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Field Crops Research

Fungicide and Plant Growth Regulator Effect on Cereal Rye Production

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Funding By:
This project is supported in part by
Walton Family Foundation

In a Nutshell

- Fungal diseases and lodging can present challenges to raising small grain crops, like cereal rye, in Iowa.
- Farmer-cooperators investigated the use of fungicides and plant growth regulators on cereal rye seed crops to determine effects on yield and germination rate.

Key Findings

- Across four fields at three farms, in only one instance, when a fungicide was paired with a growth regulator, were cereal rye seed yields and financial returns improved.
- Germination percentage of harvested seed was generally greater than 90% regardless of treatment.

Project Timeline
2016

Tim Sieren harvesting cereal rye seed on July 15, 2016.

Background

Crop rotations that include small grains along with corn and soybeans have been shown to improve productivity, profitability and environmental quality (Davis et al., 2012; Cambardella et al., 2015). In recent years, a growing number of farmers have become interested in raising their own cereal rye seed to use as cover crop seed. Growing a high-yielding cereal rye seed crop that also has a high germination rate has proven to be a challenge. Warm and humid conditions during heading and grain fill periods are conducive to fungal pathogens of cereal rye; fungal infections can both reduce yields and germination rates of the resulting seed. Lodging of tall plants due to excessive stem growth makes harvesting difficult and can also reduce yield. To overcome these challenges in Iowa, careful variety selection, fungicides and plant growth regulators (PGR) are recommended to farmers (Hansen, 1994).

The objective of these trials was to determine the agronomic and economic effect of fungicides and PGR on seed yield and germination rate of cereal rye seed crops. "I've been committed to growing cereal rye for seed for several years and I want to try maximizing yield and seed quality through increased management practices," says Tim Sieren. "I hope to show that cereal rye seed production can be a viable alternative crop to include in a corn-soybean crop rotation." Jack Boyer sees lodging as a concern and is primarily interested in the effectiveness of plant growth regulators. Dick Sloan adds, "I will learn to do a lot more field scouting of winter small grains [when using a fungicide]."

Methods

Trials were conducted by Tim Sieren near Keota in Washington County in SE Iowa; Jack Boyer near Reinbeck in Tama County in east-central Iowa; and Dick Sloan near Rowley in Buchanan County in NE Iowa.

Sieren conducted two separate paired strip trials in two separate fields of cereal

rye: 1) fungicide vs. no-fungicide and 2) fungicide+PGR vs. no fungicide+PGR. Boyer conducted a single paired strip trial comparing PGR vs. no-PGR on cereal rye. Sloan left a single check strip that did not receive a fungicide in a field of cereal rye. Strips ran the length of the field at each location. Trial design details for each location are provided in **Table 1**.

Sieren and Boyer harvested cereal rye seed separately from each strip in each of their fields (Boyer harvested from the middle 15 ft of each strip). They also both had the resulting seed tested for germination percentage. Boyer additionally collected samples of aboveground plant biomass at seed harvest. Sloan harvested cereal rye separately from the treated area and a single check strip in the field.

Cereal rye yields are corrected for 14 % moisture reported on a 56 lb/bu basis.

Data from Sieren's and Boyer's were analyzed using JMP Pro 12 statistical software (SAS Institute Inc., Cary, NC). Statistical analysis could not be conducted at Sloan's due to lack of replication. Means separations between treatment and control at Sieren's and Boyer's are reported using the least significant difference (LSD) generated from a t-test. Statistical significance is reported at the $P \leq 0.05$ level with tendencies noted at the $0.05 < P \leq 0.10$ level.

Jack Boyer harvesting cereal rye seed on July 14, 2016.

Table 1

Trial designs for each field for each cooperator in 2016. Treatments in each field were paired with a control that did not receive the fungicide and/or PGR.

