Joliet Junior College
Demonstration & Research Guide
2004

Learn how:

CRW Control Products
Protected Corn Roots

Narrow Row Corn Performed

Soybean Insecticides
Influenced Yield

Tillage and Planting
Date Interacted

and much much more...

Prepared by: Jeff Wessel

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Acknowledgments

Numerous people have contributed in many ways to the J.F. Richards Land Laboratory, Demonstration & Research Farm during 2004. Resources donated range from the time donated by drivers for our field day, to equipment, pesticides, cash, and seed, all are listed in the paragraphs and tables below including the following page. Take some time to look over these folks and their supporting employers and give them a friendly thanks for their support from Joliet Junior College and myself.

A few folks I would like to mention here are; Alan Venters and the following JJC Ag students; Lisa Wallin, Samantha Beal, Adam Thorndyke, and Rich Mangers, for assisting in planting the corn and soybean varietal demonstrations. Rob Thomas of Monsanto, Gary Bretthauer with University of Illinois Extension, Mark Chastain of AMVAC, and Alan Venters of Hughes Hybrids all volunteered to help dig, wash and rate roots in our two corn rootworm studies. At harvest a number of JJC Ag students took a active role in helping to complete it, they are; Rich Mangers, Anna Douglas, Jenny Thomas, Tom Seegemiller, Jeremy Beetz, Matt Meyer, and Chad Kitchens. Our field day speakers were; Emerson Nafziger, Dean Riechers, Joe Spencer, and Russ Higgins, all associated with the University of Illinois.

New shanks for our strip-till implement were donated by Grainco FS located at Dwight, IL. John H. Weitendorf, Sr. was very generous in his financial support of our efforts. Finally, John Cronin was very kind in loaning a pickup truck for much of the Fall harvest, and helped move equipement along with a variety of other activities.

Table 1.
List of people and companies they represent that donated various products for crop protection at Joliet Junior College in 2004.

Last	First	Organization	Product
Chastain	Mark	AMVAC	Fortress
Eager	John	Syngenta	Force
Eager	John	Syngenta	Dual II Mag.
Eager	John	Syngenta	Lumax
Hosky	Jeremy	BASF	Guardsman Max
Hosky	Jeremy	BASF	Distinct
Roelfs	Duane	Heritage FS	Harness Xtra
Roelfs	Duane	Heritage FS	Atrazine
Ruhl	Kreg	Bayer	Aztec
Ruhl	Kreg	Bayer	Epic
Stine	Scott	Monsanto	RoundupWM
Verdun	Brad	Pioneer	CinchATZ
Verdun	Brad	Pioneer	SteadfastATZ

Contributors

Table 2.
List of people and companies they represent that donated seed to Joliet Junior College in 2004.

Last	First	Organization
Asbury	Andy	NK
Berg	Jerry	Stone Seed Co.
Brummel	Don	Golden Harvest
Buhr	Rod	Sieben
Coffman	Lyle	Great Lakes
Cowherd	Tommy	Croplan
Engler	Tom	Ag Venture
Fugate	Bill	Burrus
Gick	Ron	Beck's
Horner	Jeff	Garst
Johnson	Les	Cornelius
Kepner	Hoot	Cornelius
Lagar	Scott	Wyfells
Laudeman	Craig	Grainco FS, Minooka
Nesbitt	Doug	Adler
Roelfs	Duane	FS
Schneider	Dan	LG
Skonetski	Bill	Dairyland Seed
Stine	Scott	Dekalb
Stine	Scott	Asgrow
Thumma	Todd	Garst
Twait	Mike	Crows
Venters	Allan	Hughes
Wals	Wayne	Pioneer
Zeigler	Matt	Fielders Choice

Table 3.
People who helped with the field day, harvest, and other miscellaneous activities.

Last	First	Organization
Cronin	John	
Dumney	Bill	
Smerz	Dick	
Thomas	Rob	Monsanto
Wessel	Bill	

Agriculture and Horticultural Sciences Department
Faculty and Staff

The agriculture and horticulture faculty and staff at Joliet Junior College are always willing to answer questions and discuss the information contained within this document. As an institution of higher learning we value the discussion of the contents of our demonstration and research guide, and desire input from the public concerning our farm. Below is a complete list of all faculty and staff in the Agriculture and Horticulture Sciences Department. For more information or additional copies of the JJC Demonstration and Research Guide 2004, contact: Jeff Wessel, Joliet Junior College, 1215 Houbolt Road, Joliet, Illinois 60431. Phone: (815)280-6602 e-mail: jwessel@jjc.edu. To contact faculty and other staff members call (815)280-2320, or fax at (815)280-6650.

Brad Angus - Agronomy / Business / Livestock Judging
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Caryn Genens - Horticulture Lab Manager
Dale Hummel - Animal Science
Bill Johnson - Agricultural Economics / Marketing
Scott Keller - Veterinary Technology
Mark Kuster - Landscape Design
Karen Magno - Veterinary Technology secretary
Eileen McKee - Veterinary Technology
Fredric Miller - Nursery Management
Tammy Miller - Soils / Fertilizers
Roxanne Olson - Veterinary Technology
Lisa Perkins - Turf Management
Lynda Scerine - Department Secretary
Walter Stein - Veterinary Technology
Donna Theimer - Floral Design / Interior Plantscaping
Jeff Wessel - Farm Manager / Crop Protection Instructor

Introduction

The Joliet Junior College Demonstration and Research Farm was put into operation in 1983 with the expressed purpose of being an educational resource for agricultural students and their instructors. There are three major objectives of the Demonstration and Research Farm, they are: 1) Provide an instructional setting for crops and soils analysis, this allows students to put into practice skills they have learned in the classroom. 2) Demonstrate crop response to various agronomic practices, this provides an environment for students to observe first hand the impact of various agronomic practices on crop growth and development. 3) Provide unbiased, sound agronomic information to crop producers.

The Demonstration and Research Farm consists of 108 cropped acres with 63 acres of corn and 45 of soybean in 2004. Twenty agronomic studies and two demonstrations were implemented, they included the evaluation of corn and soybean herbicides and insecticides, tillage systems, row spacing and plant populations, and planting dates in both corn and soybean. Nitrogen(N) fertilizer rates and application timing in corn were among other replicated studies. Demonstrations (unreplicated) of corn and soybean varieties were also included in our work during 2004.

Our Demonstration and Research Farm is situated in Joliet, Illinois (North Eastern Illinois) a region dominated by soils with low phosphorous(P) supplying power and high cation exchange capacity. Soil fertility levels at the Demonstration and Research Farm are within acceptable ranges for row crop production. P soil levels range from 50 to 140 with a median of 69lbs available P per acre, and exchangeable K^+ ranges from 277 to 502 with a median of 360 lbs per acre. Soil pH ranges from 5.6 to 7.4 with an average of 6.7. Given these soil fertility levels, maintenance fertilizer P and K are applied annually at a rate of 50lbs P_2O_5 and K_2O per acre. The five year moving average yield for corn and soybean is 138 and 38 bushels per acre respectively, these yields include the severe drought year of 2002. Annual removal of P and K given recent yields is 46lbs P_2O_5 and 43lbs K_2O per acre.

Zero tillage is the primary tillage system used, and as such Fall, Spring preplant, or Spring preemerge "burndown" herbicides are used to kill existing vegetation. Areas not receiving burndown herbicides included tilled areas and a few treatments in the corn and soybean herbicide studies. Fall preplant burndown herbicides were applied in November of 2003 where soybean was to be planted in 2004 and included; CanopyXL @ 2.5 ounces + Express @ 0.10ounces + 2,4-D @ 1pint + crop oil concentrate @ 1% by volume. For corn, Spring applied preplant or preemerge burndown herbicides consisted of Roundup Weather Max(WM) @11ounces + 2,4-D @ 1pint per acre + Ammonium Sulfate @ 17lbs per 100 gallons of water. For the balance of the document where RoundupWM was applied, Ammonium Sulfate @ 17lbs per 100 gallons of water was always included. In addition to the burndown, weed control in corn was accomplished by preemerge applications of Epic+Atrazine, or HarnessXtra + Atrazine followed by RoundupWM, or Dual II Magnum followed by Callisto, or Lumax, or a post application of SteadfastATZ. Weed control for soybean, in addition to the Fall burndown, was accomplished with V5 applications of RoundupWM.

Introduction

Both corn and soybean were planted using a Kinze model 3000 pull-type planter manufactured in 2002 and equipped with a colter and residue remover combination for zero-till planting. Corn was planted in 30 inch rows at a rate of 32,000 seeds per acre and planting dates for most corn ranged from April14th through April 28th. During the two weeks of corn planting rain delays occurred twice, once on April 20th and 24th. Early planted corn (April 6th) emerged by April 21st, aided in it's emergence by warm April temperatures. The accumulation of Modified Growing Degree Days (MGDD's) was well above average for April (page 6, figure 2), although most of above average temperatures occurred during the 2nd half of April. The last freezing air temperature (28.1 degrees Fahrenheit) occurred on May 3rd, despite the relatively "hard" frost V1 corn plants suffered little to no injury. April 6th planted corn flowered (VT) around July 8th, with the balance of the crop flowering at mid July. As in 2003, corn rootworm larvae caused heavy root injury in unprotected corn, in contrast however, adult emergence was noted to be later than 2003.

Soybean was planted in 15 inch rows at a rate of 175,000 seeds per acre. Soybean planting began in earnest on May 5th and all studies were planted by May 18th. Early planted soybean (during or before the 1st week of May) responded to the warm April and May by flowering before June 21st. Soybean is photoperiod sensitive and will flower when day lengths are < some maximum and have progressed beyond V3. The extent of flowering (on a per plant basis) before June 21st was minimal though, and probably had little impact on yield. Unlike 2003, soybean aphid in 2004 was virtually nonexistent.

Corn was harvested from September 21st through the October 5th, and soybean from October 5th through the 28th. Both crops were harvested with a International Harvester model 1460 combine. Weigh wagons were used to measure grain yield, hand held moisture meters for determining grain moisture. Yield was calculated by assigning corn 15% and soybean 13% water by mass.

No precipitation fell during the first two weeks of April, however, slightly above normal precipitation fell the last two weeks (page 6, figure 1). Early May saw below average rainfall, while the balance of the month had considerable precipitation that resulted in > 3 inches above the 27 year average. June had near normal rainfall, although ~95% of rain fell the 2nd week. The last two weeks of July were dry, with a monthly sum of 2.96 inches. August was somewhat of a "monsoon", or at least the last week. Typically 3.87 inches fall in August, in 2004 a sum of 10.24 was measured.

April and May had MGDD accumulations above average,June, July, and August were below average (page 6, figure 2). At some point during the second week of August, the excess MGDD's accumulated earlier became depleted, so to speak, and 2004 was similar to the 27-year average at that time. During August MGDD's were accumulated at a rate 80% of normal, and so by the end of the month the growing season (May-August) sum was 181 MGDD's below average.

The corn and soybean varietal demonstrations averaged 169 and 52 bushels per acre respectively. The corn in 2004 produced the second highest yield recorded, surpassed only by 2003, while the soybean was also the second highest, being surpassed by 1998.

Jeffrey R Wessel, Farm Manager/Crop Protection Instructor

Introduction

Figure 1.

Weekly precipitation at Joliet Junior College in 2004 for April through August (bars), and a 27 year average. The historical sum is 20.5, in 2004 28.1 inches of precipitation fell.

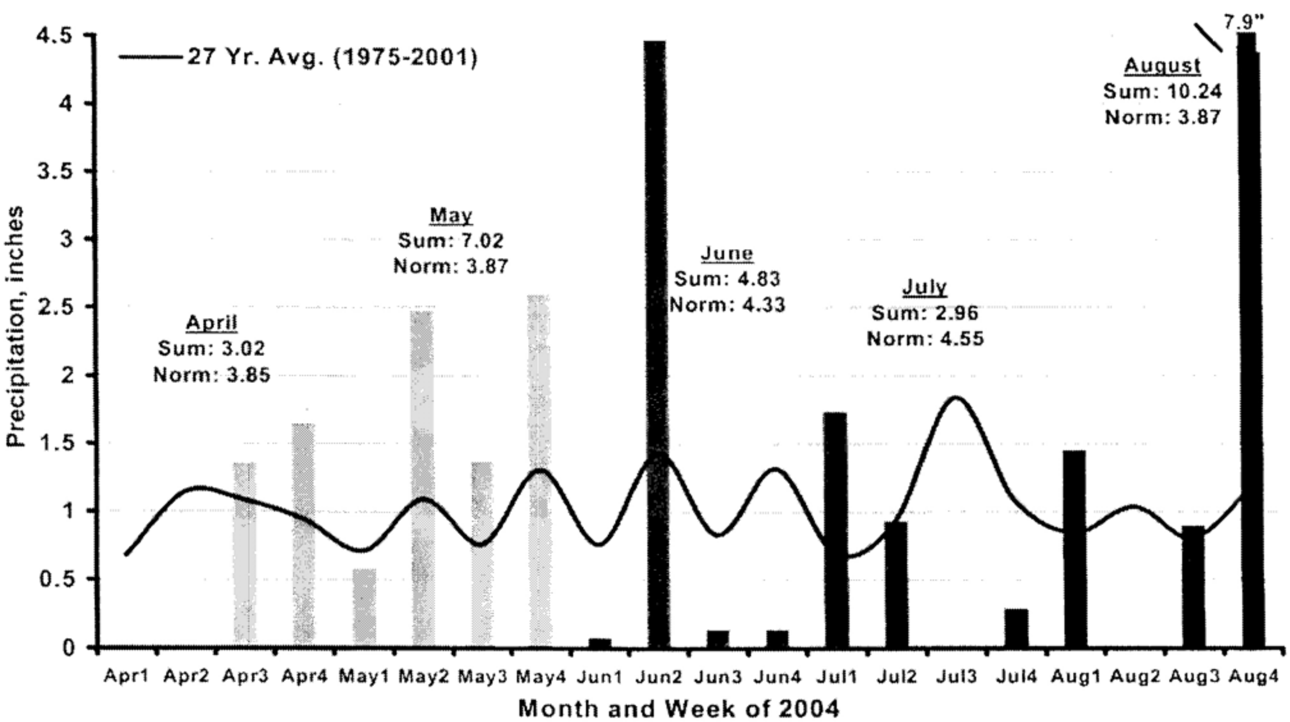
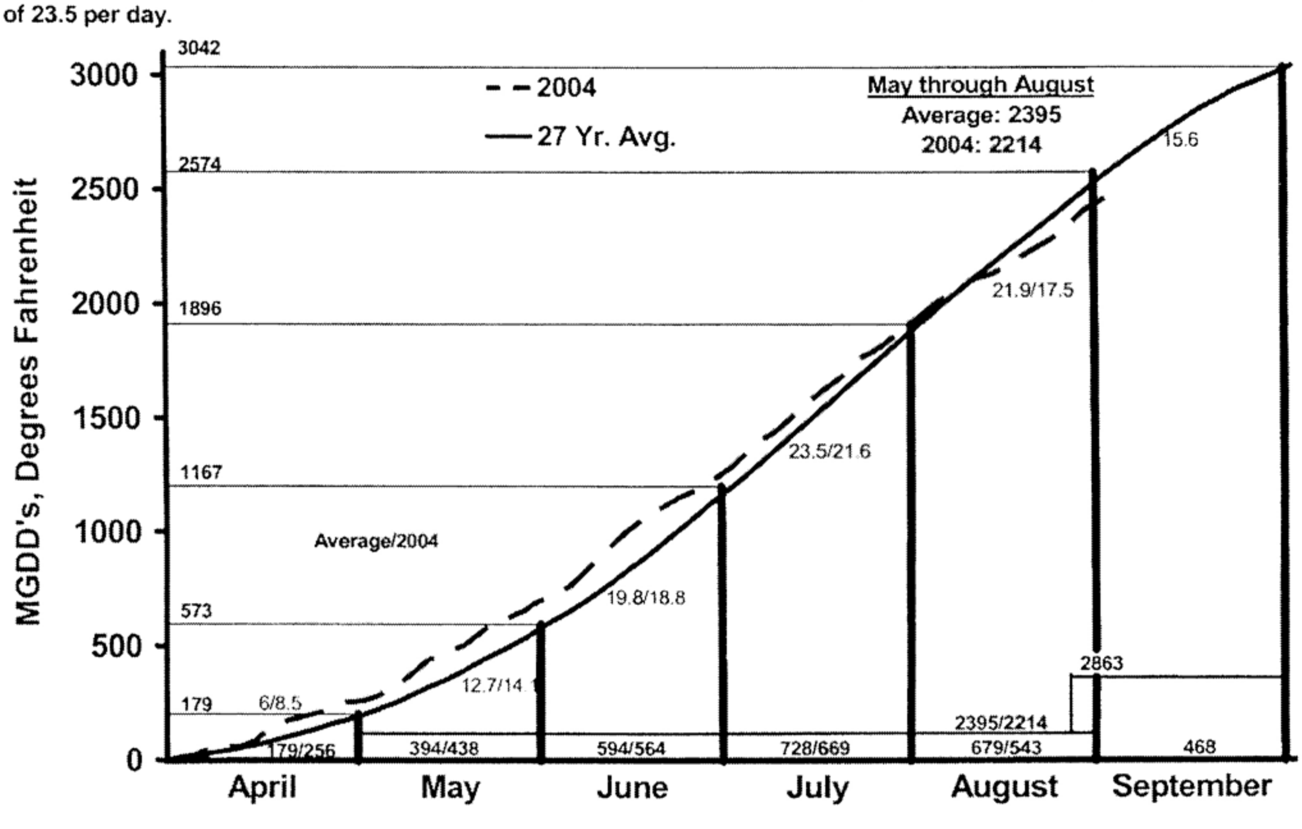


Figure 2.

