CORN INSECTICIDE SEED TREATMENT AND FOLIAR FUNGICIDE EFFECTS ON CORN RESPONSE TO FERTILIZER NITROGEN

S. A. Ebelhar, C. D. Hart, and C. A. Bradley

S. A. Ebelhar is an agronomist and C. D. Hart is a research specialist, Dept. of Crop Sciences, University of Illinois, Dixon Springs. C. A. Bradley is an assistant professor, Dept. of Crop Sciences, University of Illinois, Urbana.

INTRODUCTION

The current nitrogen use efficiency numbers for corn in Illinois ranges from 0.8 to 1.2 lb N/bu based on yield goal, previous crop, manure credits and other incidentals. Recent studies have enhanced the process of identifying optimum N needs based on N prices and value of corn (Nafziger et al, 2005). As N prices continue to escalate, further fine tuning of the nitrogen rate equation will be needed.

Changes in yield potential associated with technological advances such as insecticide seed treatments (IST) and foliar fungicides should increase the need for additional fertilizer N. However, there are increased efficiencies of N use expected as plant roots are protected from insect damage. Improving photosynthetic capacities may extend and enhance grain filling but would also be effective in prolonging root efficacy to take up soil nutrients, including N.

As N prices continue to climb, reduction in N rates associated with increased N use efficiency becomes more of an economical consideration. These gains in efficiency could be combined with potential increases in yield to more than offset the costs of IST and/or foliar fungicide treatments.

The objectives of this study are to 1) evaluate the effects of corn insecticide seed treatment (IST) on plant stand, yield and fertilizer N response of corn, 2) determine the interactions of foliar fungicide, IST, and N rates on corn health, diseases, and grain yields, and 3) determine the economics of the use of IST and foliar fungicides in corn production in southern IL

MATERIALS AND METHODS

A field study was established at two locations in southern Illinois – the University of Illinois Dixon Springs Ag. Center (DSAC) and the Southern Illinois University Belleville Research Center (BRC). Corn (DeKalb DKC 61-69 hybrid) was treated with either Poncho 250 or 1250 insecticide seed treatment (IST) for comparison and planted at 32,000 seed/acre in conventionally tilled soil. Details of the study are presented in Table 1 below. The study design was a split-split-plot design with foliar fungicide treatment as whole plot, insecticide seed treatment as subplots and N rates as sub-subplots. Fungicide treatments consisted of +/- Headline foliar applied to corn at tasseling (VT). Nitrogen (N) rates were 0, 60, 120, 180 and 240 lb N/acre applied as liquid UAN (32%) applied sidedress injected four to six weeks after planting. There were four replications per location. Leaf disease ratings were taken 3-4 weeks after fungicide applications and again at 6-7 weeks. Stalk quality and disease ratings were taken at physiological maturity.

Table 1. Site information for each location, 2008-2010.

	DSAC	BRC
2008:		
Soil Type	Sharon sil.	Caseyville sil.
Previous crop	Corn	Wheat
Planting date (rate)	May 1 (32,000 plts/acre)	June 12 (32,000)
Fungicide (rate)	Headline (9 oz/acre)	Headline (9 oz/acre)
Fungicide application date	July 17 (VT)	August 11 (VT)
2009:		
Soil Type	Belknap sil.	Pierron sil.
Previous crop	Corn	Soybean
Planting date (rate)	May 22 (32,000 plts/acre)	June 26 (32,000)
Fungicide (rate)	Headline (9 oz/acre)	Headline (9 oz/acre)
Fungicide application date	August 3 (VT)	August 25 (VT)
2010:		
Soil Type	Sharon sil.	Pierron sil.
Previous crop	Corn	Soybean
Planting date (rate)	May 11 (32,000 plts/acre)	April 22 (32,000)
Fungicide (rate)	Headline (9 oz/acre)	Headline (9 oz/acre)
Fungicide application date	July 12 (VT)	July 7 (VT)

RESULTS AND DISCUSSION

Ear-Leaf Diseases. In 2008, primary diseases were gray leaf spot, northern corn leaf blight and common rust at both locations. Common and southern rusts were most prevalent at BRC. There was a significant reduction in leaf diseases at DSAC with the application of fungicide, even though disease levels were low (<12%) (Table 2). At BRC, there was also a significant reduction in leaf diseases with the application of fungicide, but here the diseases exploded with greater than 50% leaf coverage on Sept. 29, primarily common and southern rusts.