Cooperator	Sieren		Boyer	Sloan
Field	*1*	*2*	*1*	*1*
Previous crop	Corn	Soybeans	Soybeans	Soybeans
Cereal rye variety	VNS	VNS	Elbon	Spooner
Cereal rye seeding date	Oct. 27, 2015	Oct. 15, 2015	Oct. 3, 2015	Oct. 2, 2015
Cereal rye seeding rate	150 lb/ac	150 lb/ac	50 lb/ac	110 lb/ac
N fertilizer	34 lb N/ac on Apr. 14, 2016	34 lb N/ac on Apr. 14, 2016	30 lb N/ac on Apr. 23, 2016	45 lb N/ac on Mar. 10, 2016
Treatment	Fungicide	Fungicide+PGR	PGR	Fungicide
Product	SharShield PPZ	SharShield PPZ+Ethephon	Palaside EC	Caramba
Application rate(s)	2.6 oz/ac	2.6 oz + 1.8 pt/ac	14.4 oz/ac	15.3 oz/ac
Application date(s)	May 18, 2016	PGR: May 7 Fungicide: May 18, 2016	Apr. 23, 2016	May 23, 2016
Product + application cost	$6.59/ac	$19.95/ac	$22.00/ac	$26.93/ac
No. replications	4	4	5	No replication; 1 check strip
Strip width	27 ft	27 ft	30 ft	60 ft
Harvest date	July 15, 2016	July 15, 2016	July 14, 2016	July 26, 2016

Table 2

Mean monthly temperature and total monthly rainfall at each farm for the period October 2015–July 2016 and the long-term averages.

Month	Tim Sieren				Jack Boyer				Dick Sloan			
	Temperature (˚F)		*Rainfall (in.)*		*Temperature (˚F)*		*Rainfall (in.)*		*Temperature (˚F)*		*Rainfall (in.)*	
	2015-16	Avg.	2015-16	Avg.	2015-16	Avg.	*2015-16*	*Avg.*	*2015-16*	*Avg.*	*2015-16*	*Avg.*
Oct. '15	54	54	1.70	2.55	52	50	1.84	2.41	50	50	2.19	2.38
Nov. '15	43	40	4.57	2.00	41	35	2.85	1.78	40	35	3.73	2.02
Dec. '15	38	27	4.10	1.56	33	22	5.86	1.21	35	22	4.37	1.25
Jan. '16	23	22	0.46	1.30	18	16	1.41	0.82	18	16	0.68	0.89
Feb. '16	31	26	0.96	1.30	26	21	1.37	1.03	26	22	0.92	0.99
Mar. '16	43	38	2.57	2.35	40	33	2.95	2.10	40	34	2.45	1.93
Apr. '16	51	51	1.84	3.32	50	47	1.73	3.53	48	48	2.51	3.41
May '16	61	62	3.78	4.04	59	59	2.67	4.41	59	59	3.15	4.16
Jun. '16	74	71	2.04	4.50	72	69	9.30	5.06	72	69	6.76	5.12
Jul. '16	74	76	5.32	3.94	73	72	3.96	4.43	72	72	5.66	4.50

[a] Rainfall and temperature data were accessed from the Washington (120 years, approx. 12 mi. from Sieren's), Grundy Center (60 years, approx. 10 mi. from Boyer's), and Independence (60 years, approx. 11 mi. from Sloan's) weather stations (Iowa Environment Mesonet, 2016).

Results and Discussion

Mean monthly temperature and total monthly rainfall for the experimental period near Sieren's, Boyer's and Sloan's farms compared to the long-term averages is presented in **Table 2** (Iowa Environmental Mesonet, 2016). November and December 2015 were particularly warmer and wetter than average at each farm. These made for very favorable conditions for winter small grain establishment and winter survival.

Sieren Farm

Cereal rye seed yields from all reps in both fields at the Sieren farm are shown in **Figures 1** and **2**. In Field 1, Sieren applied a fungicide; in Field 2, the treatment applied was a fungicide+PGR. In Field 1, the fungicide by itself did not provide any significant yield benefit compared to the control that did not receive the fungicide (**Figure 1**, average yield of 41 bu/ac between treatments). However, in Field 2 where the fungicide+PGR was applied, mean seed yield was improved by 10 bu/ac compared to the control (**Figure 2**).