Accumulation of modified growing degree days (MGDD's) at Joliet Junior College for April-August of 2004 (dashed curve) and a 27 year average. Historically, MGDD's are accumulated at the highest rate during July with an average of 23.5 per day.

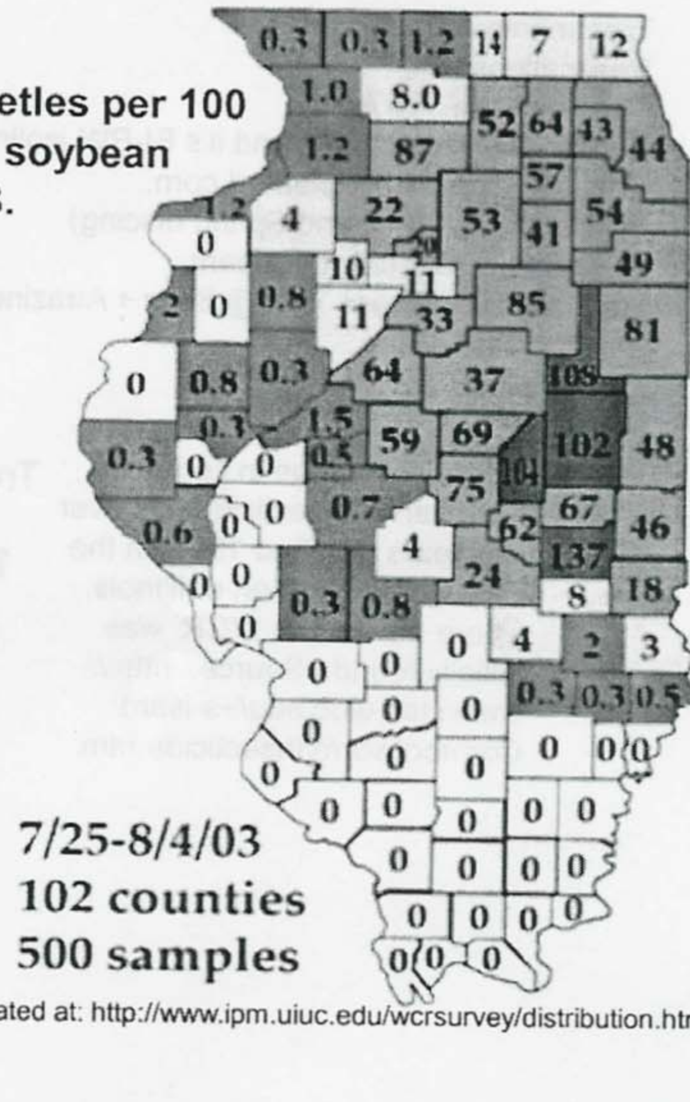


Corn Rootworm Larval Control Product Performance

Justification and Objective

Corn rootworm (CRW) is the most damaging insect pest of monocropped corn in the Midwest (Levine and Oloumi-Sadeghi, 1996), and as such has the potential to inflict heavy economic losses (Gray et al., 1993). The development of a variant Western Corn Rootworm (WCR) exhibiting a behavioral shift to oviposition in soybean fields has been identified in much of Illinois (page 7, figure 3). The spread of this variant WCR in Illinois over the last decade has become fairly extensive and now covers much of the Northern two-thirds of the state. Illinois entomologists believe the variant has continued it's expansion in 2004 (Gray et al., 2004). A dramatic increase in rotated corn acres treated with corn rootworm larval insecticides is likely to accompany the expansion of the variant. Page 8 figure 4 depicts a 5-fold increase in rotated corn acres treated with CRW insecticides in East Central Illinois where the variant WCR was first discovered. Our objective was to evaluate the efficacy of corn rootworm larval insecticides (seed treatment & granular) and transgenic Bt-rootworm corn in an effort to demonstrate root injury and it's effect on grain yield.

Figure 3. WCR beetles per 100 sweeps in Illinois soybean fields during 2003.



University of Illinois Extension; IPM Field Crops, located at: http://www.ipm.uiuc.edu/wcrsurvey/distribution.html

Corn Rootworm Larval Control Product Performance

Methods

Four granular insecticides and one seed treatment corn rootworm larval insecticide, a transgenic Bacillus thuringiensis for corn rootworm (Bt-RW), and an untreated control were evaluated for their effect on lodging, root injury, and grain yield. Each treatment was replicated three times and planted on April 15th with the Asgrow corn hybrid RX708 and it's isoline Asgrow RX708YGRW for the Bt-RW treatment. The previous crop was late planted corn (trap crop) which is predisposed to attract corn rootworm adults, and can increase the number of rootworm eggs laid and the potential number of rootworm larvae the following growing season. Full width tillage, which included Fall and Spring discing was performed on the entire experimental area. Corn was planted at a rate of 32,000 seeds per acre and granular insecticides were applied "in-furrow", behind the disc openers and in front of the closing wheels, with heavy chains drug directly behind the closing wheels. Herbicides were applied after preemerge and interrow cultivation was performed at V5 for additional weed control. On July 15th five plants were randomly selected from each experimental unit, roots dug, washed with a high pressure washer, and rated (0 to 3 scale). The crop was harvested on September 27th.

Treatments: 8
Replications: 3
Planting Date: 15 April
Hybrid: Asgrow RX708, and it's Bt-RW isoline (Asgrow RX708YGRW).
Previous Crop: Late planted corn.
Tillage: Mulch (Fall and Spring discing)
Soil Series: Will silty clay loam
Herbicides: Harness Xtra @ 83oz + Atrazine @ 12oz per acre applied preemerge.
Insecticides: Many

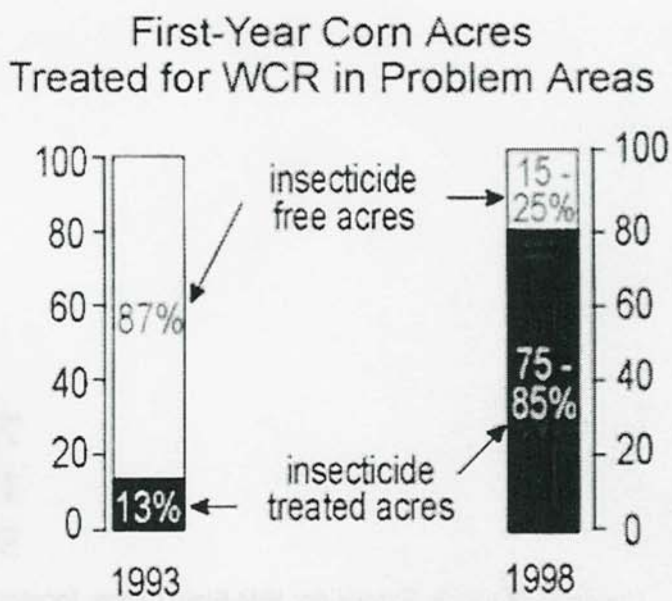


Figure 4. Change in corn rootworm larval insecticide use over five years (1993 to 1998) in the East Central portion of Illinois, where the variant WCR was initially found. Source: http://www.staff.uiuc.edu/~s-isard/Cornrootworm/Insecticide.htm

Corn Rootworm Larval Control Product Performance

Results and Discussion

Heavy corn rootworm (CRW) larval injury (2.7, 0 to 3 scale) to corn roots occurred in the untreated control (page 10, table 5), approximately 90% of roots destroyed. The seed treatment Poncho (clothianidin) was applied at two rates, 250(0.125mg a.i./kernel) and 1250(1.25mg a.i./kernel). Poncho 250 is not labeled for control of CRW larvae, although it did significantly (0.05 alpha) reduce root injury and increase grain yield compared to untreated corn. Poncho 1250 is labeled for CRW larval control and significantly reduced root injury and increased grain yield when compared to Poncho250. Additionally, Poncho 1250 reduced lodging by approximately one half when compared to either the untreated plots or Poncho 250, both were 100% lodged. The granular insecticide Lorsban 15G did not provide any root protection or reduce lodging when compared to untreated control. It did, however, significantly increase yield compared to the untreated control. Fortress2.5G protected roots similar to Poncho250 (root rating 2.1), although, it had a significantly lower yield compared to Poncho250. Force3G and Aztec2.1G had similar root ratings, grain yield, lodging scores, and both provided better root protection than any other seed treatment or granular insecticide. Despite the lowest root ratings and highest yields of the insecticides, Force and Aztec treated corn suffered significant yield loss compared to transgenic Bt-rootworm corn (Bt-RW). This is not surprising, since root injury between one root and one node of roots destroyed (0.1 to 1.0, 0 to 3 scale) is commonly thought to produce economic losses (Ratcliffe et al., 2003). Bt-RW produced significantly higher yields and lower root ratings than any of the other 7 products for CRW control.

Although it is not unusual yield reductions occurred with root ratings of approximately 1.0 (0 to 3, scale), in 2003 however, root ratings of 2.0 were required for grain yield to be reduced (page 11, figure 8). Two figures (7 & 8) on page 11 depict the response of yield to root injury under two distinct environments (rainfall) at Joliet Junior College. In 2004 (figure 7) the response of yield to root injury was linear ($P=0.05$, $R^2= 0.68$), indicating little root injury required for yield loss, in 2003 however (figure 8), the yield response to root injury fit a quadratic model ($P=0.05$, $R^2= 0.68$). The 2003 data suggest much greater root injury required for yield loss. In 2004 maximum yields were approximately 50 bushels per acre less than in 2003, indicating a more stressful environment. The stress (reduced dry matter accumulation) can be attributed to a droughty July, as 2004 received only 35% of the rainfall that occurred in 2003 (5.55 inches less).

Similar to 2003, Force and Aztec protected roots better than any other CRW insecticide evaluated, although neither had a root rating as low as Bt-RW plants. Unlike 2003, however, little root injury was required for yield reductions in 2004. Yield response to root injury over the two distinct July rainfall environments, suggest that yield losses from CRW larval injury may depend on drought stress during reproductive growth of corn.

Corn Rootworm Larval Control Product Performance

Figure 5. 0 to 3 node-injury Iowa State root rating scale (Oleson and Tollefson, 2000).

Value	Damage Description
0.00	No feeding damage (lowest rating that can be given)
1.00	One node (circle of roots), or the equivalent of an entire node, eaten back to within approximately two inches of the stalk (soil line on the 7th node)
2.00	Two complete nodes eaten
3.00	Three or more nodes eaten (highest rating that can be given)

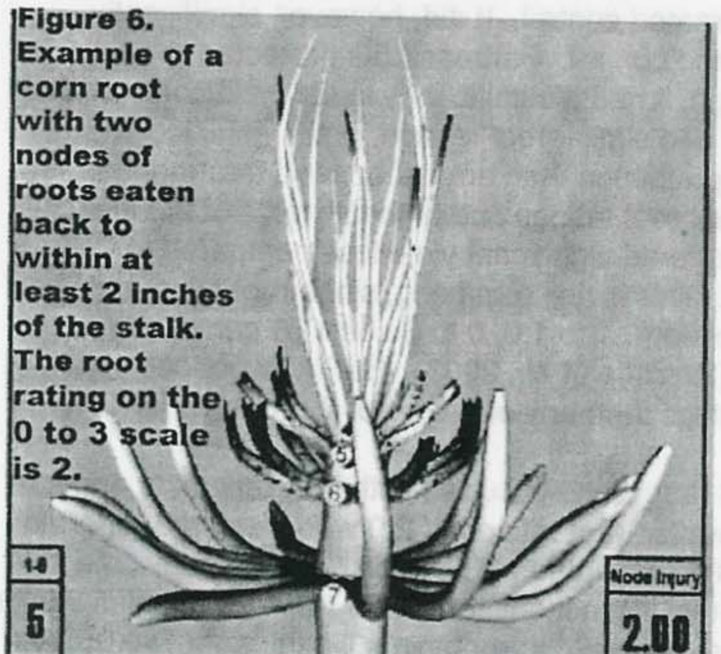


Figure 6. Example of a corn root with two nodes of roots eaten back to within at least 2 inches of the stalk. The root rating on the 0 to 3 scale is 2.

Table 4.
Influence of corn rootworm larval control products on the harvest population of corn grown at Joliet Junior College in 2004.

Corn Rootworm Control Product	Harvest Population
	plants/acre
Untreated	27,775
Poncho 250	27,750
Poncho 1250	28,917
Lorsban 15G	28,083
Fortress 2.5G	28,150
Force 3G	29,017
Aztec 2.1G	29,250
Bt-RW	28,375
LSD(0.05)	N/S

Table 5.
Influence of corn rootworm larval control products on lodging, root rating(0-3), and grain yield of corn grown at Joliet Junior College in 2004. The previous crop was late planted corn(trap crop) and the hybrid is Asgrow RX708 for the non-Bt treatments, and it's Bt-Rootworm isoline RX708YGRW used in the Bt-rootworm(Bt-RW) treatment. The four granular insecticides were applied in-furrow.

Corn Rootworm Control Product	Active Ingredient	Product Application Rate	Lodging	Root Rating	Grain Yield
		oz/1000 ft. row	—%—	0 to 3†	Bu. per Acre
Untreated	- - -	- - -	100	2.7	46
Poncho 250	Clothianidin	0.125mg a.i. / Kernal	100	2.1	70
Poncho 1250	Clothianidin	1.25mg a.i. / Kernal	49	1.6	82
Lorsban 15G	Chlorpyrifos	8	99	2.8	58
Fortress 2.5G	Chlorethoxyfos	7.35	73	2.1	64
Force 3G	Tefluthrin	4	14	1.1	87
Aztec 2.1G	Cyfluthrin+Phosphorothioate	6.7	17	1.0	83
Bt-RW	Insecticidal Protein Toxin	- - -	12	0.6	95
LSD(0.05)	- - -	- - -	23	0.4	5

† Roots were rated using the 0 to 3 node-injury scale, Oleson and Tollefson.

