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Effect of Planting Date and Cultivar on Cereal Rye Development and Termination for Organic No-Till Production Systems

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Introduction

Cereal rye (*Secale cereale*) has emerged as a key player, as acceptance of cover cropping grows. Organic growers are invested in incorporating cereal rye and strip tillage in their reduced tillage production systems. However, termination of cereal rye continues to be a challenge. Many organic growers have embraced the chevron-patterned roller crimper as a promising method of termination to address this issue. Unfortunately, many farmers are concerned about the potential delay of planting their cash crop. This concern is due to the requirement of cereal rye to be at the anthesis (flowering) stage for successful termination. Moreover, many growers are planting VNS (variety not stated) cereal rye, which complicates the issue. Growers need specific information on cereal rye cultivars, establishment, growth, anthesis, and termination methods. The purpose of this research was to investigate the effect of planting date and performance of five cereal rye cultivars (Aroostook, Elbon, Prima, Wheeler, and Wrens Abruzzi) under Midwest growing conditions. This research is intended to serve as a decision making tool for Midwest organic growers who want to select the best cereal rye cultivar to use in their no-till production system.

Materials and Methods

Seeding of cereal rye. All plots were tilled and cultimulched prior to seeding. On both September 16 and October 13, 2015, all five

cereal rye cultivars were broadcast at a rate of 110 lb/acre using a Gandy drop spreader. The seed was incorporated by tilling at a 2-in. depth. Several continuous days of rain after the September planting date gave those plots an excellent start. The planting date in October had to be irrigated to promote germination. Plots from both planting dates were well established going into the winter months. Data was collected on date of anthesis, kill after roller crimping, cover crop biomass, soil coverage, carbon-to-nitrogen ratio, and soil temperature and weed biomass.

Dates of anthesis and roller crimping.

Beginning May 17, plots were assessed visually for anthesis (flowering) stage. Individual plots were considered as having reached anthesis when 50 percent or more of the plants had anthers visible. Rye in all plots was rolled and crimped after reaching full anthesis June 3, 2016. The roller crimper was mounted to the front of the tractor operated at 5 mph. Four days after the use of the roller crimper (June 7, 2016), plots were scored for success of termination by three individuals. A second round of rolling and crimping took place June 10, 2016 for a complete termination of all cultivars.

Biomass. On May 22, 2016, prior to roller-crimping, a 50 cm by 50 cm quadrat of above-ground cereal rye biomass was collected from each plot. Biomass was dried and weighed to assess average dry weight.

Carbon-to-nitrogen ratio. The carbon-to-nitrogen (C:N) ratio of plant material is a strong indicator of the ability of soil microbial organisms to break down organic matter into a useable source of nitrogen, making it an

important variable to consider when utilizing cover crops. The same biomass analyzed for dry weight was ground and submitted to the ISU Soil and Plant Analysis Lab for estimation of total carbon and total nitrogen using combustion analysis.

Soil coverage and temperature. Soil coverage was assessed May 26, 2016 using a LI-COR Line Quantum Sensor and Handheld Meter (Model # LI-191 and LI-1400, respectively). The light bar was held level at the soil surface in three points of the plot compared with a control (full light reading) to establish percentage of light blocked by plant biomass. Soil temperature was measured using a HOBO Pendant Data Logger (Onset Data Loggers) buried 6 in. below the soil surface in the middle of each plot. Data was collected from March 23–August 27, 2016.

Weed biomass. On June 28 and September 2, 2016, a 50 cm by 50 cm quadrat was placed randomly in the plot for the collection of weeds within the quadrat. The weed biomass was dried and weighed to collect average dry weight biomass. No weed control was performed throughout the season. All data was analyzed using PROC GLIMMIX of SAS Version 9.3.

Results and Discussion

Dates of anthesis and roller crimping. Planting date, which is important for rye establishment prior to winter, did not have a significant effect on the date of anthesis. Each cultivar reached 50 percent anthesis within a window of five days with Aroostook flowering first and Prima and Wheeler flowering last (Table 1). After roller crimping, the termination success of each cultivar was rated on a scale of 0 to 5, with 0 being no kill, and 5 being completely dead. Rating was significantly different among cultivars ($P \leq 0.0001$). Aroostook and Wrens Abruzzi had significantly higher kill ratings (4.86 and 4.75,

respectively), followed by Elbon (4.45), Wheeler (3.08), and Prima (2.05), which were all significantly different from one another.

Biomass. It was surprising there was no significant difference between the September and October planting dates for biomass accumulation at termination. Had the plots not been irrigated in October, differences in biomass accumulation by planting date may have been larger. When examining the five cultivars, there was no significant difference in biomass (Figure 1). Aroostook had an average biomass of 9,387 lb/acre and Prima had an average biomass of 7,647 lb/acre. Increased biomass can contribute to increased water and nutrient retention, moderation of soil temperature, and enhanced weed suppression.