Sieren says that the fungicide treatment in Field 1 had no effect on seed yield because 2016 was a low disease pressure year for small grains: "Field 1 had corn last year, so I thought there might be disease pressure [due to a grass following a grass]. The warm, dry weather in late May and June, though, was not conducive to disease development (**Table 2**)."

In Field 2, the fungicide was paired with a PGR. "I think the PGR [in Field 2] made for bigger, better stem quality, therefore the standability was better," Sieren recalls when considering the improved yields compared to the control (**Figure 2**). "Since rye gets most of its photosynthesis from the stem; that would transfer into higher yield. And because of the low disease pressure this year that would contribute to better stem quality through less stem disease such as rust, smut, and other stem diseases."

Figure 1

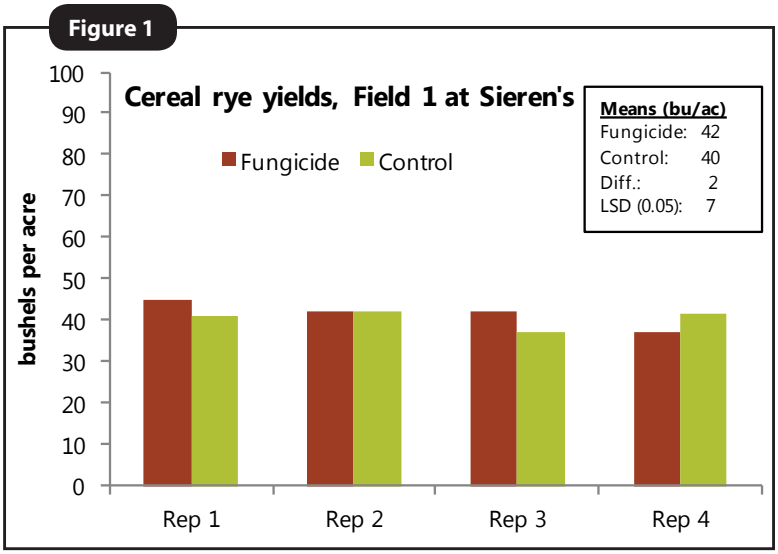

Figure 1. Cereal rye seed yields from each Rep in Field 1 at Tim Sieren's farm near Keota in Washington County in 2016. Field 1 assessed the effect of a fungicide (control received no fungicide). Mean yields and the least significant difference (LSD) at the $P \leq 0.05$ level are indicated in the inset table. If the difference between the two treatment means is greater than the LSD, the treatments are considered significantly different.

Neither the fungicide nor the fungicide+PGR had any effect on test weight or germination rate of the harvested seed at Sieren's (**Table 3**). The average germination percentage for cereal rye seed harvested was