Corn Rootworm Larval Control Product Performance

Figure 7. **Influence of corn rootworm larval root injury (0-3 node-injury scale) on the grain yield of corn grown at Joliet Junior College in 2004.**

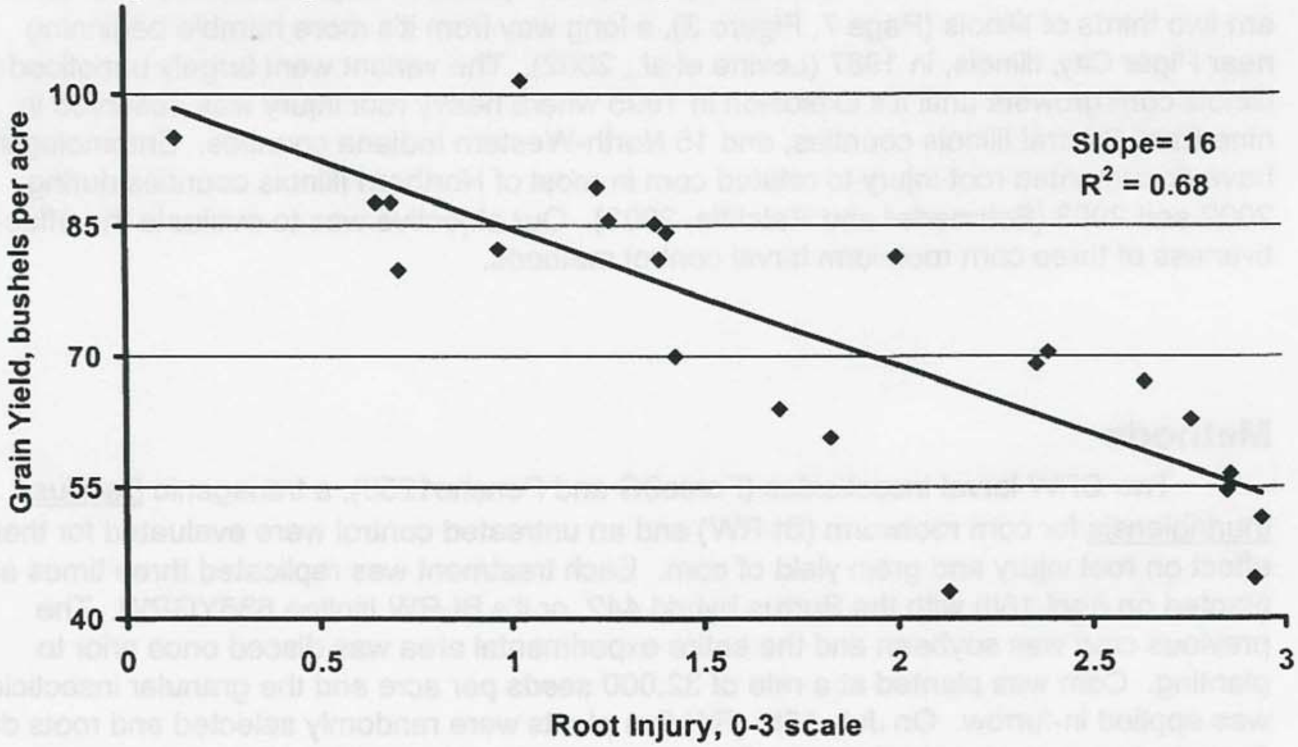
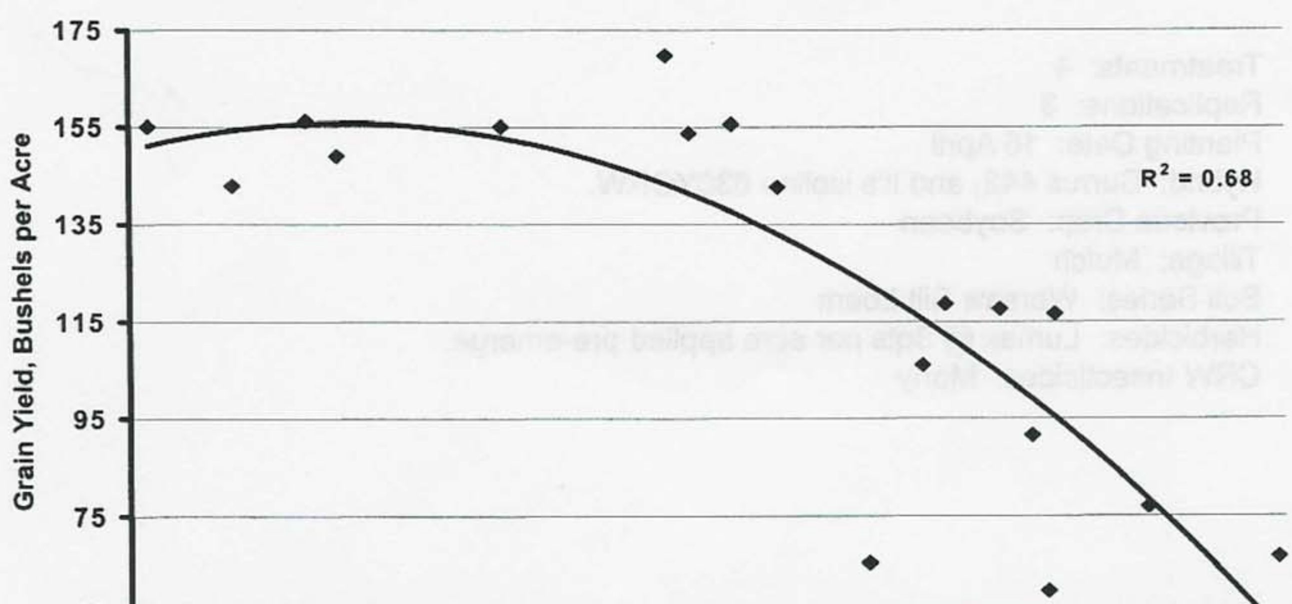


Figure 8. **Influence of corn rootworm larval root injury on the grain yield of corn grown at Joliet Junior College in 2003.**



Corn Rootworm Control in Rotated Corn

Justification and Objective

Variant Western Corn Rootworm (WCR) has spread throughout most of the Northern two thirds of Illinois (Page 7, Figure 3), a long way from it's more humble beginning near Piper City, Illinois, in 1987 (Levine et al., 2002). The variant went largely unnoticed by Illinois corn growers until it's explosion in 1995 where heavy root injury was observed in nine East-Central Illinois counties, and 15 North-Western Indiana counties. Entomologists have documented root injury to rotated corn in most of Northern Illinois counties during 2002 and 2003 (Schroeder and Ratcliffe, 2003). Our objective was to evaluate the effectiveness of three corn rootworm larval control methods.

Methods

Two CRW larval insecticides (Force3G and Poncho1250), a transgenic Bacillus thuringiensis for corn rootworm (Bt-RW) and an untreated control were evaluated for their effect on root injury and grain yield of corn. Each treatment was replicated three times and planted on April 16th with the Burrus hybrid 442, or it's Bt-RW isoline 636YGRW. The previous crop was soybean and the entire experimental area was disced once prior to planting. Corn was planted at a rate of 32,000 seeds per acre and the granular insecticide was applied in-furrow. On July 15th (R1) five plants were randomly selected and roots dug from each experimental unit (plot). Roots were washed thoroughly with a high pressure washer to remove all soil and debris for visual rating. At R6 harvest population and lodging were measured, and the crop was harvested on September 30th.

Treatments: 4
Replications: 3
Planting Date: 16 April
Hybrid: Burrus 442, and it's isoline 636YGRW.
Previous Crop: Soybean
Tillage: Mulch
Soil Series: Warsaw Silt Loam
Herbicides: Lumax @ 3qts per acre applied pre-emerge.
CRW Insecticides: Many

Corn Rootworm Control in Rotated Corn

Results and Discussion

Force3G and transgenic Bacillus thuringiensis rootworm (Bt-RW) treatments both significantly (alpha 0.05) reduced root injury from corn rootworm (CRW) larvae when compared to the untreated control (page 13, table 6). Additionally, Bt-RW significantly reduced root injury relative to Force 3G, while Poncho1250 did not reduce root injury compared to the untreated control. Poncho 1250 and Force3G did not reduce lodging relative to untreated plots, however, Bt-RW reduced lodging by approximately five-fold.

Bt-RW plants were virtually untouched by CRW larvae (0.04, 0 to 3 scale), while untreated corn averaged about 14 roots destroyed per plant (47% of roots). Despite root injury well in excess of economic thresholds (0.10 to 1.0, 0 to 3 scale) (Ratcliffe et al., 2003) in the untreated control and Poncho1250, grain yields were not reduced when compared to Bt-RW. Yields in this study averaged 117 bushel per acre higher than the highest yielding treatment in the CRW study on page 10. The higher yields indicate less stress (relatively small reduction in dry matter accumulation), and there is good reason to believe that non-stressed plants (especially water stress) can tolerate some root injury without suffering yield losses (Chiang et al., 1980).

Table 6.
Influence of corn rootworm larval control methods on lodging, root rating, and grain yield of corn grown at Joliet Junior College in 2004. The previous crop was soybean and the hybrid is Burrus 442 used for the non-Bt treatments, and it's Bt-RW isoline 636YGRW used in the Bt-Rootowrm (Bt-RW) treatment.

Corn Rootworm Control Method	Active Ingredient	Lodging	Root Rating‡	Grain Yield
		- - %- -	0 to 3	bu. / acre
Untreated	- - -	24	1.39	207
Poncho 1250	Clothianidin	29	1.30	205
Force 3G†	Tefluthrin	25	0.63	214
Bt - RW	Insecticidal Protein Toxin	5	0.04	207
LSD(0.05)	- - -	8	0.61	N/S

† Force 3G was applied in-furrow at 4 ounces per 1000 feet of row.

‡ Roots were rated using the 0 to 3 node-injury scale, Oleson and Tollefson.

Table 7.
Influence of corn rootworm larval control methods on the harvest population of rotated corn grown at Joliet Junior College in 2004.

Corn Rootworm Control Method	Harvest Population
	plants / acre
Untreated	28,889
Poncho 1250	28,822
Force 3G	29,236
Bt - RW	28,311
LSD(0.05)	N/S

Corn Herbicides

Justification and Objective

Large numbers of herbicidal compounds are available for weed control in corn. The Illinois Agricultural Statistical Service (2004) lists 26 herbicidal compounds for corn. Nineteen of the 26 herbicides listed are used on less than 10% of corn acres. Seedling shoot and root inhibitors (chemical family, Amide) are used extensively, as 76% of corn acres receive an application of one of several seedling shoot & root inhibitors (Acetochlor ect...). Additionally, a mobile photosynthesis inhibitor (atrazine) is used on 77% of corn acres. While many compounds are available for weed control in corn, the overwhelming majority of Illinois corn acres receive similar herbicides.

Our objectives were two fold. First, provide a demonstration of the weed efficacy of commonly used corn herbicides in the Midwest to students at Joliet Junior College. Second, demonstrate the combination of the effects of weed efficacy and potential herbicide injury on corn grain yield.

Methods

Eleven corn herbicide treatments and a no-herbicide control were used to determine the efficacy of commonly used corn herbicide systems. Each treatment was replicated three times and planted on April 20th with the Dekalb hybrid 57-81 (RR+YGRW). The previous crop was soybean and corn was planted at a rate of 32,000 seeds per acre. The entire experimental area was zero-tilled and preemerge burndown herbicides (Roundup Weather Max @11oz + 2,4-D@16oz per acre; and AM.S.@ 2%by mass + COC @ 1% by volume) were used to control existing vegetation. Herbicides were broadcast with flat fan spray nozzles (XR11004) on a Hardy sprayer applying 20 gallons per acre of spray solution and 20 pounds per square inch nozzle tip pressure. Weed efficacy was measured at R6 by visual assessment (% control), and the crop was harvested in early October.

Treatments: 12
Replications: 3
Planting Date: 20 April
Hybrid: Dekalb 57-81YGRW
Previous Crop: Soybean
Tillage: Zero-Till
Soil Series: Warsaw Silt Loam
Herbicides: Many
Insecticides: None

Corn Herbicides

Results and Discussion

All eleven herbicide treatments significantly (0.10 alpha) increased grain yield when compared to the no-herbicide control (page 15, table 8). Ten of the eleven herbicide treatments produced similar yields. Only the single, late-post (V7) application of RoundupWM had significantly lower yields when compared to the other herbicide treatments. It is not surprising yields were reduced with the relatively late application of RoundupWM, in general, crops should be kept weed-free during the first four to six weeks after planting to prevent yield losses (Wood et al., 1996). During this "critical weed-free period" interference (competition+allelopathy) from weeds can have a lasting effect in terms of reducing crop growth rate (CGR), and the resulting decreased leaf area and leaf efficiency (net assimilation rate) may persist into the important yield producing reproductive stages. Weed height at the late RoundupWM application ranged from 10 to 15 inches. Although our yield loss was approximately 9%, others have found 21% lower yields when weeds were allowed to obtain a similar size (Gower et al., 2003).

All herbicide treatments controlled more than 90% of weeds. SteadfastATZ + Callisto had the highest control rating (100% control), while V7 applied Roundup WM controlled significantly (0.10 alpha) fewer weeds (91% control). Reduced weed efficacy can be attributed to the large sized weeds. The RoundupWM label recommends application no latter than four inch tall weeds, while the Illinois Agronomy Handbook (Sprague and Hagar, 2002) suggests six inches as a maximum weed height for several broadleaf weeds.

In general, most (10/11) of the corn herbicide systems evaluated in this study provided excellent weed control and similar yields. Four herbicide systems with only a single application time averaged 97% control. With timely applications and appropriate rates most commercially available corn herbicide systems produce satisfactory results.

Table 8.
Influence of corn herbicide systems on weed efficacy, grain yield, and herbicide cost for corn grown at Joliet Junior College in 2004. Herbicide costs were calculated using pricing information from WeedSOFT2004, costs include adjuvants (i.e. AM.S., COC, ect.) and application(s). The corn hybrid Dekalb DKC57-81YGRW was planted on April 20th.

Corn Herbicide System - Application Time	Application Rate	Weed Efficacy	Grain Yield	Cost
	oz (lbs) / acre	% Control	bushels/acre	$/acre
No Herbicide	—	0	143	0
Harness Xtra + Atrazine - Pre	83+12	94	207	30.17
Harness Xtra+Atrazine - Pre; Clarity+2,4-D ester - Post†	83+12; 8+8	95	204	41.87
Dual II Mag. - Pre; Callisto+Atrazine - Post	27; 3+8	98	216	48.5
Lumax - Pre	96	97	207	39.2
Harness Xtra+Atrazine - Pre; RoundupWM - Post	83+12; 21	98	205	45.42
RoundupWM - Post(V1); RoundupWM - Post(V5)	21; 21	96	218	30.5
Guardsman Max - Pre; Distinct - Post	70; (0.375)	98	207	48.24
Epic+Atrzine - Pre	(0.75)+64	97	210	36.02
CinchATZ - Pre; SteadfastATZ+Callisto - Post	24; (0.875)+2	99	204	45.42
SteadfastATZ+Callisto - Post	(0.875)+2	100	210	30.5
RoundupWM - Late Post(V7)	21	91	189	15.25
LSD (0.10)	—	4	15	—

Abbreviations: Pre=Pre-Emerge, Post=Post-Emerge, RoundupWM=Roundup Weathermax.
† Applied at corn growth stage V3-V4.

