium nitrate (UAN) nitrogen was applied side-dress to V6 stage corn at zero and 140 pounds nitrogen per acre on both cover crop and non-cover crop plots. The target nitrogen rate for 150 bushel corn is 180 pounds of nitrogen per acre. The winter peas were projected to supply 40 pounds of organic nitrogen per acre so 140 pounds of inorganic nitrogen fertilizer was added to achieve 180 pounds total nitrogen. An additional non-cover crop plot had 220 pounds per acre nitrogen applied as an upper nitrogen rate comparison.

All the above ground cover crop biomass samples were taken on May 2, 2011 from one square foot and air dried. Due to budget constraints, soil nitrate samples were taken on July 7, 2011 from the zero nitrogen treatments only to represent cover crop nitrogen contribution. Harvest data was collected from the center two rows on November 11, 2011. ANOVA for variance was calculated for soil nitrate and yield measurements using Agricultural Statistics Analysis Program (http://pnwsteep.wsu.edu/agstatsweb/wfrmMain.aspX?creatNEW=true).

RESULTS

Biomass samples taken in May 2011 showed that the August planting of Austrian winter pea had 2.1 ton/acre dry biomass, September planted Austrian winter pea had 7.7 ton/acre, and September planted Windham winter pea had 9.2 ton/acre biomass.

Soil nitrate soil samples were taken from the zero fertilizer plots and the results are listed in Table 1. Mean soil nitrate levels ranged from 15 to 23 ppm and there were significant differences (LSD .05, 5.0 PPM). The September plantings of Austrian and Windham winter pea with the oil seed radish with zero nitrogen fertilizer had significantly higher nitrate levels (25-47% higher) than the no cover crop. Also, the September planted Windham winter peas with oil seed radish had significantly higher nitrate levels (28%) than the August planted Austrian winter peas with oil seed radish.

Table 1. Soil nitrate levels collected from zero 28% UAN plots.

Treatments	Rep #1	Rep # 2	Rep # 3	Rep # 4	Mean value of 4 reps PPM (Parts per Million
No Cover Crop	18	11	16	13	15A
Austrian WP, August planting	16	21	18	16	18AB
Austrian WP, September planting	24	20	17	18	20BC
Windham WP, September planting	27	25	18	23	23C

S. D. = 3, C.V. = 16%, LSD .05=5.0 PPM

WP = Winter Pea + Oilseed Radish

Table 2 shows the corn yields from all the treatments. The corn yields ranged from a low of 108.2 bushels per acre with no cover and no fertilizer to 205.1 bushels per acre with no cover and 220 pounds of nitrogen (N) fertilizer. The winter pea plus oilseed radish corn yields with zero nitrogen fertilizer were significantly higher than the no cover zero fertilizer treatments (LSD =.05, 8.9 bushels) however the winter pea treatments plus oilseed radish with no added nitrogen fertilizer were not significantly different from each other. The average corn yield on all the winter pea plus oil seed radish treatments with zero nitrogen fertilizer was 134 bushels per acre or 25.8 bushels (23.8%) higher than the no cover with zero fertilizer treatments.

All the 140 pounds N fertilizer treatments were significantly higher than the zero fertilizer treatments. The no cover treatment (140 pounds N) was not significantly different in corn yield than the covered treatments (140 pounds N) with winter peas and oil seed radish. However, the September planted Austrian winter peas corn yield was significantly higher than the August planted treatment (LSD.05, 8.9 bushel) with a difference of 11.7 bushels (6.4% increase) per acre. The 220 pounds N treatment with no covers yielded 205.7 bushels corn and was significantly higher (LSD .05, 8.9 bushels) than all other treatments.

Table 2. Corn yields from all treatments.

Treatments	Rep # 1	Rep # 2	Rep # 3	Rep # 4	Mean value of 4 reps Bushels per acre
No cover crop, 0 N	107.8	108.5	107.0	109.5	108.2A
Austrian WP, 0 N, August planting	141.7	133.7	138.4	134.9	137.2B
Austrian WP, 0 N, September planting	123.2	138.0	135.8	124.7	130.4B
Windham WP, 0 N, September planting	137.0	140.0	120.5	139.9	134.4B
Austrian WP, 140 lb. N, August planting	189.2	186.4	176.9	180.0	183.1C
No cover crop, 140 lb. N	179.9	199.9	193.3	185.3	189.6CD
Windham WP, 140 lb. N, September planting	187.1	198.1	187.8	191.4	191.1CD

Austrian WP, 140 lb. N, September planting	183.3	198.2	202.9	194.7	194.8D
No cover crop, 220 lb. N	205.2	206.9	206.6	203.9	205.7E

S.D. = 6.1, C.V. = 3.7%, LSD .05 = 8.9 Bushels/Acre

WP = Winter Peas + Oilseed Radish

Picture 1. Oilseed Radish & Winter Pea Plot at Custar OARDC Agricultural Research Station.

Table 3 lists the partial budget for cover crop cost and nitrogen fertilizer differences. In partial budget analysis, only the income and costs that are different are compared and analyzed. All other costs are assumed to be constant between treatments. In 2011, the average corn price was assumed to be $6.50 per bushel. Austrian winter peas cost $.80 per pound and Windham winter peas cost $.88 per pound with 30 pounds per acre applied. Austrian winter peas cost $24 per acre and Windham cost $26 per acre. The oilseed radish cost $2.75 per pound with four pounds per acre applied at $11 per acre. Planting cost is $15 per acre based on Ohio Custom Rate Survey, 2010. Nitrogen cost $.50 per pound or $70 per acre for the 140 pounds N application using 28% UAN for side-dressed nitrogen. The 220 pounds N application rate cost $110 per acre.