In 2009, primary leaf diseases were gray leaf spot and northern corn leaf blight at both locations, but most prevalent at DSAC. The effect of fungicide application was highly significant (Table 2). Leaf disease severity was higher at DSAC in 2009 than 2008, but much lower at BRC in 2009 than in 2008. At DSAC, leaf disease severity without the use of a fungicide increased as N rates increased, similarly to both locations in 2008. At BRC in 2009, this response was not significant, but leaf disease severity was very low (at the time of sampling) even without fungicide application.

In 2010, primary leaf diseases were gray leaf spot and southern corn rust with some northern corn leaf blight at DSAC. Primary leaf diseases at BRC were gray leaf spot with a secondary infection of southern corn rust. At both locations in 2010, there was a significant reduction in diseases with the application of the fungicide and no response to IST.

On average across the six site-years, increasing N rates significantly increased leaf diseases, especially without fungicide application (Figure 1). IST had no effect on leaf diseases and there were few significant interactions between IST and either N rates or fungicides.

Stalk Rot. Stalk rot was evaluated using the UI stalk rot rating system (0-5 scale, with 0 = no damage and 5 equal severe damage with stalks broken). In 2008, Stalk rot was not affected by fungicide treatment at DSAC but was significantly lower at BRC with the application of fungicide (Table 3). Increasing N rates to 120 lb N/acre had the highest stalk rot rating at DSAC, whereas, at BRC the maximum rating occurred at approximately the 60 lb N rate (data shown previously). IST had no effect on stalk rot diseases.

In 2009, stalk rot severity was significantly reduced at both locations with the application of foliar fungicide (Table 3). At DSAC, stalk rot maximized at the 120 lb/acre N rate with fungicide application, similar to 2008 (data shown previously). At BRC, the trend was similar but not statistically significant. IST had no effect on stalk rot, similar to 2008. In 2010, stalk rot was not affected by fungicide or IST application, although there was a significant fungicide x N rate interaction at DSAC.

On average, stalk rot was maximum at the 60-120 lb/acre N rates (Figure 2) and was slightly reduced by fungicide application (significant in 3 of 6 site-years) with a significant interaction between N rates and fungicide in 2 of 6 site-years. IST had no effect, nor was there a significant interaction between N rate and IST.

Corn Stand Densities. Corn stand densities were determined for each site-year except for BRC in 2008 (Table 4). That year we had significant wind damage which caused severe root lodging, which we were able to measure. Fungicide application had no significant effect on stand densities, as expected, but IST did in 3 of 5 site-years. However, this was a mixed bag, with the 1250 rate of IST having higher stands at DSAC in 2008, but lower stands at both locations in 2010. Only in 2010 at BRC was there a slight yield decrease associated with these stand differences (Table 6).

Increasing N rates increased the incidence of root lodging, presumably due to larger ears and a higher center of gravity for these plants. Neither fungicide nor IST significantly affected lodging.

Ear-leaf N Concentrations. Increasing N rates significantly increased ear-leaf N concentrations at both locations (Table 5) all three years. The IST had no effect on ear-leaf N concentration at DSAC, but significantly increased ear-leaf N (by 5%) at BRC in 2008 only. The fungicide treatment had no effect on ear-leaf N concentrations at either location. There were few interactions of significance.

Corn Grain Yields. Increasing N rates significantly increased corn grain yields at both locations (Table 6) for all three years. The IST had no effect on yield at either location or year, except BRC in 2010 where there was a 5 bu/acre yield decrease with the 1250 IST, presumably due to the lower stand density with this treatment. The application of a foliar fungicide significantly increased grain yield in 2 of 6 site-years, although there was trend toward higher yields for every site-year, and on average, there was a 6 bu/acre yield increase associated with

the fungicide application. There was not a significant interaction between N rates and fungicide treatment.