Corn Herbicides

Figure 9. An untreated (no-herbicide) control plot at V7, note the severe infestation of lambsquarter during the critical weed-free period.

Table 9.

Herbicide trade name, active ingredient, and application rate of eleven corn herbicide systems evaluated at Joliet Junior College in 2004.

Herbicide Trade Name	Active Ingredient	Application Rate
		lbs a.i.(a.e.) / acre
Harness Xtra + Atrazine	Acetochlor & Atrazine + Atrazine	2.00 & 1.62 + 0.38
Harness Xtra + Atrazine; Clarity + 2,4-D	† Acetochlor & Atrazine + Atrazine; dicamba + 2,4-D ester	2.00 & 1.62 + 0.38; 0.50 + 0.50
Dual II Magnum; Callisto + Atrazine	s-Metolachlor; Mesotrione + Atrazine	1.59; 0.09 + 0.25
Lumax	s-metolachlor & Mesotrione & Atrazine	2.01 & 0.201 & 0.75
Harness Xtra + Atrazine; RoundupWM	Acetochlor & Atrazine + Atrazine; Glyphosate	2.00 & 1.62 + 0.38; (0.75)
RoundupWM; RoundupWM	Glyphosate; Glyphosate	(0.75); (0.75)
Guardsman Max; Distinct	Dimethanamide-P & Atrazine; Diflufenzopyr	0.93 & 1.81; (0.188)
Epic + Atrazine	Isoxaflutole & Flufenacet + Atrazine	0.075 & 0.36 + 2.00
CinchATZ; SteadfastATZ + Callisto	s-metolachlor & atrazine; Nicosulfuron & Atrazine & Rimsulfuron + Mesotrione	0.45 & 0.58; 0.024 & 0.74 & 0.011 + 0.06
SteadfastATZ + Callisto	Nicosulfuron & Atrazine & Rimsulfuron + Mesotrione	0.024 & 0.74 & 0.011 + 0.06
RoundupWM	Glyphosate	(0.75)

† An acitive ingrediant followed by a "&" indicates two or more active ingrediants per trade name (pre-mix). A "+" indicates a herbicide added to the spray tank solution (tank-mix). A herbicide trade name or active ingrediant listed after a semicolon was applied in subsequent applications.

Roundup Application Time in Corn

Justification and Objective

Currently 45% percent of U.S. and 33% of Illinois corn acres are transgenic (NASS, 2004). The 1/3 of Illinois corn acres transgenic can be further broken down into 26% insect resistant, 2% stacked gene, and 5% herbicide resistant (IASS, 2004). While only 5% of Illinois corn is herbicide resistant, there is good reason to believe this figure will increase considerably in the future. Foremost, 81% of Illinois soybean in 2004 was herbicide resistant (Roundup Ready). The Roundup Ready system in soybean has been largely successful, boasting reduced production costs (Slater et. al., 2003), improved weed control (Knezevic and Cassman, 2003), and despite great concern for the appearance of resistant weed biotypes, none have been documented (Weed Science.org, 2003). In addition to the success of Roundup Ready soybean in Illinois, nationally, herbicide tolerant corn more than doubled (7 to 15%) from 1998 to 2001 (Knezevic, 2003).

An inherent management concern for postemerge herbicide systems is early-season weed competition. In general, crops should be maintained weed free for four to six weeks after planting (wood et. al., 1996). However, the optimal corn growth stage for Roundup application(s) is likely to vary with environment (Bloomberg et. al., 1982), weed species (Buhler, 1997), weed density (Hartzler, 1996), and N fertilizer usage (Knezevic et al., 2003). Our objectives were: 1) determine optimum Roundup application time, 2) determine if two applications are necessary, 3) determine if yield reductions are caused by weed competition before or after Roundup application.

Methods

Roundup weathermax (glyphosate) was applied at three corn growth stages (V3, V5, V7) at a rate of 0.75lbs a.e. per acre (21oz/acre). Velvetleaf was the dominant weed, and for corn growth stages V3, V5, and V7 maximum velvetleaf height was 1.5, 3.0, and 18 inches. For each application time (corn growth stage), a second treatment with glyphosate was applied two weeks after the initial application. Two treatments for each growth stage (6-treatments) and a weed free control made up the seven treatments included in this study. The Dekalb corn hybrid DKC53-34 was seeded at a rate of 32,000 seeds per acre on April 14th in 30-inch row spacing. Glyphosate applications were broadcast with flat fan spray nozzles (XR11004) (Spraying Systems Co.) on 20-inch spacings using a Hardy pull-type sprayer. Weed efficacy for broadleaf and grassy weeds was measured 70 days after planting, and the crop was harvested on September 21st.

Treatments: 7
Replications: 4
Planting Date: 14-April
Hybrid: Dekalb, DKC53-34 (RR+CB)
Previous Crop: Soybean
Tillage: Mulch (Spring disc)
Soil Series: Warsaw Silt Loam
Herbicides: RoundupWM @ 21oz per acre.
Insecticides: Aztec2.1G @ 6.7 ounces per 1000 feet of row.

Roundup Application Time in Corn

Results and Discussion

No significant (LSD 0.05) differences were found in corn grain yield for any of the seven treatments (page 18, table 10). Corn grown without weed competition (Weed Free) during its entire development produced yields similar to a single V3 (1.5-inch tall weeds) or V7 (18-inch tall weeds) application of RoundupWM. A single V3 application had some weeds emerge after the treatment and survive with the crop, significantly reducing weed control. Despite reduced control of both broadleaf and grassy weeds, yield was unaffected. This finding is not in agreement with Gower et. al. (2003), where weed removal at two-inch tall weeds resulted in a 7% yield loss that could be contributed entirely to weed interference after weed removal.

A single V7 glyphosate application controlled grassy weeds similar to the weed free control, however, broadleaf weed efficacy was significantly reduced (LSD 0.05). Reduced efficacy of glyphosate when applied to 18-inch tall broadleaf weeds (V7 application) is not unexpected (Sprague and Hagar, 2002). Despite heavy early-season weed competition with clearly visible plant height reductions, the V7 RoundupWM application did not suffer yield loss. Again this finding is not in agreement with Gower et. al. (2003), where 22% yield loss was attributed to early-season weed competition when weed removal was delayed until weeds reached 12 inches tall.

It is unclear why yield reductions did not occur from either early or late season weed competition, as it is well established that many crops suffer yield losses from early season weed competition (Wood et. al., 1996). Although weed density was not measured, field notes of visual assessments indicate fairly dense populations of both velvetleaf and lambsquarter by V5. Additionally, when weeds were allowed to compete to mid V7, obvious decreases in corn plant height were noted relative to the weed free control.

Table 10.
Influence of Roundup application time (corn growth stage) and number of applications on the weed control and grain yield of corn grown at Joliet Junior College in 2004. A "+" indicates a 2nd application two weeks after the initial.

Roundup Appl. Time & No. of Applications	Weed Control: Grass	Weed Control: BLW's	Grain Yield
	———— %	————	Bu./Acre
Weed Free	100	100	140
V3	91	91	148
V3+	96	98	154
V5	98	97	142
V5+	100	99	157
V7	99	83	148
V7+	100	98	147
LSD(0.05)	3	4	N/S

Tillage & Planting Dates for Corn

Justification and Objective

Optimum corn planting dates are well documented in Illinois, planting within the two week window between April 20th and May 4th usually produces optimum corn grain yields in most of Illinois (Nafziger, 2002). Tillage generally increases corn yields, although interactions with previous crop and soil water holding capacity have been recorded (Hoeft et al., 2000). Corn zero-tilled after soybean and in droughty soils can produces yields similar to tilled soils, however, monocropped corn and corn grown in soils with relatively high water holding capacity often produce higher yields with tillage. The influence tillage has on optimum corn planting date is not well known. Observations made by researchers at Purdue from long-term tillage comparisons have been that a response to tillage is more likely when planting is done in late April compared to late May (Vyn et al., 2002). In Minnesota, Randall and Vetsch (2002) found no interaction between planting date and tillage. Our objective was to determine if tillage influences optimum corn planting date.

Methods

Three planting dates and tillage systems (9 treatments) were replicated three times to determine whether tillage influences optimum corn planting date. Tillage systems were zero, strip, and mulch-tillage, mulch tillage consisted of Fall chisel-plowing followed by one Spring shallow tillage operation. Strip-tillage consisted of narrow bands (~ 10-inches wide) of Fall tillage spaced 30-inches apart where corn is to be planted. Planting dates were April 6th, April 28th, and May 27th. The corn hybrid Burrus 628BtRR was seeded at 32,000 seeds per acre and the soil insecticide Force 3G was applied in-furrow. Weed control was achieved by preplant tillage for tilled plots and burndown herbicides in strip and zero-till plots, followed by Harness Xtra+Atrazine applied preemerge and Roundup Weather Max postemerge. The nitrogen source was urea ammonium nitrate (UAN), 40 lbs N per acre applied 2X2 during planting and 80 lbs N per acre soil injected at V5. Corn was harvested October 5th.

Treatments: 9 (3 tillage systems and 3 planting dates).
Replications: 3
Planting Date: April 6th, April 28th, and May 27th.
Hybrid: Burrus 628BtRR
Previous Crop: Soybean
Tillage: Zero, Strip, and Mulch
Soil Series: Warsaw silt loam
Herbicides:
RoundupWM @ 21 ounces and 2,4-D @ 1pint per acre applied preplant (burndown) in zero and strip tillage only.
Harness Xtra5.6L + Atrazine @ 83+12oz/acre applied pre-emerge.
RoundupWM @ 21 ounces per acre applied postemerge (V3).
Insecticides:
Force3G @ 4oz/1000 ft. of row.

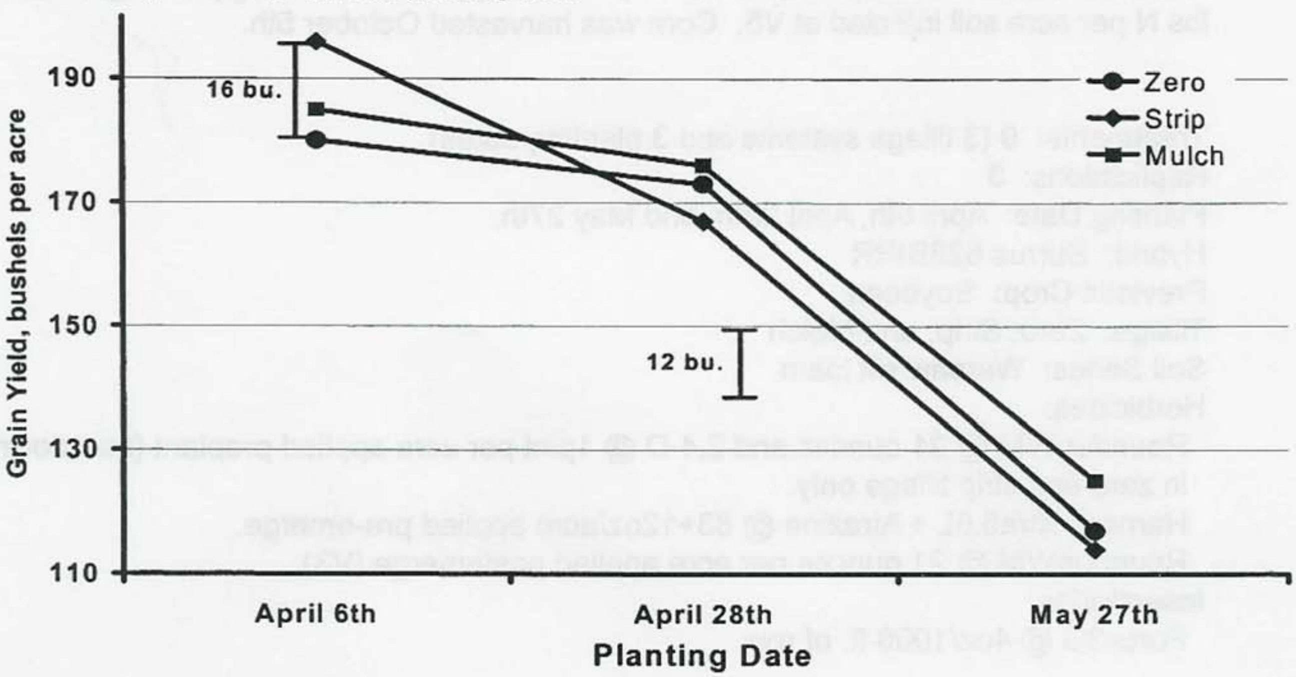
Tillage & Planting Dates for Corn

Results and Discussion

A significant (P=0.05) tillage by planting date interaction occurred as a result of a larger reduction in yield of strip tillage between April 6th and 28th when compared to the zero and mulch tillage during the same time period (page 20, figure 10). Although strip-tillage lost yield faster from April 6th to the 28th, it produced significantly higher yields than zero-tillage when planted on April 6th. Mulch-tillage, however, produced yields similar to both strip and zero tillage. At both the April 28th and May 27th planting dates no differences in yield were found due to tillage. All three tillage systems had significantly lower yields when planted on May 27th, compared to either of the earlier planting dates.

When main effects are viewed (page 21, table 11), yields can be seen to significantly increase with earlier planting dates. This finding differs from that of Nafziger (2002), where the current Illinois Agronomy Handbook shows yield reductions for corn planted in mid to early April. One possibility for this difference is the relatively warm second half of April (page 6, figure 2) at Joliet Junior College in 2004, where MGDD's were accumulated at a 42% faster rate than normal. Warmer temperatures and faster seedling development likely reduced some negative effects of early planting, such as slow and uneven emerging plants, which almost always reduce yield (Carter and Nafziger, 1989). The substantial yield reduction from late May planting is consistent with Nafziger (2002), although the magnitude is greater in this study. Tillage did not effect yield (page 21, table 11), which is consist with the findings of many others (West et al., 1996; Hoeft et al., 2000; Hoeft et al., 2002; SOILS Project, 2003).

Figure 10.
Influence of planting date and tillage system on the grain yield of corn grown at Joliet Junior College in 2004. Tillage systems are zero, strip, and mulch tillage. Tillage significantly (0.05 Alpha) influenced yield at the April 6th planting date.



Tillage & Planting Dates for Corn

Results and Discussion (continued)

Harvest populations were nearly unaffected by tillage and planting date (page 21, table 12). The May 27th planted zero and strip tillage reduced harvest populations by approximately 9%, this is surprising given that environmental conditions are usually more favorable for seedling development when planting is delayed. Although our findings indicate a significant strip-tillage advantage compared to zero-tillage for early planted corn, strip-tillage tended to produce less grain at the two latter planting dates. These data suggest tillage has a relatively small impact on corn yield, while planting date can have a large effect. This finding is similar to our results in 2003.

Table 11.
Main effects of tillage and planing date on the grain yield of corn grown at Joliet Junior College in 2004. Each tillage system was averaged over the three planting dates, and each planting date was averaged over the three tillage systems.

Main Effects			
Tillage		Planting Date	
	bu/ac		bu/ac
Mulch	162	April 6th	187
Strip	159	April 28th	172
Zero	157	May 27th	119
LSD (0.05)	N/S	LSD (0.05)	7

Table 12.
Influence of tillage and planting date on the harvest population of corn grown at Joliet Junior College in 2004.

	Tillage			
Planting	Zero	Strip	Mulch	P. Date Avg.
Date	Harvest Population			
	——- - - - plants per acre- - - - ———			
April 6th	29,833	29,944	30,945	30,241
April 28th	30,833	29,778	30,667	30,426
May 27th	26,550	26,778	29,667	27,665
Tillage Avg.	29,072	28,833	30,426	29,444

Tillage & Planting Dates for Corn

Table 13.
Growth stage of corn from three planting dates at various times throughout the growing season at Joliet Junior College in 2004. R1 attainment for the three planting dates was; 9-July, 15-July, and 3-August for April 6th, April 28th, and May 27th planting dates.