The partial budgets show that at the zero N application rates, the no cover had the lowest income over added costs at $703.30 while the August seeded Austrian winter pea plus oil seed radish cover crop treatment had the highest income over added costs at $841.80. Austrian winter peas plus oilseed radish planted in August netted $138.50 over added costs, followed by Windham winter pea mixture planted in September ($118.30 gain) and Austrian winter pea mixture ($94.30 gain) planted in September.

At the 140 pounds N application rates, the Austrian winter pea mixture planted in August had the lowest income over added costs at $1,070.15 while the no cover crop treatment had the highest income over added costs at $1,162.30. At the 140 pounds N application rate, none of the winter pea mixtures paid for the added cost of seed and planting. The highest ovrerall net income over added costs occurred at the 220 pounds N application rate at $1,227.05 per acre and $523.75 dollar gain over the zero N application rate.

Table 3. Partial Budget for Cover Crop Cost and Nitrogen Fertilizer Differences.

Treatments	Mean value of 4 reps Bushels per acre	Income	Nitrogen cost	Cover Crop Costs	Income above Added Input Costs	Dollar Gain from control, no cover, zero N
No cover crop, 0 N	108.2	$703.30	$0	$0	$703.30	$0
Austrian WP, 0 N, August planting	137.2	$891.80	$0	$50.00	$841.80	$138.50
Austrian WP, 0 N, September planting	130.4	$847.60	$0	$50.00	$797.60	$94.30
Windham WP, 0 N, September planting	134.4	$873.60	$0	$52.00	$821.60	$118.30
Austrian WP, 140 lb. N, August planting	183.1	$1190.15	$70.00	$50.00	$1070.15	$366.85

No cover crop, 140 lb. N	189.6	$1232.40	$70.00	$0	$1162.40	$459.10
Windham WP, 140 lb. N, September planting	191.1	$1242.15	$70.00	$52.00	$1120.15	$416.85
Austrian WP, 140 lb. N, September planting	194.8	$1266.20	$70.00	$50.00	$1146.20	$442.90
No cover crop, 220 lb. N	205.7	$1337.05	$110.00	$0	$1227.05	$523.75

WP = Winter Peas + Oilseed Radish

DISCUSSION

The 2011 planting season was an unusually wet year with almost twice the precipitation received compared to a normal year. Corn planting was delayed until the first week of June compared to a normal planting in early May. On heavy clay soils like Hoytville, nitrogen losses may be high from denitrification. As was shown previously by Flanary and Crawford (2012), moisture plays a key role in nitrogen management and extra nitrogen generally leads to higher corn yields in a wet year.

While 2011 was excessively wet, the fall of 2010 was extensively dry. The dry weather reduced cover crop stands in August versus September plantings of the Austrian Winter peas plus oil seed radish and subsequent biomass production (2.1 tons per acre August versus 7.7 tons per acre from September plantings). While the September planted Windham winter peas plus oil seed radish biomass out produced the Austrian winter peas planted at the same time (7.7 tons per acre versus 9.2 tons per acre), the added biomass did not translate into higher corn yields.

Past experience with winter peas in alternating rows with oilseed radish has shown that corn planting placement directly on top the row, beside the row, or in between the rows was not an issue. Precise placement of corn rows was not required to achieve higher yields, so precision planting with global positioning systems is not required. The oilseed radish decomposes during the winter and the planter coulter pushes mellow soil into the root cavity after root decomposition.

The no cover with zero nitrogen fertilizer had significantly lower yields than the covers with zero added nitrogen fertilizer. Nitrate testing in the spring showed that the winter peas and oilseed radish treatments had higher nitrate levels (25-47% higher) which translated into higher corn yields, especially in a wet year. However, the difference in corn yield was not maintained when an additional 140 pounds of nitrogen was added to the no cover treatment.

The significant difference in corn yields between the August and September planting of Austrian winter peas and oil seed radish can be explained by the improved biomass production and the higher soil nitrate levels in the spring. The 220 pounds N application of fertilizer with no covers showed that nitrogen levels may still be limiting corn yields, since the corn yield were still increasing.

Soil quality factors were not analyzed in this experiment. In future research, the authors would recommend using additional soil chemical and physical tests like soil organic matter, bulk density, and aggregate stability and quality tests like microbial biomass to understand the differences in soil productivity. Since this is a one year no-till corn experiment, additional testing and continued use of no-till and cover crops with the same treatments on the exact same plot of land may reveal changes in soil quality and soil productivity changes over time.

SUMMARY

With the zero nitrogen rates, the no cover crop had significantly less corn yield compared to all other cover crop plantings with zero nitrogen. One can conclude that the winter pea did add significant amounts of nitrogen to increase corn yields. The effect of adding oilseed radish to the cover crop mixture on corn yield is unknown. The planting date or type of winter pea cover crop (Windham versus Windham) at zero nitrogen had similar corn yields.

With 140 pounds N per acre, there was significant difference between Austrian winter pea planted in August compared to Austrian winter pea planted in September. The later planting resulted in higher corn yield, likely due to a higher population and growth of biomass due to moisture. This was the only significantly different comparison among the treatments using 140 pounds N per acre.

The treatment using 220 pounds N per acre was significantly different from all other treatments with an average corn yield of 205.7 bushels per acre. This shows that the 140 pounds N was not sufficient for maximum corn yield.

Soil quality improvements from using cover crops were not analyzed but additional soil quality testing may help to explain the difference in corn yields between these treatments over time.

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