USDA United States Department of Agriculture

FINAL STUDY REPORT of MIPMC-T-1301-CP
Rose Lake Plant Materials Center, E. Lansing, MI

WINTER COVER CROP GROWTH AND EFFECT ON YIELD OF CORN (*Zea mays* L.)

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ABSTRACT

Growth of cover crops in late summer through early spring and their effect on subsequent crop yield are of interest to researchers and farmers. This study considers cover crop growth and effect on subsequent corn yield on a crop and livestock farm in Shiawassee County, Michigan. Cover crops were drilled in August about one month after wheat harvest. Cover crop growth data were collected and will be provided to USDA modelers for use in developing and validating conservation planning tools. Cover crops were terminated and corn was no-till drilled in May. Corn was harvested in October with no yield response to cover crop treatment observed in this one-year study.

INTRODUCTION

Cover crops are grown during or between primary cropping seasons, not primarily for harvest, but to benefit subsequent crops or the environment. Subsequent crop yield may be increased and fertilizer and pesticide costs decreased. Environmental benefits or ecosystem services (Cavigelli et al., 1998) provided by cover crops include reduced nutrient leaching and runoff, nitrous oxide emission, and soil erosion; long-term improvement in soil health and stabilization of crop yields; increased carbon sequestration and oxygen generation; enhanced aesthetics; increased snow capture; and protected surface and groundwater. Managing Cover Crops Profitably (Clark, 2007) and Midwest Cover Crops Field Guide (Midwest Cover Crops Council, 2014) distill the agronomic and environmental benefits of cover crops from published sources and on-farm experience.

Grasses, legumes, and brassicas in monoculture and mixtures have been used as over-winter cover crops to provide environmental benefits and to increase subsequent crop yield. This study, conducted by USDA-NRCS Rose Lake Plant Materials Center (PMC) and hosted by Lee Farms (Figure 4) in Laingsburg, Michigan, was designed to measure the growth of these cover crops and their effect on yield of a subsequent corn (*Zea mays* L.) crop in southwest Shiawassee County, Michigan.

This study supports Rose Lake PMC Long Range Plan Strategic Goal 2 “Provide plant materials and plant technology that are economically feasible for solving conservation problems” and Program Objective 1.2 “Improve water quality and quantity with plant science technology.” It also supports the Plant Materials Program National Action Plan item measuring plant parameters to support criteria and specifications for conservation practice standards. A collateral benefit of this study was the venue that it provided for in-field teaching and learning by groups such as the local Conservation District and area high school agriscience classes and FFA chapters.

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MATERIALS AND METHODS

Cover crop plots were no-till drilled (Truax, New Hope, MN) on 20 Aug 2012, about one month after wheat harvest. Soil was a Celina loam, 2 to 6 percent slope, with above optimum P, optimum K and Mg, 6.7 CEC in top 6 inches, and lime applied to maintain 6.5 pH (Table 2). Field plot design was a split-plot randomized complete block with three replicates. Main plots were 70 ft by 24 ft. Cover crop and seeding rate treatments were chosen based on the Cover Crop Decision Tool (Midwest Cover Crops Council; n.d.) and indigenous knowledge and are shown in Table 1.

Cover crop height, percent groundcover, plant population, and biomass data were measured and recorded at approximately 30, 45, 60, and 70 days after planting and in the spring. Cover crop height and percent groundcover was estimated using a grazing stick (Figure 1; Smith et al., 2010). Plant population and biomass data were collected by pulling plants in one 2 ft^2 quadrat per plot. Quadrats were placed to obtain representative biomass samples. Collected plants were separated by species and counted, washed to remove soil, placed in paper bags, dried at 60˚ C (140˚ F) to a constant weight, and weighed to obtain biomass data.

Details of corn production practices are shown in Table 3. Briefly, corn was planted in spring 2013 with nitrogen in the starter fertilizer at 10 lb/acre. Plots were split which allowed additional nitrogen application to approximate '0', ½, and full recommended rates. ('0' nitrogen rate included 10 lb/acre nitrogen applied as starter fertilizer.) Corn was hand harvested in fall 2013 and yield of dry shelled corn was determined. Data were subjected to analysis of variance.

