Cereal Rye Seeding Method, Seeding Rate, and Termination Timing Trial

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Introduction

The use of cover crops has numerous environmental benefits. However, farmers remain hesitant to change their current production practices mainly due to cost of implementation and potential yield drag. Aiming to design best management practices (BMPs) for the adoption of cereal rye between soybean and corn cropping system, this trial was conducted to learn about the effects of different seeding methods and rates of a cereal rye cover crop, and different timings on its termination prior to corn planting.

Materials and Methods

These trials started with planting of Elbon cereal rye in the fall of 2018. For the broadcast treatment, plots were planted before soybean harvest, and drilled plots occurred after harvest. For broadcast plots, seeding rates were 1.0 (low), 1.33 (medium), and 1.67 (high) million seeds/acre. For drilled plots, seeding rates were 0.33 (low), 0.67 (medium), and 1.0 (high) million seeds/acre. Termination treatments were 14 days before planting (DBP) and 3 DBP of corn. This trial is part of a larger trial with locations near Crawfordsville and Sutherland, Iowa.

Results and Discussion

Cereal rye biomass accumulation was very different between years due to weather. The fall of 2018 and 2019 were both cooler and wetter falls that limited fall growth (data not shown). Cereal rye broke dormancy about 30 days earlier in spring 2020 (early March) compared with the spring of 2019 (early April). These extra 30 days of growth accumulated about 940 heat units (GDD50), approximately 400 higher than the previous year.

Seeding method strongly influenced the amount of cereal rye biomass growth for both years (P-value < 0.0001). However, due to the weather conditions in 2019, the broadcast method reached 1,353 lb/acre, and in 2020, 3,528 lb/acre. Additionally, in fall 2018, the drill seeding method did not germinate, resulting in delayed and lower biomass accumulation in spring 2019. This also negated the influence of seeding rate.

In 2019 and 2020, the cereal rye seeding rate did not influence biomass accumulation (Table 1). Surpringly, the pattern was the same. Although the low and high rates reached higher and similar levels, the medium rate had less biomass growth. As expected, termination timing was significant between timings for both years, with the later 3 DBP termination always reaching significantly higher biomass accumulation.

Corn grain yields were responsive to only seeding method and termination timing in 2019, where broadcast method and later termination timing were significantly lower than the drill method and early termination timing (Table 1). However, in 2020, there was no significant difference for the main effects. Interestingly, the three-way interaction was significant between seeding method, seeding rate, and termination timing (P-value = 0.0483). The three highest yielding treatments

were all drilled "high rate and 14 DBP," "medium rate and 3 DBP," and "low rate and 14 DBP," respectively.

Effect of year was significant for incidence and severity of radicle and seminal rot, and densities of *Pythium* clade B and clade F species within radicle root tissue ($P < 0.05$). Greater root rot incidence and severity on corn seedlings was observed in 2020 growing season compared with 2019. Effect of seeding method was detected for radicle rot severity in 2020 only, seminal rot incidence and severity in both 2019 and 2020, and Pythium clade B species in 2019 only (Table 2). In general, root rot was greater in seedlings from broadcasted plots than from drilled plots in both years. Similarly, densities of Pythium clade B in radicles from the broadcasted plots was greater than drilled plots. Except for Pythium clade F spp. in 2019, no significant effect of cereal rye seeding rate was detected on root rot incidence and severity of radicle and seminal root in any year (Table 2). Less clade F spp. was quantified from the low seeding rate plots. Similarly, except for radicle rot severity in 2020, termination timing did not influence root rot incidence and severity (Table 2). In 2020, mean radicle rot severity was greater in seedings when cereal rye was terminated 3 DBP corn. Seedlings sampled in 2020 from no rye control plots had greater root rot incidence and severity than seedlings sampled in 2019. However, the percentage of root rot was very low on seedlings from no rye check compared with the treatment plots. (Table 2). Densities of *Pythium* spp. quantified from no rye control plots were very low and not different between years.