The only IST x N rate interaction occurred at BRC in 2008 (shown in Figure 3). This figure shows a significantly lower economic optimum N rate (EONR) for the 1250 IST compared to the 250 IST, and at similar yield levels. This may have been due to better roots with this treatment providing better N uptake, but with stand density data, one cannot rule out differences in plant stands having differences in N uptake.

There was a significant quadratic response to increasing N rates at both locations all three years which allowed us to calculate the EONR assuming a N price of $0.50 and a corn price of $6.00 (Table 7 and Figure 4). At the EONR, the fungicide treatment increased corn yields by 10 bu/acre compared to the no fungicide treatment, and the 1250 IST decreased yields by 8 bu/acre compared to the 250 IST treatment.

CONCLUSIONS

Increasing N rates tended to increase leaf diseases, but this effect was significantly reduced as were leaf diseases in general with the application of a fungicide at tasseling. When averaged across N rates and IST treatments and across 6 site-years, the fungicide application increased corn yield by 6 bu/acre, but at the EONR this difference was 10 bu/acre. IST had few effects on yields at either location, except the higher IST at BRC significantly reduced the EONR in 2008 and grain yield in 2010. It appears that high demand for N during grain fill tends to rob leaves and stalks of tissue N. This seems to creates conditions of increased stalk rot at lower N rates, especially without the use of fungicides, but increased leaf diseases at higher N rates, again without the use of fungicides.

REFERENCES

Nafziger, E. D., R. G. Hoeft, E. A. Adee, R. E. Dunker, S. A. Ebelhar and L. E. Paul. 2005. Assessing variability in corn response to N rate. In R. G. Hoeft (Ed.) 2005 Proc. IL Fert. Conf.

Table 2. Effects of N rate, IST and foliar fungicide application on corn ear-leaf diseases, 2008-2010.

Variable		DSAC			BRC			
		Ear-leaf 8/29/08	**Ear-leaf 9/11/09**	**Ear-leaf 8/16/10**	**Ear-leaf 9/29/08**	**Ear-leaf 9/15/09**	**Ear-leaf 8/16/10**	**6-yr Ave.**
Fungicide	N Rate	---------- *Disease Severity (%)* ----------						
No	0	5.8	10.8	8.5	42.7	1.9	11.0	14.1
	60	9.8	16.5	10.2	49.0	2.1	8.0	16.0
	120	9.2	14.4	14.4	61.9	1.9	10.4	18.8
	180	10.2	19.2	12.2	62.7	2.3	10.2	19.5
	240	11.3	17.7	13.3	71.7	2.0	10.4	21.2
	Average	9.2 a	15.7 a	11.7 a	57.6 a	2.0 a	10.0 a	17.9
Yes	0	1.5	2.6	1.5	7.5	0.6	9.1	4.1
	60	3.7	3.7	1.6	8.8	1.0	6.2	4.4
	120	3.3	3.8	2.9	6.7	1.0	4.2	4.1
	180	3.8	3.7	4.9	6.7	1.0	4.8	4.4
	240	3.8	4.4	4.3	7.9	0.9	3.7	4.5
	Average	3.2 b	3.6 b	3.0 b	7.5 b	0.9 b	5.6 b	4.3
Insecticide								
250		6.6 a	9.6 a	7.1 a	32.6 a	1.5 a	7.6 a	11.0
1250		5.9 a	9.7 a	7.7 a	32.5 a	1.4 a	8.0 a	11.2
Statistics								
+/- Fungicide (F)		***	***	***	***	***	***	
+/- Insecticide (I)		*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	
N lin (N)		***	***	***	***	*NS*	***	
N quad		*NS*	*NS*	**	*NS*	*NS*	**	
F x I		*	*NS*	*NS*	*NS*	*NS*	*NS*	
F x N		*NS*	***	**	***	*NS*	***	
I x N		*NS*	*NS*	*NS*	*	*NS*	*NS*	
F x I x N		*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	

*, **, and *** refer to significance at the 10%, 5% and 1% levels, respectively.
NS = non-significant. Means within a column followed by the same letter are not significantly different at the 5% level.

