PRACTICAL farmers of Iowa
working together, always learning

Field Crops Research

Oat Variety and Fungicide Trials

Staff Contact:
Stefan Gailans – (515) 232-5661
stefan@practicalfarmers.org
Sarah Carlson - (515) 232-5661
sarah@practicalfarmers.org

Web Link:
http://bit.ly/pfi_fieldcrops

Cooperators:
- **Ken Pecinovsky – Kanawha, Nashua**
- **Brian Lang – Kanawha, Nashua**

Funding by:
This project is supported in part by
Walton Family Foundation
General Mills
Grain Millers, Inc.
Albert Lea Seed House
Sustainable Food Lab

In a Nutshell

- Small grain crops, like oats, are seeing renewed interest by farmers in Iowa. Iowa was once a nationwide leader in oats production, but many farm families have not grown them for a generation or two.
- 16 oat varieties were screened at two Iowa State University research farms. Additionally four varieties were included in a separate fungicide trial at one of the research farms.

Key findings

- Betagene, Deon, Badger and Natty varieties were among the top performers in terms of yield at both locations. These entries also scored low for incidence of crown rust.
- Badger, Betagene, GM423, Goliath and Natty varieties met all of the quality specifications (except test weight) identified by food processors.
- Fungicide improved test weight for two varieties (Badger and Rockford) while Beta glucan concentration and fat concentration were not affected.

Project Timline:
2015

Sarah Carlson and Ken Pecinovsky stand in front of the oats variety plots at Nashua. Photo courtesy of Albert Lea Seedhouse.

Background

Oats are a major spring-sown, small grain crop in Iowa. They can be used for grain and straw production, as a companion crop to establish hay and pastures, or for early-season forage as hay or haylage. Because oats mature in late July to early August, more crop management options are available for the remainder of the season. These include establishment of a perennial forage or cover crop and a timely window for a mid-season animal manure application.

Careful management and proper choice of variety can make oats a profitable crop due to their low input requirements and favorable effects on succeeding crops in a rotation. Planting oats before April 15 is recommended for optimal yields in Iowa. This helps avoid exposure to warmer weather during grain fill.

Test weight is the most commonly used indicator of grain quality. High test-weight varieties should be chosen by growers who intend to market oat grain. Additionally, the concentration of Beta glucans in the grain, noteworthy for its positive effects on health, is considered by food processors. Fat concentration is also considered for storage purposes with low concentrations reducing the potential for grain rancidity and increasing shelf life.

Oat growth is regularly affected by rust and barley yellow dwarf virus. Variety resistance to these diseases should be considered. Another option is the use of a foliar fungicide applied at Feekes 9 growth stage, defined as flag leaf emerged with ligule visible. Two separate experiments were carried out in 2015 to assess oat variety performance and the effect of a foliar fungicide.

Methods

Two separate experiments were conducted in 2015. In Experiment 1, 16 oat varieties were tested at both the ISU Northern and Northeast Research Farms in Kanawha and Nashua, respectively. In Experiment 2, four of the 16 varieties of oats were entered into a fungicide vs. no-fungicide trial at ISU Northeast Research Farm in Nashua. Both locations were in soybeans the previous year, and both locations have been in a corn-soybean rotation for the past 20 years. Information about each of the varieties included in both experiments can be found in **Table 1**.

Table 1

State of origin, PVP[a] and disease ratings[b] for oat varieties included in both experiments at ISU Northern and Northeastern Research and Demonstration Farms in Kanawha and Nashua, respectively, in 2015.

