Insecticide Seed Treatments in Grain Corn Production 2003 - Central Corn Belt

Introduction

Control of insect pests in the field is a major economic concern to corn farmers in all U.S. production areas each year. The introduction of systemic, field effective insecticides in the form of seed treatments (IST's) offers a new method in chemical control of many secondary pests, such as wireworm and white grubs. It has been demonstrated that these products, when used at higher rates, can also be effective against several primary pests such as, black cutworm and rootworm.

This development raises important management questions for farmers selecting control measures based on the kind of pests common to their fields, crop rotation, the availability genetic resistance and soil or post emergence insecticide applications. The effectiveness of these options, used alone or in some combination, is essential to making decisions that best meet their needs.

Cooperators

Management personnel at Syngenta Crop Protection, Gustafson and Bayer Crop Science were solicited by Agronomic Seed Consulting in February 2003 to underwrite a cooperative research project. The project's primary objective was to examine the effectiveness of Cruiser IST at the 250 (.250 mg per seed) and 1250 rate and Poncho IST at the 150, 250 and 1250 rate against the labeled rate (7.3 pounds per acre) of Aztec 2.1G applied in furrow, trademarks of these companies respectively. A secondary objective was to determine what effects genotype may have on the insecticide treatments. An untreated check was also included, bringing the total number of insecticide treatments to seven.

Seed companies were encouraged to enter two seed corn hybrids each, one genetically improved and one without major gene resistance. Pedigrees, ranging from 108-112 Day CRM, were selected to eliminate genetic overlap between seed companies. Submitted for testing were Golden Harvest H-8673Bt and EX28795RW, UAP Dyna-Gro DG5449Bt and CX03412, LG Seeds LG2540 and LG2540Bt, Renk Seed RK896 and RK896YGCB and Growmark FS Seeds FS6342 and FS6473.

Two additional hybrids were added - WG110 (Widely Grown 110 Day CRM) and WG110RW, the first one the unimproved version of the second. The total number of genotypes tested equals 12, five conventional (not genetically improved for insect resistance) five improved by YGCB (YieldGard Corn Borer) and two improved by YGRW (YieldGard Rootworm), both improvements trademarks of Monsanto. Participating seed companies sent one 80,000 kernel unit of each product to Biodiagnostics of River Falls, WI, an independent seed service company, for treatment application per manufacture specifications.

Methods

The 84 entries (12 hybrids and seven insecticide treatments) were randomized in a split plot design with hybrids as whole plots (insecticide treatments side by side per hybrid) and replicated four times per location (336 strips). Aztec treatments were not randomly assigned within whole plots but instead applied as strips across them to increase accuracy and reduce the possibility of misapplication. Consequently, data for Aztec is not included in the analyses of variance. Test strips measured 4-30 inch rows in 40 foot lengths. Only the center two rows were measured for lodging, grain moisture and yield. Each test site occupied three acres split into equal quadrants, one for each complete replication. The experiment was conducted at six sites - a north central and central location in Iowa, Illinois and Indiana.

Test sites were situated in fields with a common soil type for the area with a bias favoring drainage. All sites were planted following soybeans and seeded at 30,000 kernels per acre. The La Porte City, IA location was planted May 13 in a strip-tilled loam, New Sharon, IA May 14 in a minimum tilled silty loam, Rochelle, IL April 28 in a minimum tilled loam, Heyworth, IL April 22 in a minimum tilled silty clay loam, Goshen, IN April 26 in a conventional tilled clay loam and Windfall, IN April 27 in a minimum tilled silty clay loam.

Per Site Results

Table 1 presents the untreated (no insecticide) yield and lodging averages of hybrids grouped by genetic insect resistance for each of the 6 test site locations. Yield and lodging ranged nearly 90 bu/A and 33% respectively, providing a wide margin of environments to review insecticide performance. It should be noted that the large majority of lodging observations were for root lodging with the exception of Rochelle and Heyworth, which experienced a fairly even mix of plants lodged at the stalk and root. Root lodging followed hybrid and insecticide effects on yield, especially in the case of the two YGRW improved hybrids and the Aztec insecticide treatment, the latter making regular improvements on plant integrity (intact leaves and plant tops). Yields were not lowered due to harvest losses but because root lodging was symptomatic of poor root development and insect pressure.