Planting	Date			
Date	27-May	16-June	25-June	8-July
	corn growth stage			
6-April	V6	V10	V14	VT
28-April	V4	V8	V11	V16
27-May	—	V4	V6	V9

Figure 11. Tillage by planting date study in corn on May 26th. Pictured below are the three planting dates (from left to right: April 6th, April 28th, and May 27th-not yet planted) in a mulch-tilled main plot.

Corn Row Spacing and Population

Justification and Objective

Optimum grain yields for corn grown in Illinois includes planting between April 20th and May 4th, and seeding to achieve 30,000 plants per acre at harvest (Nafziger, 2002). While most (>80%) Illinois corn is grown in 30-inch row spacing, equipment has been developed to plant and more noticeably harvest corn in 15-inch rows. Because we can physically manage 15-inch row corn (appropriate equipment), it begs the question as to whether or not their is an economic or yield benefit from narrowing rows. Chapter two of the Illinois Agronomy Handbook (23rd edition) summarizes a considerable amount of work to answer the above question. In six Northern Illinois environments (3 years and 2 locations) rows spaced 20 and 30 inches apart did not yield differently when optimum populations were used. However, when plant population was relatively low (10,000-25,000 ppa), 20-inch row spacing produced more grain than 30-inch rows.

Later in the 1990's row spacing and populations over nine Illinois environments were again studied, but potential hybrid differences were also evaluated. A latter maturing relatively tall hybrid produced 1 bushel per acre more (~ 1/2%) in 15-inch rows compared to 30-inch rows. However, the second hybrid (presumably with less leaf area) responded to 15-inch rows with a 6 bushel per acre increase at optimum plant populations. The difference in response to narrow rows by hybrids is probably related to differences in plant height and presumably leaf area. A goal of cropping management is to achieve 95% or more light interception prior to flowering, hybrids with reduced leaf area can more easily accomplish this goal when row spacing is reduced.

Numerous practical considerations should be included in a row spacing change. While an average 6 bushel per acre increase has been found in numerous row spacing studies located throughout the North Central US A, (Lambert and Lowenberg-DeBoer, 2003) the cost of equipment changes must be weighed with the potential increase in gross income. Our objective was to determine the effect of row spacing and harvest population on corn grain yield in a Will silty clay loam located in North Eastern Illinois.

Methods

Two row spacings (15 and 30 inch) and five seeding rates to approximate harvest populations ranging from 20 to 40 thousand plants per acre in 5,000 plant increments was planted on April 19th with a KINZE model 3000 pull-type planter. The planter was equiped with "interplant" row units that can be lowered for 15-inch row spacing, or raised for 30-inch row spacing. In an effort to obtain harvest populations of 20, 25, 30, 35, and 40 thousand plants per acre, it was attempted to seed at the above rates plus 10%. A Bt-rootworm (Bt-RW) hybrid (Crows 6W866) was used for corn rootworm larval control. The nitrogen (N) source was $(NH_4^+)_2\ SO_4^{2-}$ broadcast on the soil surface in mid-January at a rate of 130lbs N per acre. The entire experimental area was Fall chisel-plowed followed by Spring discing, twice. Weed control was achieved by a pre-emerge application of Epic at 0.75 lb per acre. Both 15 and 30 inch row spacings were harvested with a 30-inch row International Harvestor (IH) corn head on a IH 1460 combine. Random counts of ear droppage were made in both row spacings after harvest to determine the effect harvesting had on grain loss, no differences were found.

Corn Row Spacing and Population

Methods

Treatments: 10 (2-row spacings and 5-seeding rates)
Replications: 4
Planting Date: 19 April
Hybrid: Crows 6W866(Bt-RW)
Previous Crop: Corn
Tillage: Mulch
Soil Series: Will silty clay loam
Herbicides:
Epic @ 12 ounces per acre applied pre-emerge.
Insecticides: None

Figure 12. Row spacing by population study in corn on May 26th. Pictured below are the two row spacings (15 and 30 inch) at approximately V5.

May 26th

Corn Row Spacing and Population

Results and Discussion

Corn planted in 30-inch row spacing did not increase grain yield with increasing harvest population, as average harvest populations of 19,063 and 40,104 plants per acre produced similar yields (page 25, table 14). Fifteen-inch row spacing did, however, produce a significant (0.05 alpha) increase in yield to increasing population through the 29,125 plants per acre increment. At only one population (35,042) were significant differences detected between row spacings. When the two row spacings were averaged together the response to population was the same as the 15-inch row spacing, where yields plateaued at the 29,125 increment. An optimum harvest population near 30,000 plants per acre is consistent with other Illinois findings (Nafziger, 2002). Averaged over all five seeding rates, the 15-inch row spacing yielded 6 bushels per acre more than the 30-inch row spacing, which is the same response found by Lambert and Lowenberg-Deboer (2003). Analysis of variance (ANOVA) indicates a significant row spacing by population interaction (P=0.002), which resulted from a differing response to population for the two row spacings. A row spacing by population interaction is unusual, two recent studies both concluded that optimum corn population is not effected by row spacing (Farnham, 2001; Widdicombe and Thelen, 2002).

It is not clear why the 15-inch row spaced corn improved yield with increasing population while 30-inch row corn did not. Some researchers have suggested that narrow row corn may improve the consistency of corn yield. This may have been the case with our study and could have been the result of any number of factors limiting plant growth, and thus reducing yield. When yield is reduced via slow growth and decreased leaf area, narrow rows may lessen the impact.

Table 14.

Influence of harvest population and row spacing on the grain yield of corn grown at Joliet Junior College in 2004. ANOVA (P= 0.002) indicates a significant row spacing by population interaction.

Harvest‡	Average†	Row Spacing		
Population	Harvest	30"	15"	30"&15"
30"- 15"	Population	----------- Grain Yield-----------		
plants/acre	plants/acre	----- bushels per acre-----		
292	19,063	126	113	120
917	25,042	134	130	132
1,917	29,125	137	149	143
2,917	35,042	122*	147*	135
3,375	40,104	132	143	138
	LSD(0.05)	12	12	9

† Harvest population averaged over 30 and 15 inch row spacings.

‡ Increase in harvest population of 30 compared to 15-inch row spacing.

* Indicates a significant difference between row spacing at a given population level.

Corn Nitrogen Requirements

Justification and Objective

Nitrogen(N) fertilizer is usually required by corn to maximize farmer profitability. Numerous factors such as N application time (Welch, 1971), N placement (Roberts et al., 1995), use of a nitrification inhibitor (Bundy, 1986), tillage (Stecker, 1993), grain yield and previous crop (Hoeft and Peck, 2002), soil N supply (Rehm et al., 1994), and soil N loss characteristics (Smith et al., 1983) can impact corn fertilizer N requirements. In many cases either one or a number of these factors vary from field to field with changes in management and soil characteristics. Additionally, the cost of fertilizer N has increased greatly over the past several years, and currently Illinois growers may spend in excess of $40 per acre for corn N fertilization.

Economics and environmental concerns are usually at the forefront of N fertilizer considerations. During the past decade there has been increasing interest over the efficiency by which N is used. The largest zone of oxygen depleted waters in the U.S., Northern Gulf of Mexico, is often the focal point of concerns over N fertilizer use efficiency. This hypoxic area is thought by some to be partially related to or caused by an increase in nitrogen loading in the Gulf, possibly due to N fertilizer loss from Mid-Western cropland (Rabalias, 1998). Our long term objective is to characterize the response of corn grown at Joliet Junior College to N fertilization in an effort to more accurately fertilize a given set of management and soil characteristics on our farm.

Methods

Six treatments were included in this study, five nitrogen (N) fertilizer rates (40-200lbs N/acre in 40lb increments) and a no-N control. 40 lbs N per acre was applied during planting (2X2), and the balance of required N sidedressed at V5 (June 3rd). The N source was urea NH_4^+ NO_3^- (32% N) applied 2" to the side and 2" below the seed furrow for the planting portion of N, while sidedress N was injected into the soil four inches deep every 60 inches. All treatments were replicated four times and arranged in a randomized complete block design. The corn hybrid Pioneer 34M95 was planted after soybean in a zero-till system on April 20th and seeded at 32,000 seeds per acre. The corn rootworm larval insecticide Aztec2.1G was applied in-furrow and weed control was achieved by a tank mix of Roundup and 2,4-D + Dual II Magnum applied pre-emerge, followed by a post-emerge application of Callisto + Atrazine. The crop was harvested on September 30th.

Treatments: 6 (0-200 lbs N/acre in 40lb increments)
Replications: 4
Planting Date: 20 April
Hybrid: Pioneer 34M95
Previous Crop: Soybean
Tillage: Zero
Soil Series: Warsaw silt loam
Herbicides:
RoundupWM @ 11 ounces+2,4-D @ 1pint per acre applied pre-emerge.
Dual II Magnum @ 27oz per acre applied pre-emerge.
Callisto @ 3oz + Atrazine @ 8oz per acre applied post-emerge.
Insecticide: Aztec2.1G @ 6.7oz/1000 ft. of row.

Corn Nitrogen Requirements

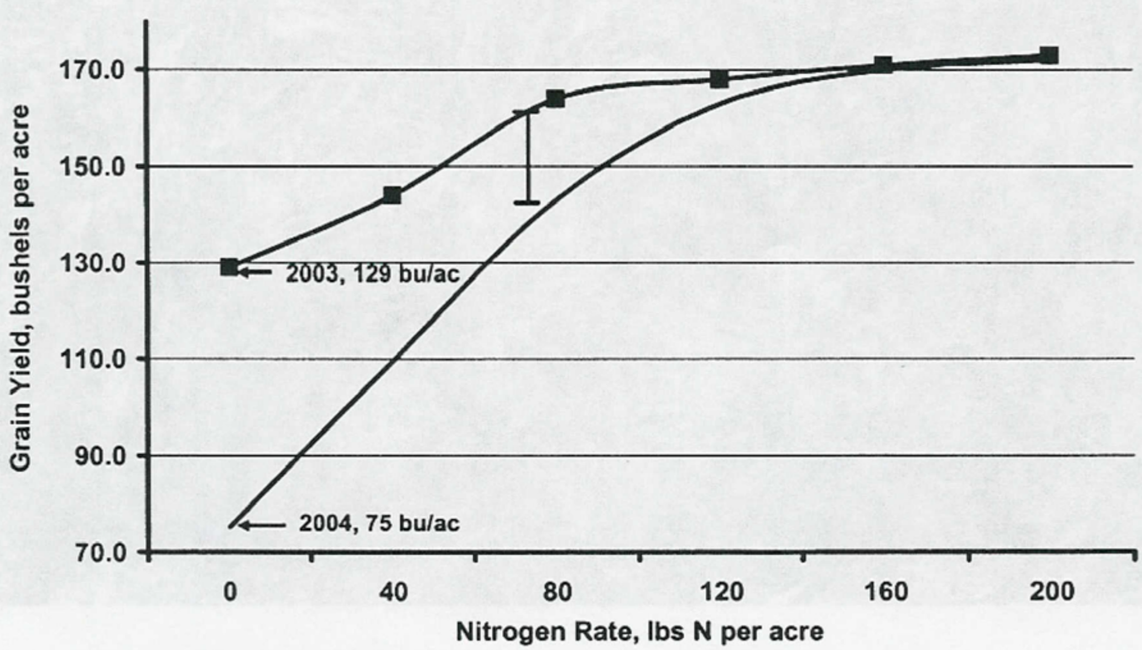
Results and Discussion

Nitrogen(N) fertilizer significantly (LSD 0.10) increased corn grain yield for each rate when compared to the zero N control (page 27, figure 13). Yields reached a statistical maximum (no significant increase from additional N) at the N rate increment of 120lbs per acre. Economically, the 160lbs N per acre increment had the greatest return for money invested in N. Pounds of N per bushel of grain at the 160lb increment, including a 40lb soybean credit, is 1.18 which is nearly identical to the N recommendations provided in the Illinois Agronomy Handbook (Hoeft and Peck, 2002). This response to N, however, is considerably different than the response found in 2003. In 2003 at Joliet Junior College the N increment most profitable was 120 lbs per acre, and lbs of N per bushel at that level was 0.83. Responses to N are known to be variable, Nafziger et al., (2004) found a range of 0.8 to 1.2 lbs N required per bushel using economic optimum N-rates and yields produced at those optima.

Figure 13 below and 15 on page 29 provide a graphical description of N response for 2003 and 2004. Analysis of variance (ANOVA) indicates a significant interaction (P= 0.01) between N-rate and year, due to differing yield responses at zero and low N-rates. Additionally, 2003 produced significantly higher yields at n rates < 80lbs per acre. The 54 bushel decrease in yield of the No-N control in 2004 compared to 2003 represents a reduction of roughly 45lbs of mineralized N per acre (No-N corn has 0.83lbs N/bu.) (Below, 1995) between the two years. The decrease in soil N supply for 2004 may be responsible for the higher fertilizer N level required to maximize net income.

N mineralization increases with increasing temperature in the range 41 to 95 degrees Fahrenheit, and in moist but not excessively wet soils (Tisdale et al., 1993). Relatively low mineralization in 2004 may have been caused by near record low mid

Figure 13.
Influence fertilizer nitrogen (N) rate on corn grain yield at Joliet Junior College in 2003 (squares) and 2004. The previous crop was soybean and zero-till was used. Yield response was significantly different (P=0.015) for years at N rates from 0 to 75lbs N per acre.



Corn Nitrogen Requirements

Figure 14. Corn grown with (left) and without (right) N fertilizer in two years (2003-top, 2004-bottom) differing greatly in the response of grain yield to N rates.

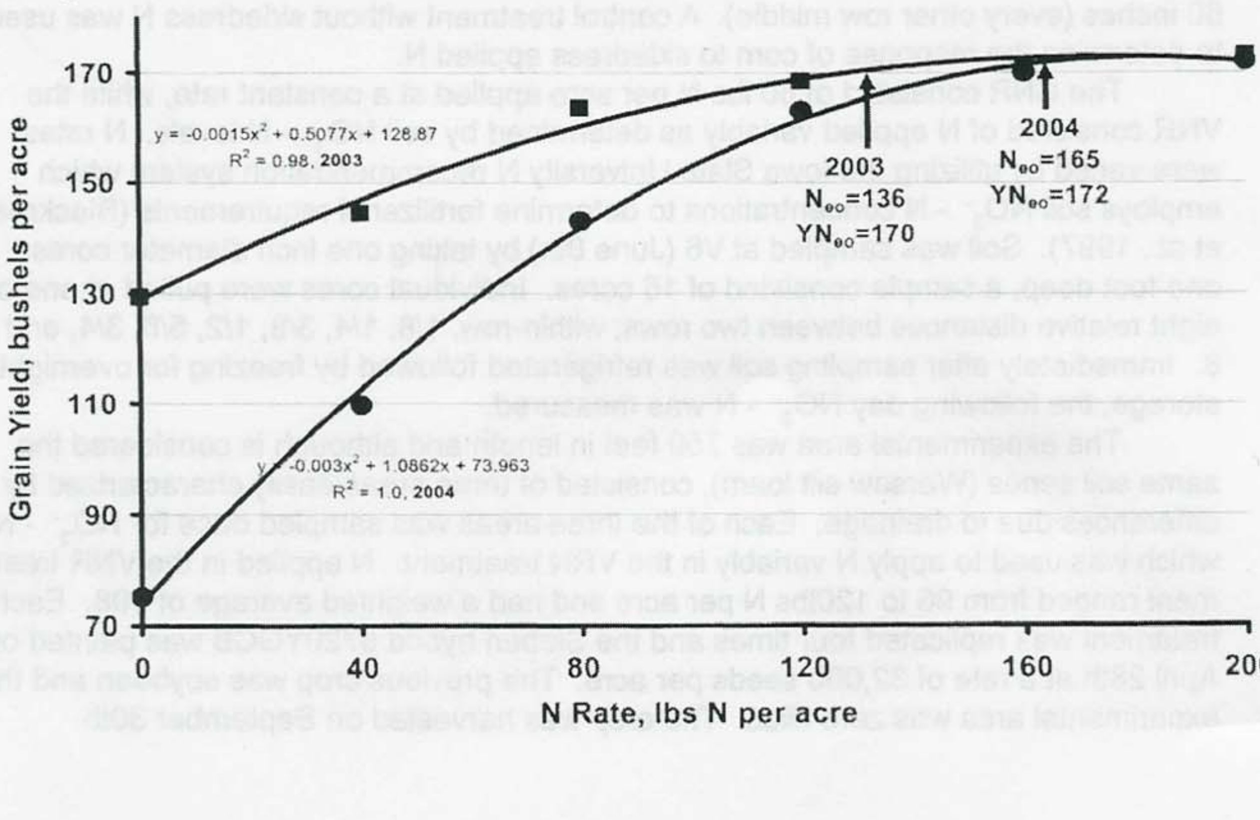
Corn Nitrogen Requirements

Table 15.
Influence of fertilizer nitrogen rate on the grain yield of corn grown at Joliet Junior College in 2004.