Variety	State of origin[a]	PVPb	Maturity	---Disease name and disease ratings[c] by variety---			
				Crown rust	Stem rust	BYDV[d]	Smut
Badger	WI	PVP	Early	MR	MS	MR	R
BetaGene	WI	PVP	Mid-Late	MR	MR	R	R
Deon	MN	PVP	Late	MR	MS	MR	R
Excel	IN	PVP	Early	MS	S	R	MR
GM423	GM	PVP	Late	MS	MS	MR	- -
Goliath	SD	PVP	Late	MS	R	MR	MR
Hayden	SD	PVP	Mid-Late	MS	MS	MR	R
Horsepower	SD	PVP	Medium	MS	MS	MS	MR
Jerry	ND	PVP	Medium	MS	MS	MS	MS
Leggett	AAFC	PVP	Early	MR	MR	S	R
Natty	SD	PVP	Medium	MR	MS	MR	R
Rockford	ND	PVP	Late	MS	MS	MR	MR
Saber	IL	PVP	Early	MS	S	R	MS
Shelby 427	SD	PVP	Medium	MS	MS	MR	MR
Souris	ND	PVP	Medium	S	MS	MS	MR
Tack	IL	PVP	Early	R	S	R	S

[a] Origin: AAFC-Agriculture and Agri-Food Canada; GM-General Mills; IL-University of Illinois, IN-Purdue University; MN-University of Minnesota; ND-North Dakota State University; SD-South Dakota State University; WI-University of Wisconsin.
[b] PVP = Plant Variety Protection. The PVP Act provides a certificate to the developer of a variety granting exclusive rights for reproducing and marketing the seed.
[c] Disease Ratings: S = susceptible; MS = moderately susceptible; MR = moderately resistant; R = resistant.
[d] Disease: BYDV = Barley Yellow Dwarf Virus.

For both experiments, oat varieties were seeded in small research plots (552.5 ft^2) and replicated three times. A seeding rate of 128 lb/ac and row spacing of 7.5 inches, followed by cultipacking, was used at both locations. Seeding depth was 1 inch. Dates of field operations for both experiments are listed in **Table 2**. In Experiment 1, no herbicides, fungicides or insecticides were applied at either location. In Experiment 2, a fungicide (Priaxor) was applied to subplots at a rate of 4 oz./ac on June 5. In both experiments, entries were screened for crown rust incidence at both locations using a numeric scale (1=low, 9=high) in late June. Plots were harvested at Kanawha with a Wintersteiger plot combine, cylinder speed at 1,450 RPM, concave set to 900 rpm and move sieves to high position; and at Nashua with a JD4420 combine with Weigh-Tronix load cells on weigh bin, cylinder speed at 1,000 RPM, slow down fan and concave set on 1.5. Upon harvest, samples of grain from each plot were sent to General Mills to be analyzed for groats, thins, beta glucan concentration and fat concentration.

Table 2

Field operations for Experiment 1 (oat variety trial) at Kanawha and Nashua and Experiment 2 (fungicide trial) at Nashua in 2015.

Location	Experiment	Fertilizer	Tillage	Oat planting date	Fungicide applied to subplots	Crown rust assessed	Grain harvest date	Straw harvest date
Kanawha	1	None	Field cultivate 2x on Apr. 3	Apr. 4	--	June 25	July 30	--
Nashua	1	18-0-35 lb N-P-K/ac on Mar. 22	Field cultivate on Mar. 22 & 31	Apr. 1	--	June 25	July 23	July 25
Nashua	2	None	Field cultivate 2x on Apr. 3	Apr. 4	4 oz./ ac Priaxor on June 5	June 25	July 23	--

Quality specifications identified by oat millers

We surveyed oat millers to provide specifications for oat quality they use when sourcing oats for rolled oats and oat flour. These specifications are presented in **Table 3**. Groats are dehulled oats following aspiration remaining after shaken over a 5/64-in. slotted screen. Thin oats are those that fall through a 5/64-in. slotted screen. Beta glucan concentration in the grain drives the "heart healthy" claim for oats (the higher, the better). Fat concentration affects shelf life and rancidity in flour and rolled oats (a high fat concentration causes rancidity and reduces shelf life).

Data were analyzed using JMP Pro 10 (SAS Institute Inc., Cary, NC). Statistical significance is determined at $P \leq 0.05$ level and means separations are reported using Tukey's least significant difference (LSD).

Table 3

Oat quality specifications identified by oat millers.