Table 3. Effects of N rate, IST and foliar fungicide application on corn stalk rot disease, 2008-2010.

Variable		DSAC			BRC			
		Stalk Rot 9/15/08	**Stalk Rot 10/1/09**	**Stalk Rot 9/3/10**	**Stalk Rot 10/31/08**	**Stalk Rot 11/5/09**	**Stalk Rot 9/3/10**	**6-yr Ave.**
Fungicide	N Rate	---------- *Disease Severity (0-5 scale)* ----------						
No	0	1.7	2.1	0.9	2.8	1.2	1.1	1.6
	60	2.7	2.4	2.0	3.8	1.5	2.2	2.4
	120	3.1	2.2	1.8	3.7	0.8	1.6	2.2
	180	2.5	2.7	1.8	3.5	1.3	1.5	2.2
	240	1.8	2.7	1.4	4.0	1.1	1.5	2.1
	Average	2.4 a	2.4 a	1.6 a	3.6 a	1.2 a	1.6 a	2.1
Yes	0	1.6	2.0	1.5	2.0	0.6	0.8	1.4
	60	2.6	2.3	1.2	2.7	0.9	1.5	1.9
	120	2.6	2.3	1.4	2.8	1.0	1.5	1.9
	180	2.3	2.1	0.7	2.0	1.1	1.3	1.6
	240	1.8	1.0	1.1	2.1	0.7	1.6	1.4
	Average	2.2 a	1.9 b	1.2 a	2.3 b	0.9 b	1.3 a	1.6
Insecticide								
250		2.3 a	2.3 a	1.5 a	3.0 a	1.0 a	1.5 a	1.9
1250		2.3 a	2.1 a	1.3 a	2.8 a	1.0 a	1.4 a	1.8
Statistics								
+/- Fungicide (F)		*NS*	**	*NS*	**	***	*NS*	
+/- Insecticide (I)		*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	
N lin (N)		*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	
N quad		***	***	*NS*	*	*NS*	**	
F x I		*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	
F x N		*NS*	***	**	*NS*	*NS*	*NS*	
I x N		*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	
F x I x N		*NS*	*	*NS*	*NS*	*NS*	*NS*	

*, **, and *** refer to significance at the 10%, 5% and 1% levels, respectively.
NS = non-significant. Means within a column followed by the same letter are not significantly different at the 5% level.

Table 4. Effects of N rate, IST and foliar fungicide application on corn stand densities, 2008-2010.

Variable		DSAC			BRC		5-yr Ave.	BRC
		2008	2009	2010	2009	2010		Lodging 2008
Fungicide	N Rate	---------- *Density (plants/acre)* ----------						
No	0	30,077	27,329	32,774	30,274	30,492	30,189	4.8
	60	30,233	28,418	32,981	29,142	30,544	30,263	4.4
	120	30,751	29,455	32,929	30,013	30,336	30,697	5.5
	180	30,388	28,107	33,085	29,316	29,714	30,122	5.3
	240	29,922	29,610	33,448	30,231	30,129	30,668	6.5
	Average	30,274a	28,584a	33,043	29,795a	30,243a	30,388	5.4 a
Yes	0	29,351	28,677	32,566	29,882	30,285	30,152	4.9
	60	29,818	29,299	32,307	28,575	29,973	29,995	4.6
	120	31,633	29,633	32,981	30,448	30,492	31,033	5.0
	180	30,181	29,196	32,774	29,359	29,299	30,162	5.8
	240	30,285	28,936	33,344	29,534	30,025	30,425	6.4
	Average	30,253a	29,144a	32,794	29,560a	30,015a	30,353	5.3 a
Insecticide								
250		29,642b	28,884a	33,749a	29,995a	30,834a	30,621	5.3 a
1250		30,886a	28,843a	32,089b	29,359a	29,424b	30,120	5.3 a
Statistics								
+/- Fungicide (F)		*NS*	*NS*	*NS*	*NS*	*NS*		*NS*
+/- Insecticide (I)		**	*NS*	***	*NS*	***		*NS*
N lin (N)		*NS*	*NS*	*NS*	*NS*	*NS*		***
N quad		*NS*	*NS*	*NS*	*NS*	*NS*		*NS*
F x I		**	*NS*	*NS*	*NS*	*NS*		*NS*
F x N		*NS*	*NS*	*NS*	*NS*	*NS*		*NS*
I x N		*NS*	*NS*	*NS*	*NS*	*NS*		*NS*
F x I x N		*NS*	*NS*	*NS*	*NS*	*NS*		*NS*