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Table 1. Cereal rye biomass accumulation and corn yields for broadcast and drill seeding method at low, medium, and high seeding rate with two termination timing treatments 3 and 14 days before planting (DBP), Ames, IA.[1]

	Cover crop biomass[2]		Corn yield[2]	
	lb/acre		bushels/acre	
	2019	2020	2019	2020
Broadcast	1,353 A	3,528 A	167 B	145
Drill	138 B	516 B	192 A	157
	P < 0.0001	P < 0.0001	P < 0.0001	P = 0.2947
Low	788	2157	181	151
Medium	619	1684	178	150
High	829	2225	181	151
	P = 0.6794	P = 0.2848	P = 0.7282	P = 0.9891
14 DBP	505 B	812 B	185 A	152
3 DBP	745 A	2,022 A	174 B	149
	P = 0.0365	P < 0.0001	P = 0.0054	P = 0.7018
No cover crop check			184	153
Broadcast, Low, 3 DBP	946	1197	161	158
Broadcast, Medium, 3 DBP	916	1523	157	143
Broadcast, High, 3 DBP	933	1689	159	146
Broadcast, Low, 14 DBP	916	1497	173	131
Broadcast, Medium, 14 DBP	819	1635	180	142
Broadcast, High, 14 DBP	952	1228	174	149
Drill, Low, 3 DBP	93	141	198	150
Drill, Medium, 3 DBP	93	258	181	174
Drill, High, 3 DBP	142	277	191	125
Drill, Low, 14 DBP	67	116	192	164
Drill, Medium, 14 DBP	92	157	192	141
Drill, High, 14 DBP	183	239	200	186
	P = 0.9285	P = 0.4155	P = 0.8523	P = 0.0483

[1]P-values within boxes are used to compare means of the main effects or interaction effects within each box.
[2]Means that are significantly different at P < 0.05 have different letters following the values within each box.

Table 2. Treatment effect (seeding method, seeding rate, and termination timing) of cereal rye cover crop on corn seedlings root disease and Pythium species of corn seedlings sampled at V2 to V4 in 2019 and 2020 from Ames, IA.[z]

Year	Trtmt	Radicle incidence (%)[w]	Radicle severity (%)[x]	Seminal incidence (%)	Seminal severity (%)	Radicle Clade B (copies/ITS)	Seminal Clade B (copies/ITS)	Radicle Clade F (copies/ITS)[y]	Seminal Clade F (copies/ITS)
2019	Broadcast	23.1	3.0	10.2	0.8	400.2	228.0	5.8	187.5
	Drilled	16.4	1.4	5.3	0.3	62.2	35.9	7.2	143.2
	P-value	0.0796	0.0288	0.0326	0.0146	0.0039	0.0202	0.7673	0.8235
2020	Broadcast	73.6	18.0	50.2	5.7	1003.4	2147.9	NQ	NQ
	Drilled	41.7	5.6	10.4	0.8	610.0	3888.7	NQ	NQ
	P-value	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.3918	0.6228	-	-
2019	High	24.7	3.1	8.7	0.7	294.2	159.0	14.6 AZ	233.4
	Medium	18.7	1.9	9.0	0.6	221.5	177.8	1.0 B	26.1
	Low	16.0	1.5	5.6	0.2	177.9	59.0	3.9 AB	236.5
	P-value	0.1661	0.1816	0.3776	0.1353	0.6960	0.4356	0.0409	0.6109
2020	High	61.8	14.3	34.4	4.0	694.6	1133.3	NQ	NQ
	Medium	55.2	9.6	28.5	2.8	403.0	2597.5	NQ	NQ
	Low	55.9	11.5	28.1	3.1	1322.5	5324.2	NQ	NQ
	P-value	0.3606	0.0952	0.4529	0.5056	0.2534	0.6166	-	-
2019	14 DBP	19.0	2.5	9.5	0.6	252.8	190.8	1.6	191.75
	3 DBP	20.6	1.9	6.0	0.4	209.6	73.1	11.4	138.89
	P-value	0.668	0.3958	0.1231	0.1958	0.7022	0.1484	0.0345	0.7900
2020	14 DBP	50.9	10.0	27.1	2.9	646.2	3811.3	NQ	NQ
	3 DBP	64.4	13.6	33.6	3.6	967.2	2225.3	NQ	NQ
	P-value	0.0019	0.0445	0.1578	0.4478	0.4841	0.6540	NA	NA
2019	No rye control	4.2	0.3	4.2	0.2	19.6	9.2	9.2	0.5
2020	No rye control	34.7	2.8	15.3	0.9	0.0	0.0	NA	NA
	P-value	0.0003	0.0299	0.0253	0.0811	0.4890	0.4377	-	-

[w]Root rot incidence was calculated as the number of seedlings with lesions on the radicle and seminal root tissue.
[x]Root rot severity was calculated as the percentage of roots covered with lesions on the radicle and seminal root tissue.
[y]Clade F Pythium species was quantified from 2019 samples only. Abbreviation: NQ= not quantified; NA= not available
[z]Values followed by the same letter within a column are not significantly different at P value 0.05.