Constituent	Limit
Test weight (lb/bu)	≥38
% Groats	≥65
% Thins	≤12
Beta glucan conc. (%)	≥4.8
Fat conc. (%)	≤8.0

Results and Discussion

2015 Growing Conditions

Near-normal rainfall and growing degree days were observed at both locations in 2015 (**Table 4**).

Table 4

Rainfall and oat growing degree days (GDD, base 32˚F) for 2015 and the long-term normal at Kanawha and Nashua.

	Kanawha				Nashua			
	Rainfall (in.)		GDD		Rainfall (in.)		GDD	
Month	*2015*	*Normal*	*2015*	*Normal*	*2015*	*Normal*	*2015*	*Normal*
April	4.3	3.2	497	498	4.3	3.7	519	498
May	3.5	3.8	833	823	3.5	4.4	867	823
June	5.8	4.8	1,103	1,098	5.8	5.1	1,099	1,098
July	4.0	4.0	1,192	1,250	4.0	4.7	1,185	1,250
Total	17.6	15.8	3,670	3,669	17.6	17.9	3,670	3,669

Experiment 1: Oat variety trial

Entries were analyzed by location and listed in alphabetical order (**Tables 5** and **6**). Reported yields are corrected for 13% moisture. A "percentage of test average" calculation is included to allow for comparison among entries at each location. Yields and test weights were slightly greater and plants were generally shorter at the Nashua site. Perhaps not surprisingly, lodging was also much less of a problem at the Nahsua site. Betagene, Deon, Badger and Natty were among the top performers in terms of yield at both locations. These entries also scored low for incidence of crown rust. Hayden and Tack had the greatest test weight at both locations. Straw yields were only collected at Nashua with Goliath and Deon the top performers in that respect. Goliath plants were by far the tallest at Nashua.

GM423 had the greatest concentration of Beta glucan at both locations with the rest of the varieties generally being equivalent. Rockford, Tack, Hayden and Deon had the greatest concentration of fat while Natty had the least fat at both locations.

None of the oat varieties met the specification for test weight identified by the oat millers (38 lb/bu; **Table 3**) at either location. However, across the two locations, Badger, Betagene, GM423, Goliath and Natty met all of the other specifications identified (≥65% groats, ≤12% thins, ≥4.8% beta glucan conc. and ≤8.0% fat conc.; **Table 3**). Of these varieties, Natty had the highest test weight and achieved 37 lb/bu at Nashua (**Table 6**).

Table 5

Results for Experiment 1 (oat variety trial) at Kanawha.

Variety	Yield (bu/ac)	Yield (% of test avg.)	% Lodging	Test weight (lb/bu)	Plant height at harvest (in.)	Crown rust (1-9)*	% Groats	% Thins	Beta glucan conc. (%)	Fat conc. (%)
Badger	141	115	80	33	41	1	**69**	**5.2**	**5.0**	**7.2**
Betagene	170	138	41	33	43	1	**71**	**5.7**	**5.0**	**6.8**
Deon	148	121	28	33	49	1	**68**	**9.6**	4.6	8.2
Excel	131	107	67	32	44	4	**66**	**9.4**	**4.9**	**7.2**
GM423	105	86	75	27	48	2	**69**	**9.8**	**6.2**	**7.9**
Goliath	107	87	70	32	49	1	**70**	**11.9**	**4.9**	**7.2**
Hayden	131	107	80	35	46	2	**70**	**9.6**	**5.0**	8.3
Horsepower	113	92	80	29	44	5	**66**	13.6	**5.3**	**7.5**
Jerry	105	86	87	29	49	7	**67**	15.7	**5.0**	**7.1**
Leggett	97	79	78	29	47	4	**66**	19.1	**5.0**	**7.6**
Natty	141	115	62	34	48	2	**65**	**9.9**	**4.8**	**6.4**
Rockford	89	73	62	32	48	5	**67**	19.6	**5.0**	9.5
Saber	133	109	43	34	43	2	**74**	**11.9**	4.6	**6.7**
Shelby 427	123	100	82	34	44	2	**71**	15.1	**5.0**	**7.7**
Souris	103	84	60	30	44	6	**68**	25.2	**5.1**	**7.4**
Tack	125	102	92	35	41	5	**72**	16.7	**4.8**	8.7
LSD (0.05)**	36		46	2	9	3	5	5.7	0.8	0.6

*Incidence of crown rust was assessed on a scale from 1 (low) to 9 (high) on June 25.