Carbon-to-nitrogen ratio. There were significant differences in C:N among cultivars. Aroostook, Wrens Abruzzi, and Elbon had significantly higher C:N ratios than both Prima and Wheeler (Table 2). For soil microbial activity, a C:N ratio close to 25:1 is ideal. The lower C:N ratio of Prima and Wheeler would allow the biomass to be more quickly broken down and converted to useable nitrogen. On the other hand, if a lasting mulch is desired for an entire growing season, the cultivars with a higher C:N ratio may provide a mulch bed with more longevity.

Soil coverage and temperature. Just as there was no significant difference in rye biomass, there was no difference in soil coverage, which is expected as the two variables should be correlated. Average soil coverage ranged from 77.5 percent (Wrens Abruzzi) to 72.5 percent (Elbon). Interestingly, there was a significant difference ($P = 0.0184$) in soil temperature between Wheeler (18.0°C) and Aroostook (17.5°C). Soil temperature observed under other cultivars was not significantly different from one another.

Weed biomass. No differences were found in weed biomass collected from plots in both July and September. In July, the average weed biomass ranged from 65.3 lb/acre (Wrens Abruzzi) to 220 lb/acre (Elbon). In September, the average weed biomass ranged from 2,039 lb/acre (Aroostook) to 2,432 lb/acre (Wrens Abruzzi). These results were consistent with the lack of significance among cultivar biomass, which would have contributed to overall weed suppression.

Looking ahead to the 2017 growing season, the study will include four cultivars—Aroostook, Elbon, Wheeler, and Wrens Abruzzi. Prima will be not be included due to issues with seed supply. The study has been adjusted to account for differences among

seed size of each cultivar, so equal numbers of seeds per acre will be planted. This will contribute to a more useable comparison of plant performance. Two planting dates will be evaluated, September 14, 2016 and October 14, 2016.

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Table 1. Dates of at least 50% anthesis for cereal rye cultivars planted on two dates at the ISU Horticulture Research Station.

Cultivar	Planting date	Date of anthesis
Aroostook	September 16, 2015	May 17, 2016
	October 13, 2015	
Elbon	September 16, 2015	May 19, 2016
	October 13, 2015	
Prima	September 16, 2015	May 21, 2016
	October 13, 2015	May 22, 2016
Wheeler	September 16, 2015	May 21, 2016
	October 13, 2015	May 22, 2016
Wrens Abruzzi	September 16, 2015	May 18, 2016
	October 13, 2015	May 19, 2016

Table 2. The carbon-to-nitrogen ratio of five cereal rye cultivars.

Cultivar	Average C:N ratio
Wrens Abruzzi	58:1 a
Aroostook	58:1 a
Elbon	57:1 a
Prima	49:1 b
Wheeler	47:1 b

Values followed by the same letter are not significantly different based on Fisher's LSD with alpha level 0.05.

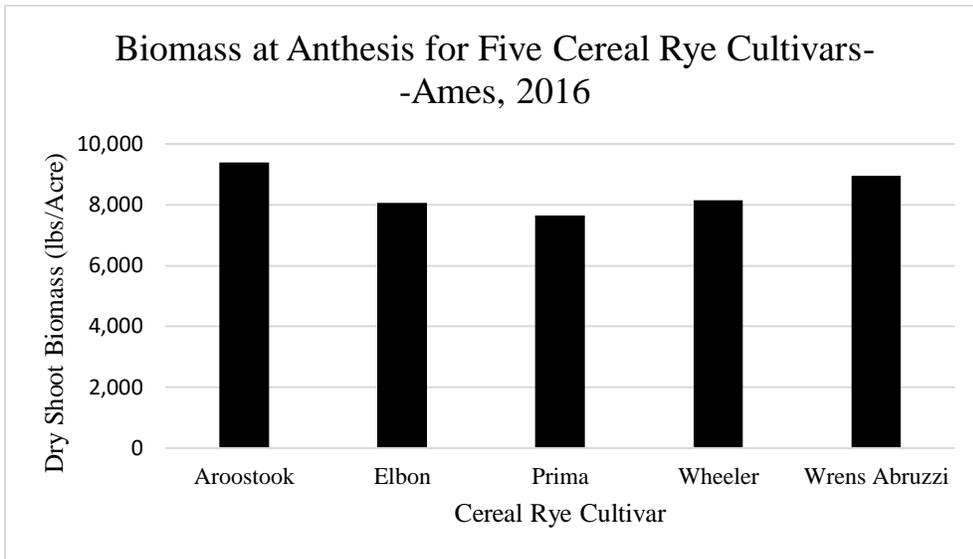


Figure 1. Shoot dry weight biomass collected at anthesis for five rye cultivars. No significant differences were found among cultivars.