*, **, and *** refer to significance at the 10%, 5% and 1% levels, respectively.
NS = non-significant. Means within a column followed by the same letter are not significantly different at the 5% level.

Table 5. Effects of N rate, IST and foliar fungicide application on corn ear-leaf N composition, 2008-2010.

Variable		DSAC			BRC			6-yr Ave.
		2008	2009	2010	2008	2009	2010	
Fungicide	N Rate	---------- *Ear-leaf N (%)* ----------						
No	0	1.26	1.30	1.70	1.96	1.47	1.68	1.56
	60	1.84	1.86	1.94	2.14	2.59	2.29	2.11
	120	2.25	2.56	2.54	2.57	2.80	2.61	2.56
	180	2.44	2.81	2.80	2.53	3.01	3.05	2.77
	240	2.59	2.98	2.92	2.51	3.17	3.02	2.86
	Average	2.08 a	2.30 a	2.38 a	2.34 a	2.61 a	2.53 a	2.37
Yes	0	1.27	1.22	1.35	1.97	1.47	1.67	1.49
	60	1.92	1.83	2.12	2.28	2.73	2.02	2.15
	120	2.32	2.35	2.58	2.46	2.91	2.76	2.56
	180	2.56	2.74	2.80	2.66	2.98	3.05	2.80
	240	2.52	2.78	2.85	2.73	2.94	3.03	2.81
	Average	2.12 a	2.18 a	2.34 a	2.42 a	2.61 a	2.51 a	2.36
Insecticide								
250		2.13 a	2.22 a	2.32 a	2.32 b	2.59 a	2.50 a	2.35
1250		2.07 a	2.26 a	2.40 a	2.44 a	2.63 a	2.53 a	2.39
Statistics								
+/- Fungicide (F)		*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	
+/- Insecticide (I)		*NS*	*NS*	*NS*	*	*NS*	*NS*	
N lin (N)		***	***	***	***	***	***	
N quad		***	***	***	***	***	***	
F x I		*NS*	**	*NS*	*NS*	*NS*	*	
F x N		*NS*	*NS*	*NS*	*NS*	*	*NS*	
I x N		*	*NS*	*NS*	*NS*	*NS*	*NS*	
F x I x N		*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	

*, **, and *** refer to significance at the 10%, 5% and 1% levels, respectively.
NS = non-significant. Means within a column followed by the same letter are not significantly different at the 5% level.

Table 6. Effects of N rate, IST and foliar fungicide application on corn yields, 2008-2010.