**The least significant difference (LSD) was calculated at the $P \leq 0.05$ level for each variable.

Values in **bold font** are those meeting specifications identified by oat millers (**Table 3**).

Table 6

Results for Experiment 1 (oat variety trial) at Nashua.

Variety	Yield (bu/ac)	Yield (% of test avg.)	% Lodging	Test weight (lb/bu)	Plant height at harvest (in.)	Straw (tons/ac)	Crown rust (1-9)*	% Groats	% Thins	Beta glu-can conc. (%)	Fat conc. (%)
Badger	137	99	32	32	31	1.1	1	**68**	**2.8**	**5.3**	**7.0**
Betagene	145	106	3	33	36	1.7	1	**67**	**3.9**	**5.9**	**6.8**
Deon	140	102	0	35	37	2.5	1	**70**	**4.7**	4.6	8.2
Excel	146	106	2	33	36	1.6	3	**66**	**3.5**	4.6	**7.0**
GM423	136	99	2	32	40	2.1	1	**69**	**4.5**	**6.2**	**7.7**
Goliath	137	100	3	36	47	2.6	1	**70**	**4.8**	**5.0**	**7.3**
Hayden	152	110	1	36	39	2.0	1	**71**	**3.0**	**4.9**	8.3
Horsepower	132	96	17	35	36	1.3	3	**68**	**4.0**	**5.0**	**7.6**
Jerry	129	94	53	36	37	1.5	3	**69**	**5.6**	4.6	**7.4**
Leggett	141	103	3	34	36	1.9	2	**68**	**5.5**	**4.8**	**7.5**
Natty	139	101	0	37	40	1.7	2	**69**	**4.8**	**4.8**	**6.3**
Rockford	123	90	1	36	39	2.0	2	**71**	**5.8**	4.7	8.8
Saber	152	110	1	34	34	1.5	1	**72**	**7.7**	**4.8**	**7.0**
Shelby 427	137	100	4	35	39	1.7	1	**70**	**5.6**	**4.9**	**7.7**
Souris	128	93	17	33	36	1.4	5	**69**	**7.7**	**4.8**	**7.3**
Tack	126	91	35	36	33	1.4	2	**72**	**7.1**	4.4	8.6
LSD (0.05)**	21		44	1	4	0.4	2	2	1.8	0.7	0.3

*Incidence of crown rust was assessed on a scale from 1 (low) to 9 (high) on June 25.

**The least significant difference (LSD) was calculated at the $P \leq 0.05$ level for each variable.

Values in **bold font** are those meeting specifications identified by oat millers (**Table 3**).

Experiment 2: Fungicide trial

Entries are listed in alphabetical order (**Table 7**). Reported yields are corrected for 13% moisture. A "percentage of test average" calculation is included to allow for comparison among entries. Oat yields were mostly affected by variety ($P = 0.0041$). GM423, Goliath and Badger tended to outperform Rockford regardless of fungicide application. Application of fungicide improved yield on average by seven bushels per acre but this was only significant at the $P \leq 0.10$ level. Test weight was slightly improved with the fungicide for the Badger and Rockford entries only. Straw yield was affected by variety ($P = 0.0188$) but not by fungicide ($P = 0.1430$).

Beta glucan concentration was affected by variety ($P < 0.0001$) but not fungicide ($P = 0.1325$). GM423 had the greatest concentration of Beta glucan with the rest of the varieties generally being equivalent. Fat concentration was affected by variety ($P < 0.0001$) but not fungicide ($P = 0.3038$). Regardless of fungicide, Goliath had the highest concentration of fat, GM423 was intermediate, and Rockford and Badger had the lowest concentration of fat.