Figure 2

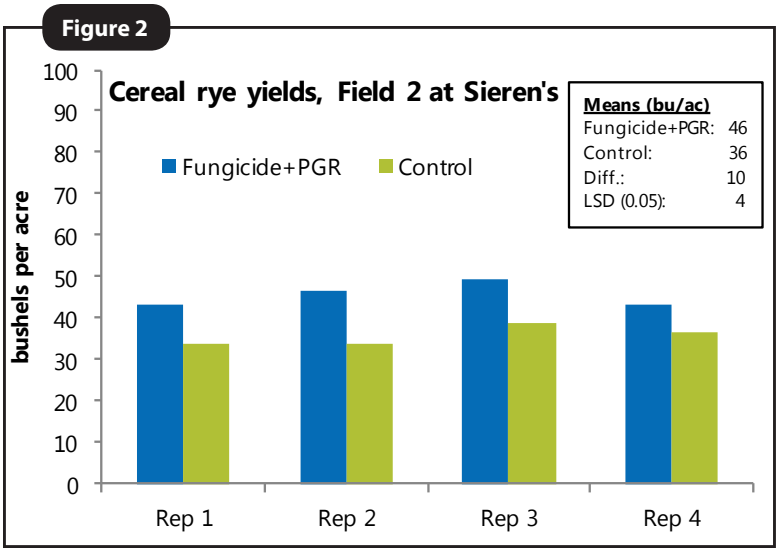

Figure 2. Cereal rye seed yields from each Rep in Field 2 at Tim Sieren's farm near Keota in Washington County in 2016. Field 2 assessed the effect of a fungicide and a plant growth regulator (PGR) (control received neither the fungicide nor the PGR). Mean yields and the least significant difference (LSD) at the $P \leq 0.05$ level are indicated in the inset table. If the difference between the two treatment means is greater than the LSD, the treatments are considered significantly different.

91.6% across the fields and treatments. The fungicide treatment did appear to result in slightly more moist seed at harvest in Field 1.

Because of the significant difference in mean seed yield observed in Field 2 (**Figure 2**), a partial budget was constructed to compare the costs and returns of the two treatments Sieren investigated in Field 2 (**Table 4**). No budget was calculated for the trial in Field 1 as no difference in seed yield was detected (**Figure 1**). In the case of Field 1, the cost of the fungicide ($6.59/ac, **Table 1**) was not warranted. Sieren says, "This year the weather conditions weren't favorable for disease development, so the fungicide could've been skipped, but it's gotten so inexpensive, if Fusarium head blight would've showed up in mid-June, with increased moisture and cooler weather, like we normally get, it would've paid in better grain quality, test weight, and yield."

Table 3

Effect of fungicide and plant growth regulator (PGR) on test weight and seed germination rate for the cereal rye seed harvested from both trials at Tim Sieren's farm in 2016.

Field 1[a]	Fungicide	Control	Diff.	LSD[c] (0.05)
Test weight (lb/bu)	55.0	55.1	0.1	0.3
Harvest moisture (%)	14.9	14.6	0.3[d]	0.1
Seed germ. (%)	91.0	88.5	2.5	6.2
Field 2[b]	**Fungicide + PGR**	**Control**	**Diff.**	**LSD (0.05)**
Test weight (lb/bu)	54.6	54.6	0.0	0.2
Harvest moisture (%)	15.6	15.8	0.2	0.4
Seed germ. (%)	93.5	93.3	0.2	3.0

[a] Field 1 assessed the effect of a fungicide (control received no fungicide).

[b] Field 2 assessed the effect of a fungicide and a plant growth regulator (PGR) (control received neither the fungicide nor the PGR).

[c] The least significant difference (LSD) is provided for both variables for both fields at the $P \leq 0.05$ level.

[d] If the difference between the two treatments is greater than the LSD, the treatments are considered significantly different.

Table 4

Partial budget comparing costs and returns between the two treatments in Field 2 at Tim Sieren's in 2016[a].

Fungicide + PGR		**Control**	
Costs	*$/ac*	*Costs*	*$/ac*
SharShield PPZ fungicide (2.55 oz/ac @ $0.47/oz)	$1.20	No fungicide or PGR applied	
Crop oil (5.1 oz/ac @ $0.08/oz)	$0.39		
Apply fungicide and crop oil	$5.00		
Ethephon PGR (1.76 pt/ac @ $4.75/pt)	$8.36		
Apply PGR	$5.00		
TOTAL COSTS	$19.95	TOTAL COSTS	$0.00
Returns	*$/ac*	*Returns*	*$/ac*
Cereal rye seed (46 bu/ac @ $11.00/bu)	$506.00	Cereal rye seed (36 bu/ac @ $11.00/bu)	$396.00
RETURNS - COSTS	$506.00 - $19.95 = **$486.05**	RETURNS – COSTS	$396.00 - $0.00 = **$396.00**

[a] Product and application costs as well as cereal rye seed value were provided by Sieren.