Variable		DSAC			BRC			6-yr Ave.
		2008	2009	2010	2008	2009	2010	
Fungicide	N Rate	---------- *Corn Yield (bu/acre)* ----------						
No	0	72	77	72	162	74	73	88
	60	142	131	132	195	142	142	147
	120	196	178	189	205	167	195	188
	180	228	182	201	213	171	204	200
	240	249	194	216	202	177	213	208
	Average	177 a	152 b	162 a	196 b	146 a	165 a	167
Yes	0	75	77	70	170	79	75	91
	60	141	136	138	209	151	145	153
	120	194	168	185	226	177	196	191
	180	227	199	210	229	186	208	210
	240	256	210	223	221	192	216	220
	Average	179 a	158 a	165 a	211 a	157 a	168 a	173
Insecticide								
250		177 a	156 a	166 a	202 a	156 a	169 a	171
1250		178 a	154 a	161 a	204 a	147 a	164 b	168
Statistics								
+/- Fungicide (F)		*NS*	**	*NS*	**	*NS*	*NS*	
+/- Insecticide (I)		*NS*	*NS*	*NS*	*NS*	*NS*	*	
N lin (N)		***	***	***	***	***	***	
N quad		***	***	***	***	***	***	
F x I		*NS*	*NS*	*NS*	**	*NS*	*NS*	
F x N		*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	
I x N		*NS*	*NS*	*NS*	**	*NS*	*NS*	
F x I x N		*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	

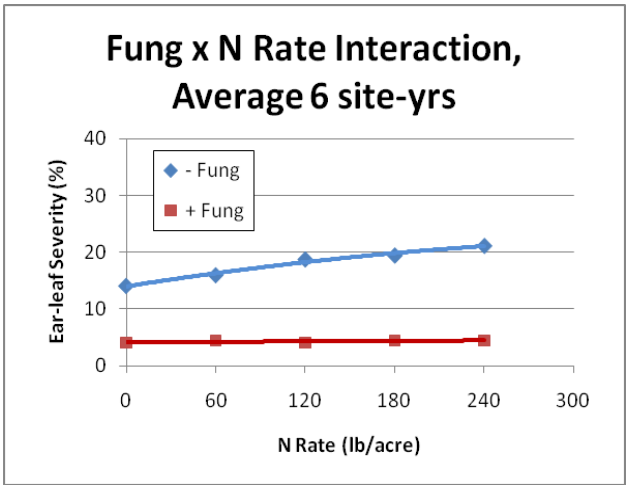
*, **, and *** refer to significance at the 10%, 5% and 1% levels, respectively.
NS = non-significant. Means within a column followed by the same letter are not significantly different at the 5% level.

Table 7. Effects of IST and foliar fungicide application on Economic Optimum N Rate (EONR), Yield at EONR, and Nitrogen Use Efficiency (NUE), 2008-2010. EONR based on $6.00/bu corn price and $0.50/lb N cost. NUE is calculated as lb N/bu and EONR.

Variable	Regression Coefficients			EONR	Yield @ EONR	NUE
	c	b	a			
- Fung 250 IST	*-0.00255*	*1.11214*	*90.6*	*202*	*211*	*0.96*
- Fung 1250 IST	*-0.00263*	*1.10585*	*87.7*	*194*	*203*	*0.96*
+ Fung 250 IST	*-0.00220*	*1.07395*	*92.1*	*225*	*222*	*1.01*
+ Fung 1250 IST	*-0.00271*	*1.15024*	*92.8*	*197*	*214*	*0.92*
- Fungicide	*-0.00259*	*1.10905*	*89.2*	*198*	*207*	*0.96*
+ Fungicide	*-0.00246*	*1.11202*	*92.5*	*209*	*217*	*0.96*
250 IST	*-0.00237*	*1.09302*	*91.4*	*213*	*217*	*0.98*
1250 IST	*0.00267*	*1.12821*	*90.3*	*196*	*209*	*0.94*

*, **, and *** refer to significance at the 10%, 5% and 1% levels, respectively.
NS = non-significant. Means within a column followed by the same letter are not significantly different at the 5% level.

Figure 1. Effects of N rate and fungicide or IST on ear-leaf diseases, six site-years, 2008-2010.