RESULTS AND DISCUSSION

Cover crop growth measurements are show in Tables 4 to 7. Oilseed radish in monoculture and/or mixtures provided the earliest and most groundcover in the fall. Annual ryegrass in monoculture and/or mixtures provided the most groundcover in the spring. Biomass accumulation by species and sampling date followed the same trends as groundcover.

These data on oilseed radish growth corroborate findings of a previous study of brassicaceous cover crops at Rose Lake PMC (Ackroyd et al., 2011; Ackroyd et al, 2012; Durling et al., 2011; Durling et al., 2012; Mutch, 2011) Oilseed radish, annual ryegrass, and red clover data are likely to be used in the WEPS (Wind Erosion Prediction System) model as brassicaceous cover crop data collected by Rose Lake PMC that have been extensively used in such (J. Douglas, pers. comm., 2010).

No corn yield response to cover crop was observed (Table 8). No interaction was found between cover crop and nitrogen fertilization. Corn yield response to nitrogen fertilizer rate was positive ($p<0.05$) within the 10 to 120 lb/acre range of the study. Findings from this one-year study are unremarkable.

CONCLUSION

Cover crop growth parameters collected in this study should prove valuable for model development and/or validation. The other enduring, albeit collateral, benefit of this study is the experiential learning opportunity that it provided for area farmers and agriscience students.

ACKNOWLEDGEMENTS

The authors wish to acknowledge the contributions of Larry Lee (farmer cooperator); Sergio Pérez (Rose Lake PMC Biological Sciences Technician), the Shiawassee Conservation District; Tom Topham and Scott Mackie (Earth Team Volunteers), Bill Kuenstler and Joel Douglas (USDA-NRCS Central National Technology Support Center staff), and the Michigan State University Cover Crops Program.

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Table 1. Cover crops and seeding rates. Lee Farms. 2012-13.

Cover crop combination	Seeding rate (lb/acre PLS[†])
Annual ryegrass (*Lolium multiflorum)*	18
Red clover (*Trifolium pratense*)	9
Oilseed radish (*Raphanus sativus*)	9
Annual ryegrass (*Lolium multiflorum)*	6
Red clover (*Trifolium pratense*)	3
Oilseed radish (*Raphanus sativus*)	3
Annual ryegrass (*Lolium multiflorum)*	9
Red clover (*Trifolium pratense*)	5
Annual ryegrass (*Lolium multiflorum)*	9
Oilseed radish (*Raphanus sativus*)	5
Red clover (*Trifolium pratense*)	5
Oilseed radish (*Raphanus sativus*)	5
control: no cover crop	0

[†] Pure live seed

Table 2. Site characteristics and history. Lee Farms, Laingsburg, MI. 2013.

Soil name	Celina loam
Cropping and cultural practices	corn, soybeans, and wheat in rotation; 30 years of no-till with livestock manure and some cover crops
Soil test	above optimum P; optimum K and Mg; 6.7 CEC in top 6 inches (fall 2012); lime applied to maintain 6.5 pH
Soil organic matter	1.2% (fall 2013)

Table 3. Selected corn production practices. Lee Farms, Laingsburg, MI. 2013.

Date	Practice
25-Apr-13	WeatherMAX® (glyphosate) @ 2 qt/acre w/ ammonium sulfate + 2,4-D @ 1 pt/acre
9-May-13	Garst 88M51GT @ 33K corn seeds/acre (Garst 88M51GT is a glyphosate resistant hybrid) 6-row, 6400 White planter w/ 3 Rawson coulters/row 5-15-40 + 3%S @ 200 lb/acre at planting SureStart® (acetochlor, flumetsulam, and clopyralid) preemergence @ 1 qt/acre
16-May-13	28% UAN solution at 0, 50, and 110 lb/acre actual N (to approximate '0', 1/2, and full rates, respectively)
10-Jun-13	glyphosate @ 1 qt/acre w/ ammonium sulfate
18-Oct-13	hand harvested 0.001 acre/plot, shelled, dried, and converted to bushels of shelled corn @ 15.5% moisture

Table 4. Height of cover crop and cover crop combinations. Lee Farms, Laingsburg, MI. 2012-13.