The partial budget in **Table 4** only considers the differences between the two treatments in Field 2: cost of fungicide, cost of PGR, cost of applying the fungicide and PGR (separate passes) and resulting cereal rye yields. The costs of planting, fertilizing and harvesting the cereal rye are equivalent between the two scenarios and are thus not considered in the partial budget.

Applying the fungicide+PGR cost Sieren $19.95/ac. The resulting cereal rye seed yield grossed $110 more per acre than the cereal rye that was not treated (control). Net returns were thus $90.05 greater per acre for the cereal rye treated with fungicide+PGR. Put another way, the increase in seed yield more than paid for the cost of applying the fungicide+PGR.

Boyer Farm

Cereal rye seed yield from all reps at the Boyer farm are shown in **Figure 3**. Both the PGR and control treatments averaged 57 bu/ac. The harvested seed, to be used as cover crop seed, had a germination percentage of 92%.

Cereal rye plant height at heading and biomass at harvest at the Boyer farm are shown in **Table 5**. The PGR had no effect on plant height at heading in mid-May. The PGR did, however, reduce the amount of plant biomass measured by over 1,500 lb/ac at the time of seed harvest. Often, too much growth and biomass production by cereal rye can result in plant lodging and yield loss. "There was no difference in standability [between the two treatments] at harvest," Boyer reports, despite the differences in plant biomass between the treatments. "I would not expect any difference in seed yield unless the control that did not receive the PGR would have lodged and gone down [due to the extra growth]. It did not lodge, so there was no yield difference."

When considering no difference in seed yield (**Figure 3**), the cost of applying the PGR ($22/ac, **Table 1**) can be deemed extraneous.

Sloan Farm

Cereal rye seed yields from the Sloan farm are shown in Figure 4. Sloan treated an entire field of cereal rye with a fungicide save for a single, 60-ft-wide check strip. Seed yields from the check strip and the rest of the field were very similar averaging 58 bu/ac. The germination percentage of harvested seed from the check strip was 94% and from the rest of the field where fungicide was applied was 92%.

Though no statistical analysis could be performed (due to lack of replication), it appears that the cost of applying fungicide ($26.93/ac) was not justified at Sloan's.

Figure 3

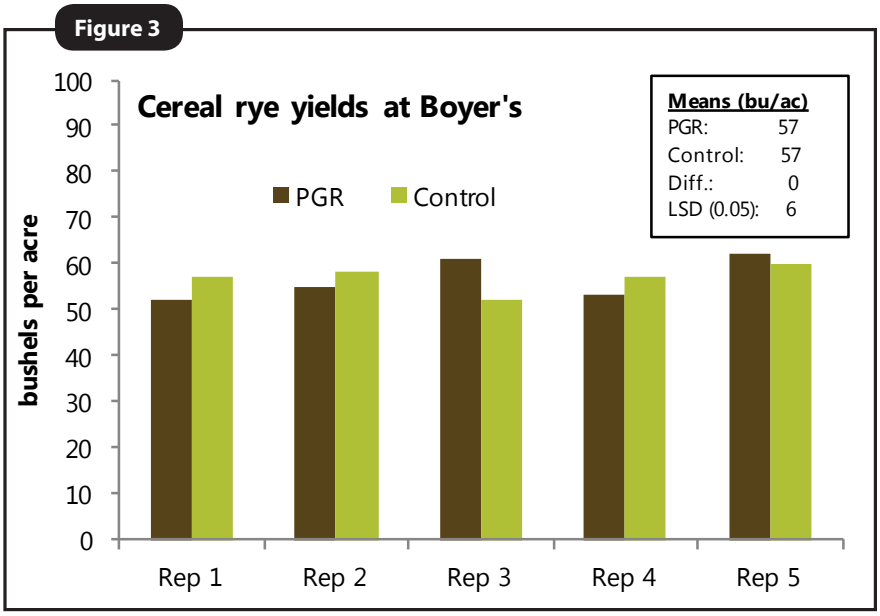

Figure 4. Cereal rye yields from each Rep at Jack Boyer's farm near Reinbeck in Tama County in 2016. Boyer assessed the effect of a plant growth regulator (PGR) on cereal rye (control received no PGR). Mean yields and the least significant difference (LSD) at the *P* ≤ 0.05 level are indicated in the inset table. If the difference between the two treatment means is greater than the LSD, the treatments are considered significantly different.