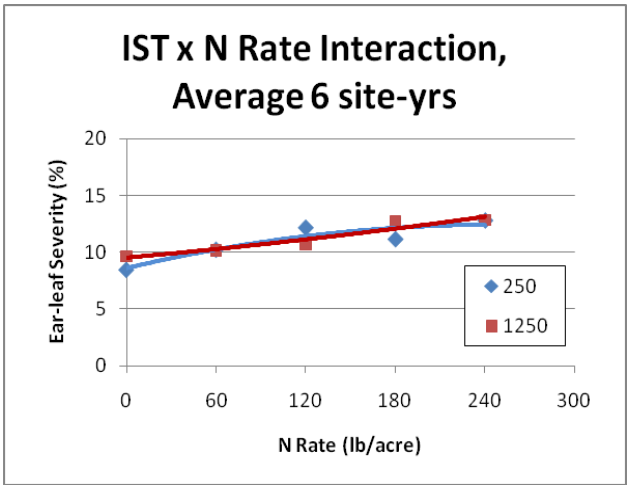
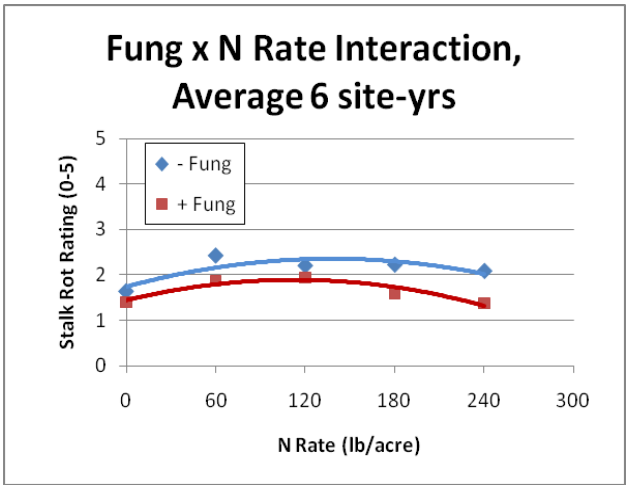


Figure 2. Effects of N rate and fungicide or IST on corn stalk rot, six site-years, 2008-2010.



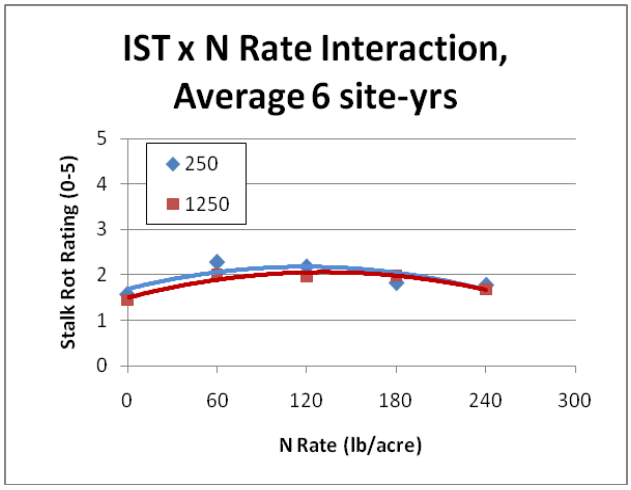


Figure 3. Effect of N rate and IST on corn grain yields at BRC, 2008.

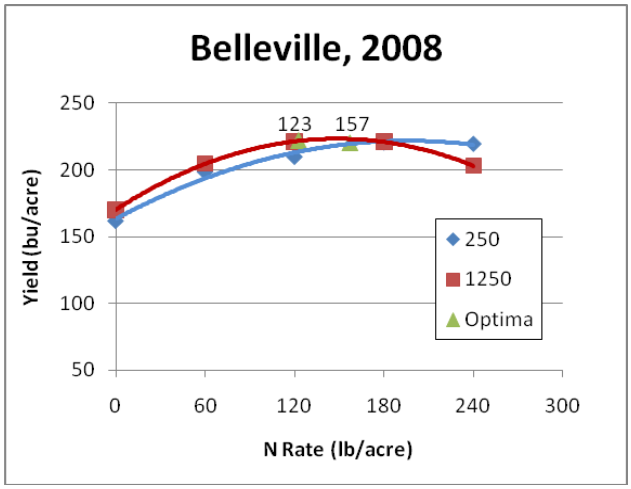


Figure 4. Effects of N rate and fungicide or IST on corn grain yields, six site-years, 2008-2010.