Separating the YGCB and YGRW improved hybrids from the remaining five conventional genotypes demonstrates their competitiveness generally, but also allows for a rough estimation of the relative level of European corn borer (CB) and rootworm (RW) pressure at the sites. Finding the differences between the groups per site, standardizing the differences by subtracting the average difference over all sites, then adding an equal number of bushels to the residuals at each site per group (bringing the greatest negative value in the group to zero) equal the values in Bu/A seen in the center portion of Table 1. The estimates are only relative differences and are meaningless outside this projects data set.

Table 1 Per Site Results

		PER SITE MEANS			PRESSURE		SIGNIFICANT DIFFERENCES lsd (.20)						
		Conventional	YGCB Improved	YGRW Improved	Euro. Corn Borer	Corn Rootworm	AZTEC 2.1	PONCHO 1250	CRUISER 1250	PONCHO 250	CRUISER 250	PONCHO 150	CHECK
NORTH CENTRAL IOWA													
La Porte City	YIELD (Bu/A)	201.6	191.3	182.0	19	0	B	A	A	BC	B	BC	C
	LODGING (%)	1.8	0.0	0.1			a	a	a	b	a	a	ab
CENTRAL IOWA													
New Sharon	YIELD (Bu/A)	222.6	205.8	213.9	8	14	ns	ns	ns	ns	ns	ns	ns
	LODGING (%)	1.5	10.4	4.3			ns	ns	ns	ns	ns	ns	ns
NORTH CENTRAL ILLINOIS													
Rochelle	YIELD (Bu/A)	133.4	135.1	135.8	20	16	A	BC	B	CD	D	D	D
	LODGING (%)	14.0	20.6	1.6			a	a	bc	b	bc	c	d
CENTRAL ILLINOIS													
Heyworth	YIELD (Bu/A)	190.0	204.3	208.8	25	26	AB	AB	A	BC	CD	CD	D
	LODGING (%)	33.3	21.1	8.6			a	b	c	d	cd	c	d
NORTH CENTRAL INDIANA													
Goshen	YIELD (Bu/A)	171.5	167.1	202.8	0	48	A	A	C	B	C	C	C
	LODGING (%)	19.6	14.1	1.1			a	a	c	b	d	c	d
CENTRAL INDIANA													
Windfall	YIELD (Bu/A)	153.5	158.0	158.7	22	17	AB	A	B	AB	B	B	B
	LODGING (%)	34.1	21.8	14.4			a	ab	bc	cd	e	de	f

Significant differences between insecticide treatments from data for all hybrids are shown on the last section of Table 1. By convention, treatments with the same letter were not found to be different from each other at the 80% confidence level. Differences between lodging means for insecticides are shown in lower case. Of interest are comparing the effect of insecticides between locations given their estimates of CB and RW pressure.

Per Site Results (continued)

The most striking contrast between locations for CB and RW pressure is between La Porte City, IA and Goshen, IN. La Porte City received superior yield protection from the highest rates of Cruiser and Poncho compared to Aztec, followed by Cruiser 250, and finally the lower rates of Poncho and the check. At Goshen, where RW pressure appeared to be greatest, Aztec and the highest rate of Poncho were best, followed by Poncho 250, then the remaining treatments. Sites at Rochelle, Heyworth and Windfall experienced a mix of these two pests, and provide a mix of insecticide effects, but the trend requiring higher rates of IST to compete with Aztec for yield, averaged from all hybrids in the test, remains.

All Site Summary – Yield

Table 2 presents the main effects on yield of hybrids and insecticides and the 84 treatment means they produce. Yield averages by hybrid break out into two distinct groups, those well above the mean of 181.5 bushels and those well below (lsd .10 = 9.0 bu/A). Insecticide averages break best into three groups, Poncho 1250 and Aztec on top, Cruiser 1250 and Poncho 250 in the middle, and the check and lower rate IST's last (lsd .10 = 2.5 bu/A). It is very important to note that these main effects were found to be highly interactive with location (P = .0000 for location by insecticide and by genotype) as we explored in the last section. Other areas in the states tested, having sampled only six in this project, would provide different answers with absolute certainty. These results are best used with other similar research and to gain a better understanding about what can be expected of IST technology generally.