Nitrogen Rate	Grain Yield
lbs N/acre	bushels/acre
0	75
40	110
80	143
120	163
160†	170
200	172
LSD (0.10)	11

† Economic optimum N-rate

Figure 15.
Influence of fertilizer nitrogen (N) rate on the grain yield of corn grown at Joliet Junior College in 2003 (squares) and 2004 (circles). N economic optima (arrows) and yield at N_{eo} were calculated for both years.



Variable Rate N Application

Justification and Objective

The advent of the common use of global positioning systems has created a means for producers and commercial applicators of crop production and protection inputs to apply these inputs varied spatially, with accuracy unparalleled in the past. Naturally this has generated much excitement among agronomists, as folks involved in the production and protection of crops are continually seeking to improve the efficiency with which inputs are used. In many cases those in the fertilizer industry have not delayed in equipping themselves with the technology to apply fertilizers variably based on any number of soil or crop characteristics. Results from variably applied N fertilizer have been mixed. In Southern Illinois on a Cisne silt loam N was varied using historical corn grain yields, when compared to a constant N application method profitability was not improved (Varsa et al., 2003). However when N was variably applied using modeled corn yields profitability was improved compared to a whole-field application technique (Paz et al., 1999). Using soil NO_3^- - N levels to apply fertilizer N variably has also been used in an attempt to improve profitability, however, corn yields and optimum N rate were similar to N applied at constant rates (Eghball et al., 2003). Our objective was to determine the effect of variably applied N, compared to N applied at a constant rate, on corn yield.

Methods

Forty pounds N per acre as urea-NH_4^+ NO_3^- (32% UAN) was applied two inches to the side and two inches below the seed furrow (2X2) over the entire experimental area during planting. The two treatments that included additional N sidedressed were a constant N rate (CNR) and a variable N rate (VNR), both of which consisted of UAN surface banded in a 1-inch wide band at V8/V9 (June 16th). Sidedressing was performed with a 10 foot wide N applicator (4, 30 inch rows) and UAN was applied every 60 inches (every other row middle). A control treatment without sidedress N was used to determine the response of corn to sidedress applied N.

The CNR consisted of 80 lbs N per acre applied at a constant rate, while the VNR consisted of N applied variably as determined by soil NO_3^- - N levels. N rates were varied by utilizing the Iowa State University N recommendation system which employs soil NO_3^- - N concentrations to determine fertilizer N requirements (Blackmer et al., 1997). Soil was sampled at V6 (June 8th) by taking one inch diameter cores one foot deep, a sample consisted of 16 cores. Individual cores were pulled at one of eight relative distances between two rows; within-row, 1/8, 1/4, 3/8, 1/2, 5/8, 3/4, and 7/8. Immediately after sampling soil was refrigerated followed by freezing for overnight storage, the following day NO_3^- - N was measured.

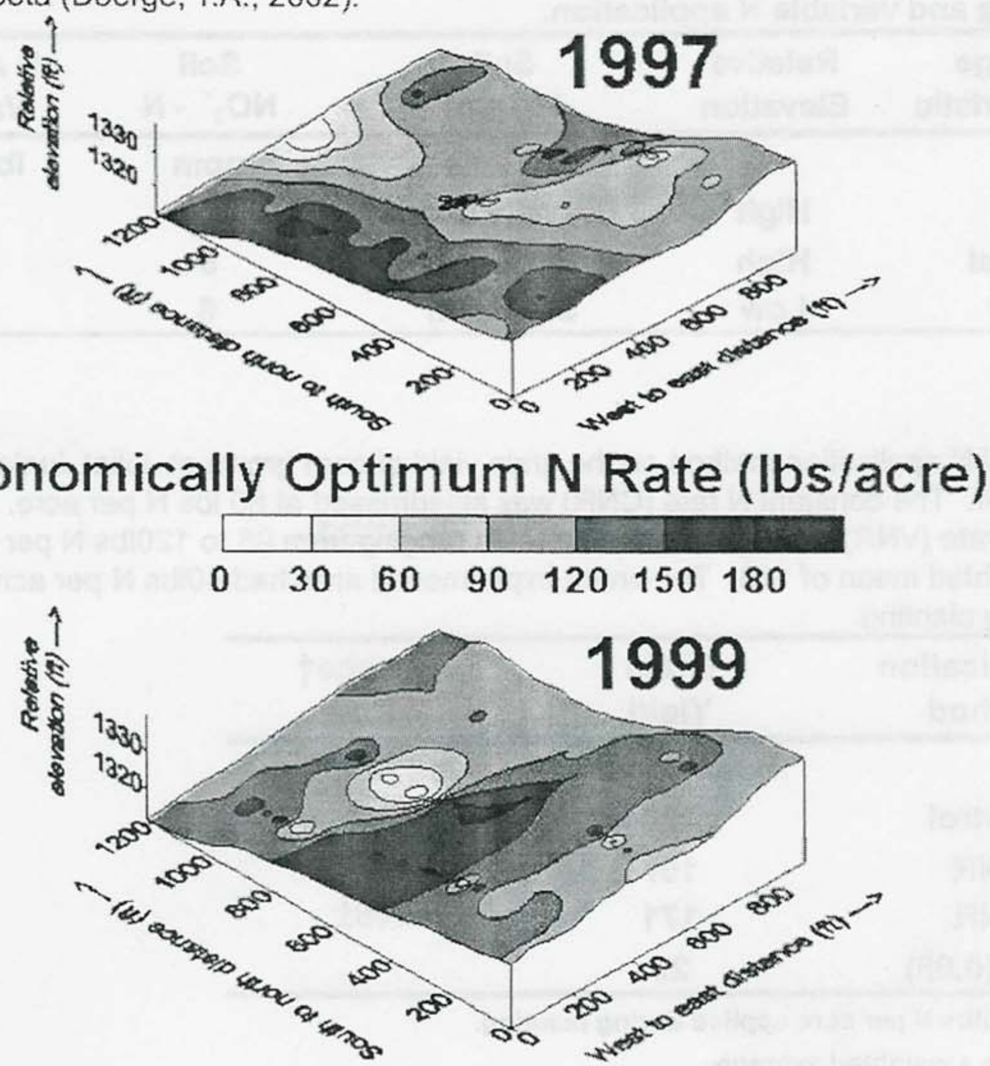
The experimental area was 750 feet in length and although is considered the same soil series (Warsaw silt loam), consisted of three areas easily characterized by differences due to drainage. Each of the three areas was sampled once for NO_3^- - N which was used to apply N variably in the VRN treatment. N applied in the VNR treatment ranged from 96 to 120lbs N per acre and had a weighted average of 108. Each treatment was replicated four times and the Sieben hybrid 6720YGCB was planted on April 28th at a rate of 32,000 seeds per acre. The previous crop was soybean and the experimental area was zero tilled. The crop was harvested on September 30th.

Variable Rate N Application

Methods

Experimental Unit Dimensions: 10' X 750'.
Treatments: 3
Replications: 4
Planting Date: 28 April
Hybrid: Sieben 6720YGCB
Previous Crop: Soybean
Tillage: Zero
Soil Series: Warsaw silt loam
Herbicides:
RoundupWM @ 11 ounces+2,4-D @ 1pint per acre applied pre-plant.
SteadfastATZ @ 0.875lbs + Callisto @ 2 oz per acre applied post-emerge (V4).
Insecticides: Aztec2.1G @ 6.7oz per 1000 feet of row.

Figure 16. Economically optimum N rates for a 30 acre field in Windom, Minesota in 1997 and 1999. Optimum N rates can vary considerably in a relatively small area, although they may not vary similarly over years. Photo from Gary Malzer, University of Minesota (Doerge, T.A., 2002).



Variable Rate N Application

Results and Discussion

Both sidedress nitrogen(N) application methods (constant N rate (CNR), variable N rate (VNR)) significantly (0.05 alpha) increased grain yield relative to the control (page 32, table 17). Although no significant difference exits between the two sidedress treatments, VNR applied N tended to produce higher yields. VNR applied N may have improved yield due to supplying more N in areas with higher requirements when compared to applying at a constant rate, or by simply applying more total N relative to the CNR treatment. The CNR method average 80lbs N per acre sidedressed, while the VNR had a weighted average of 108lbs N per acre and ranged from 96 to 120. Corn N requirements are known to vary within fields and between years (page 31, figure 16), although similar to our findings, other Illinois researchers have not found any improvement in yield or reduction in N requirements for variably applied N (Varsa et al., 2003).

Table 16.

Characteristics of the experimental area where N was applied at variable and constant rates. The area was divided into three drainage classes for soil NO_3^- - N sampling and variable N application.

Drainage Characteristic	Relative Elevation	Soil Texture	Soil NO_3^- - N	N Applied Variably
			ppm	lbs/acre
Well	High	Gravelly Loam	5	120
Normal	High	Silt Loam	8	96
Poor	Low	Silt Loam	6	112

Table 17.

Influence of N application method on the grain yield of corn grown at Joliet Junior College in 2004. The constant N rate (CNR) was sidedressed at 80 lbs N per acre. The variable N rate (VNR) was sidedressed at rates ranging from 96 to 120lbs N per acre, with a weighted mean of 108. The entire experimental area had 40lbs N per acre applied during planting.

N Application Method	Grain Yield	Average† N Rate
	bushels/acre	lbs N/acre
Control	120	40
CNR	157	120
VNR	171	148‡
LSD (0.05)	20	

† Includes 40lbs N per acre applied during planting.

‡ Represents a weighted average.

Split Versus Single Spring N Applicaitons

Justification and Objective

Corn growers often go to great lengths to "spoon feed" their crop with N fertilizer. Typically producers using sidedress applications of N believe some fraction of the crops total N requirement needs to be applied at or before planting. This thinking of supplying the crop with N before sidedress application revolves around the idea that corn grain yield is largely determined during early vegetative growth. While the potential number of ovules per plant are determined at V5 and V12, cultural practices such as fertilizer N applications have little impact on the potential for ovules to develop. Hybrid genetics, however, are almost entirely responsible for potential ovule development (Below and Brandau, 1992). Additionally, corn N requirements through the first five vegetative growth stages are no more than 5% of the crop total (Ritchie, 1993), usually less than 10 lbs N per acre. When N application time is the subject of experimentation, corn yields are unaffected by a lack of fertilizer N when applied within six weeks after planting (Reeves et al., 1993). Additionally, Scharf et al., (2002) found N applications could be delayed through V11 without reducing yield. Our objective was to determine the impact of two versus one Spring N application on the grain yield of corn when applied at planting and sidedress compared to a sidedress application.

Methods

Two treatments including timing and number of N applications were implemented to determine the effect of a single sidedress versus a planting+sidedress (split) application of N on corn yield. The split N application consisted of 40 pounds N per acre applied 2X2 during planting followed by 80 pounds N per acre sidedressed at V4. The sidedress treatment had 120 pounds N per acre applied at V4. An unfertilized control was included to determine the crops response to fertilizer N. Each treatment was replicated three times and corn was planted on April 28th. The hybrid was Dairyland Stealth 1611 planted without tillage where the previous crop was soybean. The corn rootworm larval insecticide Force3G was applied in-furrow, and the crop was harvested on October 1st.

Treatments: 3
Replications: 3
Planting Date: April 28th
Hybrid: Dairyland Stealth 1611
Previous Crop: Soybean
Tillage: Zero
Soil Series: Will silty clay loam
Herbicides:
RoundupWM @ 11 ounces and 2,4-D @ 1pint per acre applied pre-emerge.
Epic @ 12oz + Atrazine @ 2qts/acre applied pre-emerge.
Insecticides: Aztec2.1G @ 6.7oz per 1000 feet of row.

Split Versus Single Spring N Applicaitons

Results and Discussion

No significant differences (P=0.10) were detected among the three treatments. Similar to our 2003 findings, no yield increase occurred as a result of applying some N at planting in addition to sidedress. This indicates that although growers in many instances may go to some length to "spoon feed" their crop with N during seedling and early vegetative growth stages, it may be unnecessary. It is not unusual for delayed N applications to produce yields similar to early Spring. Among the many examples in the literature, a recent Missouri study indicated that N applications can be delayed as late as V11 without suffering yield losses (Scharf et al., 2002). Yields in this study are relatively low for 2004 at Joliet Junior College, as the corn hybrid demonstration averaged 169 bushels per acre. This study was located in a relatively productive area of the farm, where the previous crop was soybean. It is unclear why yields were low, but they likely contributed to the lack of fertilizer N response.

N Application Time	Grain Yield
	bushels / acre
No - N	132
Sidedress	133
Planting+Sidedress	110
LSD (0.10)	N/S

Table 18. Influence of time and number of N applications on the grain yield of corn grown at Joliet Junior College in 2004.

Figure 17. Sidedressing fertilizer nitrogen in corn.

Within-Row Spacing Variability in Corn

Justification and Objective

Considerable time and money can be spent in an effort to reduce within-row plant spacing variability in corn. For example, a grower may decide to add seed firmers/rebounders to a planter, or plant at reduced speeds to achieve a more uniform plant to plant spacing. A much more costly route would be to trade a well used but serviceable planter for a new one. In any case, efforts to improve plant spacing uniformity are likely to take time and or money. Growers however, seem to have taken interest in spacing variability by utilizing various "planter tuning" services such as Pioneer's Meter Max system.

Recent studies have differed in grain yield response to within-row spacing variability. Nielsen (2001) found a 2.5 bushel decrease in yield per inch increase in standard deviation (SD) above two inches, while Liu et al., (2004) found no effect from spacing variability. Researchers in Wisconsin found little effect on yield due to spacing variability when plants were arranged in a 2-plant pattern (Lauer and Rankin, 2004). However, when in 4 and 8-plant patterns (more hill-like) with spacing variability > 4.7 inches SD, yield was reduced 2.5 bushel per inch increase in SD. Commercial corn fields in Indiana varied from < 3 to 12 inches in SD, with nearly 1/4 of fields ranging between 6 and 12 (Nielsen, 2001). Our objective was to determine the effect of within-row spacing variability on corn grain yield in Northern Illinois.