Cover crop combination	20-Sep-12	2-Oct-12	16-Oct-12	1-Nov-12	6-May-13
	----------height (inches)----------				
annual ryegrass	4.3	5.3	5.3	6.7	7
red clover	1.3	1.3	1.7	4	5.3
oilseed radish	6	8.7	11	13.3	6
Control	1.3	2.3	3.7	3.3	6.7
annual ryegrass + red clover + oilseed radish	2.7	6.7	7.7	12	6.7
annual ryegrass + red clover	3.7	4	3.7	4.7	6.7
annual ryegrass + oilseed radish	5	5.7	9.3	10	6
red clover + oilseed radish	2.7	6	7.7	9	4.7
$LSD_{.05}$[†] (within column)	2.1	2.1	2.1	2.3	2.5

[†]Least significant difference $p<0.05$

Table 5. Groundcover provided by cover crop and cover crop combinations. Lee Farms, Laingsburg, MI. 2012-13.

Cover crop combination	20-Sep-12	2-Oct-12	16-Oct-12	1-Nov-12	6-May-13
	----------groundcover (percent)----------				
annual ryegrass	23	43	57	73	57
red clover	3	0	3	37	13
oilseed radish	83	90	97	90	13
control	3	7	13	40	7
annual ryegrass + red clover + oilseed radish	50	67	80	90	47
annual ryegrass + red clover	20	43	43	47	47
annual ryegrass + oilseed radish	70	70	73	90	27
red clover + oilseed radish	23	63	73	63	17
$LSD_{.05}$[†] (within column)	38	27	30	36	25

[†]Least significant difference $p<0.05$

Table 6. Plant population of cover crop and cover crop combinations. Lee Farms, Laingsburg, MI. 2012-13.

Cover crop combination	20-Sep-12	2-Oct-12	16-Oct-12	1-Nov-12	6-May-13
	----------plants/ft^2----------				
annual ryegrass	127	144	201	146	138
red clover	6	19	13	13	17
oilseed radish	10	11	20	14	13
Control	3	16	25	17	43
annual ryegrass + red clover + oilseed radish	48	39	36	59	101
annual ryegrass + red clover	61	80	63	101	133
annual ryegrass + oilseed radish	44	41	45	44	55
red clover + oilseed radish	12	24	12	9	19
$LSD_{.05}$[†] (within column)	37	34	93	22	36

[†]Least significant difference $p<0.05$

Table 7. Biomass of cover crop and cover crop combinations. Lee Farms, Laingsburg, MI. 2012-13.

Cover crop combination	20-Sep-12	2-Oct-12	16-Oct-12	1-Nov-12	6-May-13
	----------ton/acre oven dry biomass----------				
annual ryegrass	0.32	1.34	1.63	2.51	1.06
red clover	0.06	0.11	0.09	0.23	0.22
oilseed radish	0.62	1.27	1.37	2.48	0.06
Control	0.05	0.14	0.24	0.4	0.3
annual ryegrass + red clover + oilseed radish	0.32	0.92	1.58	2.64	0.8
annual ryegrass + red clover	0.29	0.68	0.67	2.28	1.2
annual ryegrass + oilseed radish	0.51	1.05	1.98	2.29	0.31
red clover + oilseed radish	0.16	0.76	0.94	1.6	0.17
$LSD_{.05}$† (within column)	0.29	0.67	0.8	1.33	0.32

†Least significant difference $p<0.05$

Table 8. Corn yield response to nitrogen fertilizer and cover crop and cover crop combinations. Lee Farms, Laingsburg, MI. 2013.

Cover crop combination	'0' N rate	1/2 N rate	Full N rate
	----------corn yield (bu/a)----------		
annual ryegrass	100	138	153
red clover	98	139	144
oilseed radish	117	148	170
control	96	134	151
annual ryegrass + red clover + oilseed radish	105	139	171
annual ryegrass + red clover	94	126	159
annual ryegrass + oilseed radish	95	159	166
red clover + oilseed radish	121	141	169
average	103	141	160
Statistical significance[†] (within column)	NS[‡]	NS	NS

[†]Least significant difference *p<0.05*

[‡]Nonsignificant

Figure 1. Percent groundcover was estimated using a grazing stick.

Figure 2. Oilseed radish leaves large root holes in spring.

Figure 3. Red clover emerged in late August.

Figure 4. Larry Lee (center right) of Lee Farms, Laingsburg, Michigan, has hosted several Rose Lake PMC field trials.