None of the varieties entered into this fungicide trial made the specification for test weight (38 lb/bu; **Table 3**). However, Badger met all of the other specifications identified regardless of the fungicide treatment and Rockford met the other specifications with the fungicide treatment (≥65% groats, ≤12% thins, ≥4.8% beta glucan conc. and ≤8.0% fat conc.; **Table 3**).

Table 7

Results of Experiment 2 (fungicide trial) involving four oat varieties at Nashua.

Variety	Yield (bu/ac)	Yield (% of test avg.)	% Lodging	Test weight (lb/bu)	Plant height at harvest (in.)	Straw (tons/ac)	Crown rust (1-9)*	% Groats	% Thins	Beta glucan conc. (%)	Fat conc. (%)
	Fungicide										
Badger	119	103	30	34	32	0.9	0.9	**69**	**2.3**	**4.9**	**7.2**
GM423	128	111	0	31	34	1.7	1.7	**67**	**3.9**	**6.7**	8.2
Goliath	121	105	2	34	43	1.8	1.8	**70**	**5.1**	4.7	9.3
Rockford	108	93	0	35	36	1.6	1.6	**70**	**3.4**	**4.8**	**7.4**
	No fungicide										
Badger	121	104	33	33	31	0.9	0.9	**68**	**2.9**	**4.9**	**7.2**
GM423	117	101	0	31	38	1.4	1.4	**67**	**4.6**	6.2	8.2
Goliath	111	96	0	34	41	1.4	1.4	**70**	**7.8**	**4.9**	9.4
Rockford	101	87	0	34	34	1.4	1.4	**70**	**4.4**	4.5	**7.5**
LSD (0.05)**	14		6	1	6	0.7	0.7	5	1.6	0.5	0.4
Source of variation	***P-value***										
Variety (V)	0.0041		<0.0001	<0.0001	0.0004	0.0188	0.0188	0.0317	<0.0001	<0.0001	<0.0001
Fungicide (F)	0.0979		0.4226	0.0149	0.5736	0.1430	0.1430	0.7745	0.0028	0.1325	0.3038
V x F	0.1308		0.4547	0.0116	0.1208	0.2067	0.2067	0.9358	0.0804	0.1396	0.7651

*Incidence of crown rust was assessed on a scale from 1 (low) to 9 (high) on June 25.

**The least significant difference (LSD) was calculated at the $P \leq 0.05$ level for each variable.

Values in **bold font** are those meeting specifications identified by oat millers (**Table 3**).

Conclusions and Next Steps

Selling grain into a specialty market (i.e., for human consumption) takes an increased level of management and care for the final product. Farmers interested in selling oats to food grade milling companies in the northern Cornbelt have some oat varieties to chose from which yield well and can reach close to desired milling specifications. Of the varieties screened in these trials, Natty was both high-yielding, had one of the heaviest test weights and met four of five milling specifications (**Tables 5** and **6**). Natty was not part of the fungicide trial but given that two of the four varieties had heavier test weights with the fungicide application it is possible that it could have responded positively. Additionally farmers could use a grain vacuum to further clean oats to increase the test weight of the final product leaving the farm. Grain vacuuming is a common option to further add value to harvested grains behind the farm-gate.

This study will be conducted again in 2016 and will include additional locations. It will be coupled with a "pilot project" seeking to provide 500 acres worth of oats to the food and feed markets in north-central Iowa. The results of the 2016 variety trial and the pilot project will further improve our understanding of the barriers and opportunities row crop farmers face when adding oats to their farm business.

PFI Cooperators' Program

PFI's Cooperators' Program gives farmers practical answers to questions they have about on-farm challenges through research, record-keeping, and demonstration projects. The Cooperators' Program began in 1987 with farmers looking to save money through more judicious use of inputs. If you are interested in conducting an on-farm trial contact Stefan Gailans @ 515-232-5661 or stefan@practicalfarmers.org.