Methods

A Roundup Ready (RR) corn hybrid (Hughes 2824RR) with a relative maturity of 100 days was seeded at a rate of 32,000 seeds per acre for the control treatment (Normal-RR). Two additonal treatments were seeded with the same RR hybrid and seeding rate used in the control, but with increasing amounts of a conventional hybrid (Hughes 2821) with similar seed size and shape. In one treatment (RR+25% Conv.) conventional seeds were added to the RR seeds at a rate of 25% of the RR seeding rate and planted at 40,000 seeds per acre. The final treatment had conventional seeds added to the RR seeds at a rate of 50% of the RR seeding rate, and planted at 48,000 seeds per acre.

At V2 the entire experimental area was sprayed with RoundupWM at 21oz per acre, "thining back" the two treatments with conventional plants to populations similar to the Normal-RR treatment (page 37, table 19). Standard deviation of within-row plant to plant spacing was determined by measuring interplant spacing of 41 adjacent plants in each of two areas of all plots. Harvest populations were determined by using the same areas where standard deviation was measured. The planter was a Kinze model 3000 pull-type manufactured in 2002, which utilizes a mechanical "finger-pickup" mechanism for seed tube delivery. The planter is retrofitted with a Yetter manufactured coulter and residue mover combination for zero-till planting. Each treatment was replicated four times and zero-tilled into a previous crop of corn on April 28th. The crop was harvested on September 23rd.

Within-Row Spacing Variability in Corn

Methods

Treatments: 3
Replications: 4
Planting Date: 28 April
Hybrid: Hughes 2824RR (100 day R.M.) and Hughes 2821.
Previous Crop: Corn
Tillage: Zero
Soil Series: Symerton silt loam
Herbicides:
RoundupWM @ 11 ounces+2,4-D @ 1pint per acre applied pre-emerge.
Epic @ 3/4lb + Atrazine @ 2qts per acre applied pre-emerge.
Insecticides: Aztec2.1G @ 6.7oz per 1000 feet of row.

Results and Discussion

No significant differences (P>0.10) in grain yield were found among the plant spacing variability treatments (page 37, table 19). Treatments did however, significantly effect spacing variability as measured by standard deviation (SD). The normal-RR (Roundup Ready) treatment had a relatively low SD, as Liu et al., (2004) reported that a standard deviation of 2.6 inches is probably as precise as a mechanical planter can seed. As increasing amounts of conventional seed were added to the RR seed, standard deviation increased. A slight reduction in harvest population occurred with the highest seeding rate (RR+50% Conv.), which may be the result of seeding at slightly less than the desired rate of 48,000 seeds per acre.

Our findings corroborate those of Liu et al., (2004), but differ from those of Nielsen (2001) who found yield reductions with increasing spacing variability at low SD's (>2 inches). Lauer and Rankin (2004) also found yield reductions due to spacing variability, but only when variability exceeded a SD of 4.7 inches. Our highest S.D. was 5.5 inches, so it is possible "statistical" yield reductions would occur with S.D.'s considerably greater than the 5.5 inches we achieved. Practically speaking though, it is difficult to imagine spacing variability much worse than that of the RR+50% Conv. treatment. Field observations and a few photographs (page 38, figures 19a and 19b), depict just how poor a stand can look with a SD of 5.5 inches. As mentioned in the justification section (previous page) 24% of Indiana farmers have spacing variability that ranges between 6 and 12 inches SD. This type of plant to plant spacing variability is likely to be the result of planters at the extreme end of misadjustment, poor maintenance, excessive speeds, or very low seed germination, or some number of these combinations.

Within-Row Spacing Variability in Corn

Table 19.

Effect of within-row plant spacing variability on harvest population, standard deviation, and grain yield of corn grown at Joliet Junior College in 2004. A roundup ready (RR) hybrid was planted at 32,000 seeds per acre in all three treatments. Additionally, a conventional hybrid (conv.) was added at 25% and 50% of the RR seeding rate, and the entire experimental area was sprayed with Roundup at V2.

Plant Spacing Variability Treatment	Harvest Population	Standard Deviation	Grain Yield
	plants/acre	inches	bu./acre
Normal-RR	31,275	2.6	157
RR+25% Conv.	29,360	4.2	145
RR+50% Conv.	28,121	5.5	148
LSD(0.10)	1,962	0.8	N/S

Figures 18. Image of the type of spacing variability seen in the RR+25% Conv. treatment. Note the two adjacenct plants (center of yardstick) that were conventional and are dead from an earlier RoundupWM application.

Within-Row Spacing Variability in Corn

Figures 19a and 19b. Images of the type of spacing variability that were found in the RR+50% Conv. treatment. Figure 19a represents an area within a row where six conventional seeds were planted adjacent to one another, while 19b shows 9 RR seeds planted adjacent to each other. Both images represent spacing variability, and such stands will increase standard deviation.

19a

19b

Planting Depth-Corn

Justification and Objective

Depth of corn planting is probably an age old question that deserves attention from time to time. Indeed, planting depth can have a direct impact on stand establishment and consequently grain yield. Under normal conditions corn should be planted 1.5 to 1.75 inches deep, or into soil moisture to a maximum of 3 inches (Nafziger, 2002). The shallower seeds are planted the faster seedlings emerge and quick emergence is beneficial for a number of reasons, such as reduced pest and herbicide injury. Shallow planting enhances seedling emergence because soils are drier and warmer, and less mesocotyl elongation is required. But shallow planting must be balanced with the need to get all seeds in soil moisture for uniform seedling emergence, as uniformity of emergence virtually always effects yield (Carter and Nafziger, 1989). Recent interest in planting depth revolves around the idea that nodal rooting depth can be increased by deep planting. Nodal rooting depth however, is not influenced by planting depth assuming planting is 1 inch or so deep, the depth that nodal roots usually occur at. Deep planted seeds simply have greater mesocotyl elongation which maintains nodal root depth around 1 inch (Ritchie and Hanway, 1993). Our objective was to determine the impact of planting depth on harvest population and corn grain yield.

Methods

The corn hybrid Wyfells W3164P was seeded at three soil depths, 0.75, 1.5, and 3.0 inches on April 28th at a seeding rate of 32,000 seeds per acre. Treatments were replicated three times. The planter was a Kinze model 3000 manufactured in 2002, and retrofitted with a Yetter manufactured coulter and residue mover combination for zero-till planting. Corn rootworm larval insecticide was Aztec2.1G, and weeds were controlled with SteadfastATZ. Harvest population was measured at maturity, and the crop was harvested on September 30th.

Methods

Treatments: 3
Replications: 3
Planting Date: 28 April
Hybrid: Wyfells W3164P
Previous Crop: Soybean
Tillage: Zero
Soil Series: Warsaw silt loam
Herbicides:
RoundupWM @ 11 ounces and 2,4-D @ 1pint per acre applied pre-plant.
SteadfastATZ @ 0.875lbs + Callisto @ 2oz per acre applied post-emerge (V4).
Insecticides: Aztec2.1G @ 6.7oz per 1000 feet of row.

Planting Depth-Corn

Results and Discussion

No significant differences ($P>0.05$) were found for the three planting depths and harvest populations (page 40, table 20). The shallowest depth (0.75") averaged lower harvest populations and grain yield when compared to corn seeded at 1.5 and 3.0 inches. A good stand accompanied the 3.0 inch planting depth, which was surprising given that deep planting often results in a reduced stand (Nafziger, 2002). Observations of the crop did not suggest any large differences in rate of emergence or seedling vigor. It is possible one reason for the lack of injury to seedlings or reduced stand is the herbicide program used. No soil applied seedling shoot and root inhibitor (Chloroacetamides and Oxyacetamides) was applied for grassy weed control, instead, SteadfastATZ with nicosulfuron applied post was used for the control of grassy weeds. The seedling shoot and root inhibitors are known to injure emerging corn seedlings, especially slow emerging plants.

Table 20.

Influence of planting depth on harvest population and grain yield of corn grown at Joliet Junior College in 2004.

Planting Depth	Harvest Population	Grain Yield
—inches—	plants/acre	bushels/acre
0.75	26,700	144
1.50	30,367	149
3.00	30,100	152
LSD (0.05)	N/S	N/S

Soil Compaction

Justification and Objective

As the size of farms increase and the size of equipment required to seed and harvest crops on a timely basis also increases, soil compaction becomes a greater concern for crop producers. Soil compaction is defined as a process of "rearrangement of soil particles to decrease pore space and increase bulk density" (Singer and Munns, 1987). The reduction in soil porosity from compaction is at the expense of larger pores (macropores), creating a soil with a greater proportion of smaller pores (micropores) (Wolkowski, 1990). Macropores are crucial for soil internal drainage (percolation) and when soil is compacted the remaining pore space has a higher percentage of water. The increase in water retention associated with compacted soils results in a more anaerobic environment which increases N losses through denitrification and reduces root growth. Soil compaction caused by heavy wheel traffic has been found to reduce corn grain yield (Wolkowski and Bundy, 1990). Our objective was to determine the impact of soil compaction caused by excessive wheel traffic on corn grain yield.

Methods

Soil compacted and non-compacted treatments were established in the Spring of 2002 to determine the effects of soil compaction over several years on corn and soybean yields. The compacted treatment consists of soil compacted twice during April of 2002, once during April of 2003, and twice during April 2004. Soil was compacted before planting by excessive wheel traffic when relatively wet (too wet for Spring tillage and planting operations) but not saturated. No ruts were created during the soil compaction process. A John Deere 4020 with 200 gallons of water carried primarily on the rear axle (3-point hitch) was driven at 3mph over the compacted plots so that the tractor "footprint" was run over the entire soil surface. The corn hybrid LG 258 (YGRW) was planted zero-till at 32,000 seeds per acre. The crop was harvested on October 7th.

Treatments: 2
Replications: 3
Planting Date: April 28th
Cultivar: LG 258 (YGRW)
Previous Crop: Soybean
Tillage: Zero
Soil Series: Warsaw silt loam
Herbicides:
RoundupWM @ 11 ounces + 2,4-D @ 1pint per acre applied preemerge.
Epic @ 0.75lbs + Artrazine @ 2qts per acre applied preemerge.
Insecticides: None

Soil Compaction

Results & Discussion

Soil compaction did not significantly (P>0.10) effect corn grain yield. When observations were made throughout the growing season of the compacted and non-compacted (control) plots, no visual effect was noted. On March 30th and September 1st 2004, resistance to penetration (penetrometer) was measured at various soil depths (page 43, figure 22). Prior to compacting in 2004, little difference in resistance to penetration existed between compacted and control plots. However, at the end of the growing season (September 1st) relatively large differences existed at the three and six inch soil depths. It is interesting to note the increase in soil "resistance" from March to September in the control treatment. This study will be continued in the same location for the foreseeable future in a corn soybean rotation with annual wheel traffic compaction in the same experimental units (plots). It is hoped that this work will provide a good indication of long-term annual soil compaction on crop productivity.

Table 20.

Effect of soil compaction on the grain yield of corn grown at Joliet Junior College in 2004.

Soil Compaction	Grain Yield
	bushels/acre
Control	190
Compacted	190
LSD (0.10)	N/S

Figure 21. Effect of compacted soil on corn root distribution. Note the horizontal and shallow growth of roots in the compacted soil (A) compared to the non-compacted (B).

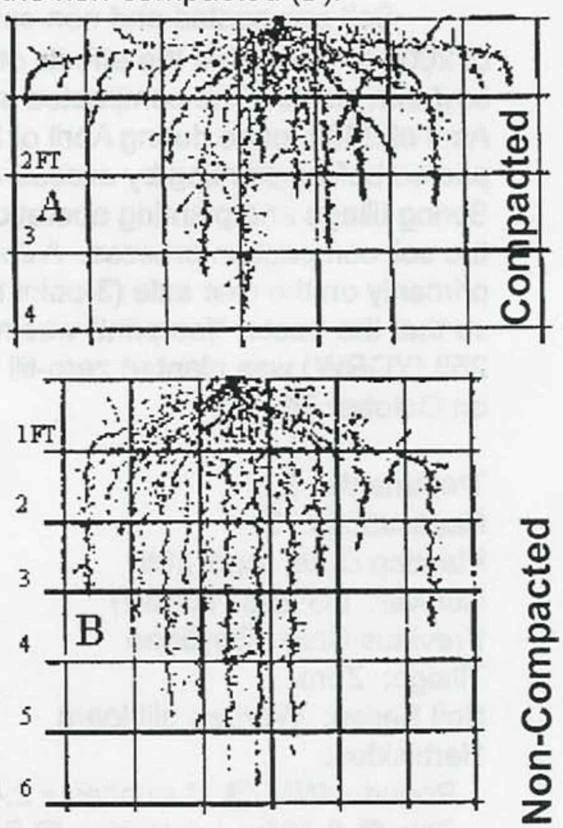


Table 21.

Effect of soil compaction on resistance to penetration (penetrometer) at two dates in 2004 at Joliet Junior College. Soil was compacted twice in April 2004, once in 2003, and twice in 2002. Data are the average of several sampling depths.

Soil Compaction	March 30th	Sept. 1st
	Resistance to Penetration -lbs / inch^2-	
Control	139	161
Compacted	147	196
P=	0.05	0.11

Soil Compaction

Figure. 22

Effect of soil compaction on resistance to penetration (penetrometer) at various soil depths sampled on March 30th (squares) and September 1st (cirles), 2004 at Joliet Junior College. Soil was compacted twice in April 2002, once in April 2003, and twice in April 2004 when soil was wet, but less than field capacity. "*" indicates significance at P≤ 0.05.

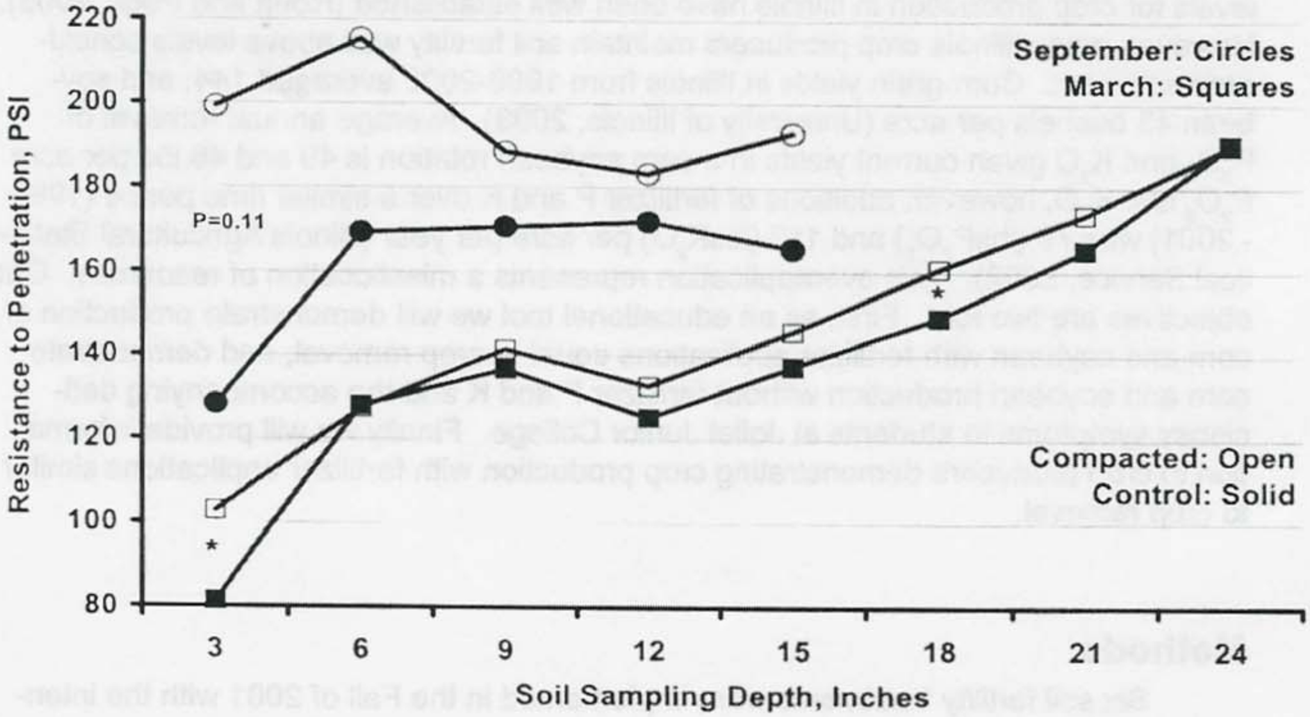
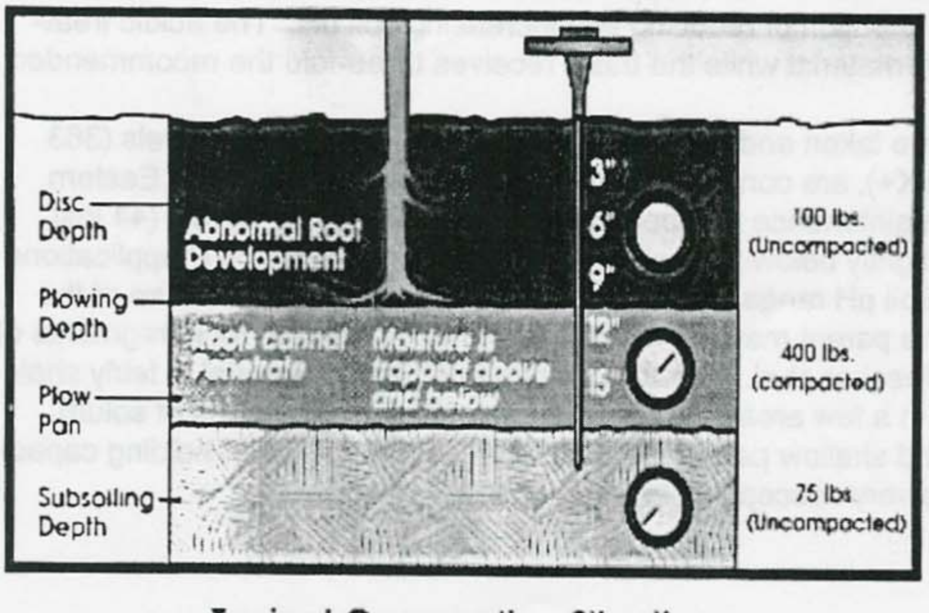