Table 2 Main Effects and Treatment Means for Yield

				PONCHO 1250	AZTEC 2.1	CRUISER 1250	PONCHO 250	CHECK	CRUISER 250	PONCHO 150
				185.9 A	184.6 AB	182.7 BC	181.6 C	178.8 D	178.7 D	177.9 D
LG SEEDS	LG2540Bt	191.7	A	195.0	200.0	191.0	195.0	193.8	183.1	183.7
RW CHECK	WG110RW	186.2	A B	187.0	184.6	184.3	189.2	184.0	187.1	187.5
CHECK	WG110	185.5	A B	195.5	187.4	188.0	184.1	182.3	179.2	182.3
LG SEEDS	LG2540	183.8	A B C	188.7	185.7	189.1	187.9	184.7	176.1	174.2
RENK	RK896	183.7	A B C	190.2	186.8	189.5	183.9	173.4	183.1	179.3
FS SEEDS	FS6473	183.6	A B C	184.8	185.2	183.9	180.9	182.1	184.7	183.8
DYNA-GRO	CX03412 (YG)	179.8	B C D	183.5	185.5	177.6	181.0	175.7	183.0	172.3
GOLDEN HARVEST	EX28795RW	179.6	B C D	182.0	183.6	181.7	174.8	183.3	176.1	175.5
RENK	RK896YGCB	178.0	B C D	182.8	182.5	181.1	176.3	173.4	176.5	173.4
GOLDEN HARVEST	H-8673Bt	176.3	C D	183.8	181.5	167.7	180.9	170.2	178.4	171.8
DYNA-GRO	DG5449Bt	175.1	C D	181.7	177.2	183.5	169.8	171.5	165.7	176.0
FS SEEDS	FS6342	174.2	D	176.1	175.7	174.5	175.6	171.5	171.1	175.1

GRAND MEAN = 181.5

Examining the different effects of insecticides when applied to different seed genetics is one such use. Results from this project indicate that genotype and insecticide are interactive. Moreover, their interdependency can move in significantly different directions (crossover interaction). Yield means inside Table 2 have been colorized to aid interpretation. The critical value separating means within hybrid equals 6.9 bushels (at the 80% confidence level). Yields appearing in red are significantly below the Aztec treatment, and those appearing green are above the check treatment.

All Site Summary - Yield (continued)

Note that the YGCB hybrids, while generally below average in their main effect, appear to be most responsive to different insecticide treatments, while the YGRW hybrids appear to be least – both interactive in their own way. Also nonresponsive are the two FS Seed entries. The fact they share the same male parent may explain their like resilience. Yields for WG110 with Aztec or a high rate IST appear to be more productive then its YGRW counterpart, but with low rate IST's it begins to fall below. Yields for EX28795RW are flat across insecticides treatments, including the check, but fall significantly when treated with a low dose IST. Erratic and sometimes negative yield responses to IST's when applied at lower rates are particularly disconcerting given that their primary application to date is for control of secondary pests at these rates. Low rate IST's in other fields or in other years may prove more beneficial.

All Site Summary - Lodging

Soil moisture conditions at project test sites this year were near capacity to saturation through much of the vegetative stages. This undoubtedly held insect development and subsequent plant injury in check, but it also discouraged root development and exacerbated the insect damage that had been inflicted. High winds in late June and the tremendous rainfall that followed in early July pushed corn plants down at the soil line. Fortunately, green snap was not observed, and most stalks corrected themselves before harvest. What lodging remained was easily harvestable and provided an excellent opportunity to study this problem as it relates to insecticide applications.

Table 3 Main Effects and Treatment Means for Lodging

				AZTEC 2.1	PONCHO 1250	CRUISER 1250	PONCHO 250	PONCHO 150	CRUISER 250	CHECK
				2.9 A	5.2 B	9.8 C	10.3 CD	11.2 CDE	12.4 DE	14.2 F
RW CHECK	WG110RW	2.4	A	0.7	2.3	2.2	2.9	1.4	2.6	4.5
FS SEEDS	FS6473	4.7	A B	0.8	2.2	3.4	5.5	4.9	7.3	8.5
GOLDEN HARVEST	EX28795RW	4.8	A B	4.9	4.8	3.0	6.1	4.6	4.3	5.6
LG SEEDS	LG2540Bt	5.8	A B C	0.6	1.4	5.5	4.9	8.3	9.5	10.4
DYNA-GRO	DG5449Bt	9.4	B C D	3.0	6.0	9.8	10.9	8.6	14.3	13.5
FS SEEDS	FS6342	10.3	B C D	2.8	4.6	11.8	11.3	13.5	9.7	18.5
GOLDEN HARVEST	H-8673Bt	11.8	C D	3.1	6.7	19.5	13.3	14.5	10.9	14.8
LG SEEDS	LG2540	11.9	D	3.5	5.1	7.6	14.0	14.3	18.9	19.6
RENK	RK896	12.1	D	1.3	5.5	11.5	15.6	11.2	17.8	21.9
CHECK	WG110	12.9	D	3.5	4.5	15.1	15.2	15.2	18.2	18.4
DYNA-GRO	CX03412 (YG)	13.1	D	4.6	8.7	14.6	12.9	16.8	17.5	16.8
RENK	RK896YGCB	14.0	D	6.3	11.2	13.0	10.7	21.2	18.0	17.8