Table 5

Cereal rye plant height at heading (May 16) and plant biomass at seed harvest (July 16) as affected by the plant growth regulator (PGR) at Jack Boyer's farm in 2016.

	PGR	Control	Diff.	LSD[a] (0.05)
Plant height at heading (in.)	63.4	64.8	1.0	3.5
Plant biomass at harvest (lb/ac)	13,529	15,109	1,580[b]	1,382

[a] The least significant difference (LSD) is provided for both variables at the P ≤ 0.05 level.

[b] If the difference between the two treatments is greater than the LSD, the treatments are considered significantly different.

Figure 4

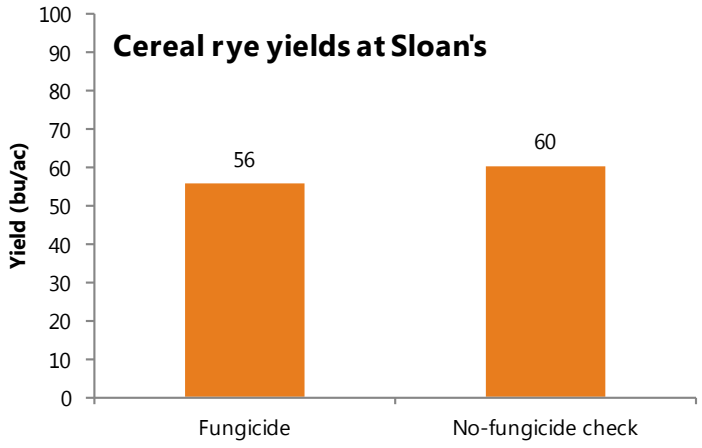

Figure 4. Figure 4. Cereal rye yields at Dick Sloan's farm near Rowley in Buchanan County in 2016. The entire field received a fungicide except for the check strip that received no fungicide. No statistical analysis could be performed due to lack of replication.

Conclusions and Next Steps

These on-farm research and demonstration trials sought to assess the effects of fungicides and PGRs on cereal rye seed production. Each of the three farmer-cooperators involved grows cereal rye for the purposes of cover crop seed production.

Dick Sloan left a check strip in one field where he applied a fungicide to a cereal rye crop. The check strip and field average were within 4 bu/ac of each other.

Tim Sieren found in one field trial that a fungicide by itself to have no effect on cereal rye seed production. When he paired the fungicide with a PGR in separate field trial, this resulted in increased yield (10 bu/ac) and returns ($90.05/ac) compared to where he did not apply the fungicide+PGR. Sieren says, "I think the synergy between the fertilizer, PGR, and fungicide is what made the plant respond with better growth, health and yield."

Jack Boyer found no effect of the PGR he applied to his cereal rye seed crop. His primary concern was standability and lodging of the cereal rye crop. Because none of his "non-treated" cereal rye lodged, yields between the two treatments were equivalent, making the PGR an added expense.

Sieren, Boyer and Sloan found the germination percentage of the harvested cereal rye seed to be greater than 90%. This was an important finding as locally-raised cereal rye cover crop seed has a reputation for poor germination.

Boyer says: "This is my first year growing rye for seed so I didn't really know what to expect, but I'm satisfied with the results. The PGR is quite expensive with no positive effect on seed yield. So I do not plan on using a PGR again until I have more experience growing cereal rye and see whether lodging is a significant problem."

Cereal rye in soybean stubble at Tim Sieren's farm near Keota. Rye was drilled on Oct. 15, 2015; photo taken on Nov. 15.

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