GRAND MEAN = 9.4

Table 3 for lodging averages is formatted in the same way as Table 2, with hybrids to the left and insecticides along the top. Data quality is very good, as were the visuals by treatment combination in the field during harvest. The main effects for both factors broke into two groups, the first being a few well above average and the second average to below average (lsd .10 equals 6.6% for hybrids and 1.7% for insecticides). There seems to be good agreement between hybrids with little yield response to insecticide and those that stood well in the field on average. The difference between the check treatment and the lower rate IST's are also better defined for lodging than for yield.

All Site Summary - Lodging (continued)

Percentages reported in the body of the table were also colorized. Red print indicates a value significantly above the Aztec average within hybrid (lsd.20 = 4.7%), and in green are those below the check. Blue indicates lodging as being both above and below respectively (significantly in-between). Those that remain black of course were not different from the Aztec or check treatments, and that is what appears for both YGRW hybrids. This was not the case for the FS Seed hybrids, despite finding no yield advantage.

Conclusion

Poncho and Cruiser insecticide seed treatments have proven to be an effective and in most cases a consistent deterrent to insect damage at high rates, and depending on genotype and environment, at lower rates. The most important agronomic challenges this technology must face, in the opinion of the author, are 1) sustaining competitive yields and acceptable plant integrity scores compared to the best granular or liquid options in high insect pressure environments. 2) to identify the proper rates needed per seed product to ensure the buyers regular satisfaction 3) to deal effectively with issues relating to seed singulation at planting.

While not an objective of this research, stand counts at the New Sharon and La Porte City, Iowa locations were taken after planting, and then re-examined before harvest. Stands were 500 to 1400 seeds per acre greater for IST treated strips than the Aztec strips. A closer look revealed two to four doubles common in 40 feet of row compared to one or two typically for Aztec. Most seed grades were medium flats and the tests were planted at 4 mph with John Deere finger pick-up meters belt-tuned just before planting. No graphite was used, however, which is a recommended practice. It is likely that a small yield benefit may have been realized by IST's in this project by over seeding at the higher yielding sites, confounding the chemical effect of the insecticide itself.

Data file: I3ALL6
Title: ALL (6) SITES

Function: FACTOR
Experiment Model Number 20:
Two Factor Randomized Complete Block Design with Split Plot
Combined over Locations
Data case no. 1 to 1728.

Variable 5: Yield

A N A L Y S I S O F V A R I A N C E T A B L E

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Location	5	1248791.513	249758.303	269.1912	0.0000
3	R(L)	18	116093.213	6449.623	6.9514	0.0000
4	Factor A	11	42211.877	3837.443	4.1360	0.0000
5	LA	55	119453.524	2171.882	2.3409	0.0000
-7	Error	198	183706.402	927.810		
8	Factor B	5	13570.859	2714.172	9.7448	0.0000
9	LB	25	16178.551	647.142	2.3235	0.0003
12	AB	55	22347.837	406.324	1.4588	0.0177
13	LAB	275	94387.707	343.228	1.2323	0.0122
-15	Error	1080	300805.965	278.524		
	Total	1727	2157547.448			

Variable 6: Lodging

A N A L Y S I S O F V A R I A N C E T A B L E

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Location	5	63853.171	12770.634	28.1311	0.0000
3	R(L)	18	61953.542	3441.863	7.5817	0.0000
4	Factor A	11	31608.630	2873.512	6.3298	0.0000
5	LA	55	64506.051	1172.837	2.5835	0.0000
-7	Error	198	89885.708	453.968		
8	Factor B	5	13224.074	2644.815	18.4597	0.0000
9	LB	25	12618.065	504.723	3.5228	0.0000
12	AB	55	9662.315	175.678	1.2262	0.1285
13	LAB	275	43491.463	158.151	1.1038	0.1440
-15	Error	1080	154736.750	143.275		
	Total	1727	545539.769			