Figure 23. A typical soil compaction situation caused by continuous use of a moldboard plow. Note the center layer requiring very high pressure for penetration.



Typical Compaction Situation

Soil Fertility-Corn

Justification and Objective

Optimum soil phosphorous (P), potassium (K), and acidity levels are critical for corn and soybean production in the Mid-Western United States. Soil P and K, and pH levels for crop production in Illinois have been well established (Hoeft and Peck, 2002). However, many Illinois crop producers maintain soil fertility well above levels considered sufficient. Corn grain yields in Illinois from 1998-2002 averaged 144, and soybean 43 bushels per acre (University of Illinois, 2003). Average annual removal of P_2O_5 and K_2O given current yields in a corn soybean rotation is 49 and 48 lbs per acre P_2O_5 and K_2O, however, additions of fertilizer P and K over a similar time period (1998 - 2001) was 76 (lbsP_2O_5) and 112 (lbsK_2O) per acre per year (Illinois Agricultural Statistical Service, 2002). This overapplication represents a misallocation of resources. Our objectives are two fold. First, as an educational tool we will demonstrate production of corn and soybean with fertilizer applications equal to crop removal, and demonstrate corn and soybean production without fertilizer P and K and the accompanying deficiency symptoms to students at Joliet Junior College. Finally we will provide information to crop producers demonstrating crop production with fertilizer applications similar to crop removal.

Methods

Six soil fertility treatments were implemented in the Fall of 2001 with the intention of maintaining them for long-term evaluation. The 2004 crop is the third harvested since the study was implemented. The normal treatment consists of a typical soil fertility program for row crops in Illinois which includes soil pH maintained between 6.0 to 6.5 and annual applications of maintenance fertilizer P and K. Two additional treatments are similar to the normal but are missing either maintenance P or maintenance K, and a fourth treatment has no P or K applications. The fifth and sixth treatments were included with the intention of reducing and increasing soil pH. The acidic treatment receives no liming material while the basic receives three-fold the recommended lime.

Soil samples were taken and analyzed in the Fall of 2001. Soil K levels (363 lbs/acre exchangeable K+), are considered sufficient for row crops in North Eastern Illinois, requiring only maintenance K (Hoeft and Peck, 2002). Soil P levels (44 lbs/acre available P) are slightly below the point at which only maintenance P applications would be necessary. Soil pH ranges from 5.9 to 7.4, somewhat high because of the calcareous nature of the parent material which is a loamy gravel with rock fragments of dolomitic limestone (Wascher et al., 1962). The depth to parent material is fairly shallow (2 to 3.5 feet) and in a few areas may only be covered with 15 inches of solum. The course textured and shallow parent material reduces the soil water holding capacity and makes the crop very susceptible to water stress.

Soil Fertility-Corn

Methods

Treatments: 6
Replications: 2
Planting Date: 28 April
Hybrid: Great Lakes 5377RW (YGRW)
Previous Crop: Soybean
Tillage: Zero
Soil Series: Will silty clay loam
Herbicides:
RoundupWM @ 11 ounces and 2,4-D @ 1pint per acre applied pre-emerge.
Epic @ 0.75lbs + Atrazine @ 2qts per acre applied pre-emerge.
Insecticides: None

Results and Discussion

No significant $P>0.05$ differences in grain yield were found among the six soil fertility treatments (page 45, figure 24). For the third year in a row (Corn-Soybean-Corn) no effect due to a lack of P or K, or pH maintenance has been found. Field notes of observations made throughout the growing season indicate no visual symptoms of mineral nutrient deficiency. Treatments of this study were begun in the Fall of 2001, three crops have been produced with the current soil fertility regimes and it is thought that over time differences between treatments will occur.

Table 24.
Influence of soil fertility treatments on the grain yield of corn grown at Joliet Junior College in 2004.

Soil Fertility Treatment	Grain Yield
	bushels/acre
Normal	158
Basic	161
Acidic	164
No-P	153
No-K	156
No-P or K	153
LSD (0.05)	N/S

Corn Hybrids

Justification and Objective

Numerous corn hybrids are available to corn producers in the Mid-Western United States. In 2002 Illinois corn growers spent an average of $36 dollars per acre acquiring seed from dozens of hybrid seed corn companies (University of Illinois, Dept. of Agriculture and Consumer Economics, 2002). Our objective is to aid corn growers in making hybrid selections most suitable to their operations, and demonstrate to JJC students the large variety of hybrids currently offered in today's market.

Methods

Fifty-seven corn hybrids were planted on April 27th at a rate of 32,000 seeds per acre with a model 3000 Kinze planter which uses a finger-type seed pickup and drop mechanism. After each hybrid was planted leftover seeds were vacuumed out of the seed box and finger pickup mechanism. The corn rootworm larval insecticide Fortress15G was applied in-furrow during planting to all hybrids not transgenic with *Bacillus thuringiensis* (Bt) for corn rootworm (Bt-RW). The check hybrid (Pioneer 34H31) was entered six times and separated by 10 hybrid entries (100 feet) throughout the entire demonstration area. Each hybrid was evaluated on a relative scale by comparing it to the nearest check, which was never more than 5 entries (50 feet) away. Corn was harvested with a International Harvester 1460 combine, and weighed with a weigh wagon. The demonstration area was zero-tilled into a previous crop of soybean.

Hybrids: 57
Replications: Unreplicated demonstration
Planting Date: 27 April
Hybrid: Many
Previous Crop: Soybean
Tillage: Zero
Soil Series: Warsaw silt loam
Herbicides:
RoundupWM @ 11 ounces and 2,4-D @ 1pint per acre applied preemerge.
Dual II Magnum @ 27oz per acre applied preemerge.
Callisto @ 3oz + Atrazine @ 12oz per acre applied postemerge.
Insecticides: Fortress15G @ 7.35oz / 1000 ft. of row, except Bt-RW hybrids.

Results and Discussion

The 57 corn hybrids had an average grain yield of 169 bushels per acre, which is the second highest yield produced in the history of the JJC farm. Yield of the 2004 corn crop is only surpassed by 2003, when 189 bushels per acre were produced. Yields ranged 56 bushels per acre from a low of 145 to a high of 201. Relative yields of the non-check entries averaged 102% and ranged from 90 to 117 percent of the check (page 47, table 25). A two year average was calculated when possible, and yields ranged from 199 to 164, with an average of 177 bushels per acre. Thirty-nine (69%) hybrids were transgenic Bt, 14 of those were Bt-RW while the balance was Bt-CB. Bt hybrids averaged 168 bushels per acre, while non-Bt hybrids were 170.

Corn Hybrids

Table 25a.

Demonstration of the grain moisture, grain yield, and relative yield of 57 corn hybrids grown at Joliet Junior College in 2004. The two year average grain yield includes 2003 and 2004. The check hybrid Pioneer 34H31 (bold font) averaged 164 bushels per acre and was entered six times and seperated by 10 entries. The hybrid with the highest relative yield is underlined, and the average yield of all hybrids is 169 bushels per acre.

Company Name	Hybrid Nomenclature	Transgenic Trait†	Seed Treatment	Relative Maturity	Grain Moisture	Grain Yield	Relative‡ Yield	Grain Yield 2-Yr Avg
				- days-	- %-	Bu. / Acre	- %-	Bu. / Acre
Dekalb	DKC54-51	Bt-CB	Poncho 250		18.7	186	102	
Burrus	628BtRR	Bt-CB + RR	Poncho 250	112	22.9	186	102	185
Great Lakes	5377RW	Bt-RW	Gaucho	103	21.8	184	101	
Stone Seed Co.	HC7B404YGCB	Bt-CB	----	111	23.1	201	110	
Adler	2700	----	----	109	23	181	99	
Pioneer	**34H31**	**----**	**----**	**109**	**21.8**	**183**	**100**	**164**
Wyffels	W4829	Bt-CB	----	106	20.9	172	94	
Gro-Tech	H790	----	Poncho 250	110	25.3	199	109	199
Croplan	610	----	Cruiser	109	22.7	179	98	
Pioneer	34M95	Bt-CB	----	110	22	175	96	180
Hughes	7101	----	----	114	24	183	100	
Becks	5627	----	----	111	27.3	177	102	
Ag Venture	AV696RW	Bt-RW	Poncho 250		23.2	175	101	180
Crows	7W057	Bt-RW	Cruiser	110	25.9	183	105	
Dairyland Seed	4515	Bt-RW	Poncho 250	113	26.2	168	97	
NK	N70-T9	Bt-CB+LL	Cruiser		27.9	179	103	
Pioneer	**34H31**	**----**	**----**	**109**	**21.3**	**174**	**100**	**164**
Golden Harvest	H8673Bt	Bt-CB	Poncho 250	108	19.6	169	97	
Sieben	3683YGRW	Bt-RW	Poncho 250	108	18.1	177	102	
Cornelius	C590YG	Bt-CB	----	110	19.1	177	102	185
Dekalb	DKC61-45	Bt-CB+RR	Poncho 250		25.3	180	103	
Wyffels	W3164	Bt-RW	Poncho 250	103	19.3	157	90	
Great Lakes	5961RW	Bt-RW	Gaucho	109	21.3	182	112	190
Garst	8424	----	----		23.2	169	104	
FS	4042Bt	Bt-CB	----	99	16.4	154	95	177
Gro-Tech	H795YGCB	Bt-CB	Poncho 250	110	22.8	177	109	
Hughes	4133	Bt-CB	----	105	20.4	167	103	
Pioneer	**34H31**	**----**	**----**	**109**	**19.7**	**162**	**100**	**164**

† Transgenic traits are: Bt(Bacillus thuringiensis) insecticidal proteins with activity on European Corn Borer(CB), Corn Rootworm(RW), and herbicide tolerant corn with tolerance to glyphosate(RR) and glufosinate(LL).

‡ Relative yield was calculated by dividing the grain yield of a given hybrid (numerator) with the grain yield of the nearest check (denominator) and multiplying by 100.

Corn Hybrids

Table 25b.

Demonstration of the grain moisture, grain yield, and relative yield of 57 corn hybrids grown at Joliet Junior College in 2004. The two year average grain yield includes 2003 and 2004. The check hybrid Pioneer 34H31 (bold font) averaged 164 bushels per acre and was entered six times and seperated by 10 entries. The hybrid with the highest relative yield is underlined, and the average yield of all hybrids is 169 bushels per acre.

Company Name	Hybrid Nomenclature	Transgenic Trait†	Seed Treatment	Relative Maturity	Grain Moisture	Grain Yield	Relative‡ Yield	Grain Yield 2-Yr Avg
				- days-	- %-	Bu. / Acre	- %-	Bu. / Acre
Burrus	576	- - - -	Poncho 250	111	22.5	156	96	
LG	2540	- - - -	- - - -	108	22.2	169	104	
Dairyland Seed	1611	- - - -	Poncho 250	109	23.8	162	100	180
Gro-Tech	H720YGRW	Bt-RW	Poncho 250	112	25.3	165	102	
Garst	8566YG1	Bt-CB	Poncho 250	109	22.4	161	99	182
Cornelius	C635YG	Bt-CB		112	23.8	161	99	180
Sieben	6720YGCB	Bt-CB	Poncho 250	112	27.5	149	91	169
Wyffels	W5541	- - - -	- - - -	109	23.7	163	94	176
Fielders Choice	7728BP	- - - -	Poncho 250	112	24.6	186	108	194
Adler	2525YGCB	Bt-CB	- - - -	107	21.8	169	98	
Pioneer	**34H31**	- - - -	- - - -	**109**	**21.7**	**173**	**100**	**164**
Golden Harvest	H9196RW	Bt-RW	Poncho 250		24.2	172	99	
Garst	8450IT	- - - -	Poncho 1250	111	27.7	181	105	
Burrus	636	Bt-RW	Poncho 250	108	24.4	162	94	
FS	6473	- - - -	- - - -	111	23.2	180	104	
Hughes	5743	Bt-CB	- - - -	108	22.7	173	100	
Dairyland Seed	1507	Bt-CB	Poncho 250	107	21.5	163	109	
Pioneer	35Y55	Bt-CB	- - - -	106	18.9	171	114	
Becks	5228CB	Bt-CB	Poncho 250		19.6	165	110	
Ag Venture	AV783CB	Bt-CB	- - - -		22.2	147	98	177
Pioneer	**34H31**	- - - -	- - - -	**109**	**20.4**	**150**	**100**	**164**
Crows	7W402	Bt-RW	Cruiser	112	23.7	158	105	
Diaryland Seed	5611	- - - -	Poncho 250	110	22.4	175	117	
Croplan	501	Bt-CB+RR	Cruiser		18.2	159	106	
Sieben	6693YGCB	Bt-CB	Poncho 250	112	20.8	166	111	
Stone Seed Co.	7J522	Bt-RW+RR	Poncho 250	109	20.6	172	115	
Dekalb	DKC60-19	Bt-CB+RR	Poncho 250	110	23.8	160	112	
Pioneer	33P67	Bt-CB	- - - -	114	24.3	153	107	172
Gro-Tech	H675YGCB	Bt-CB	Poncho 250		21	145	101	
LG	2585RWSK	Bt-RW	Poncho 250	111	20.9	154	108	
Burrus	442	- - - -	- - - -	108	23.6	148	103	
Pioneer	**34H31**	- - - -	- - - -	**109**	**19.1**	**143**	**100**	**164**
Great Lakes	5961RW	Bt-RW	Gaucho	109	19.5	150	105	174
All Hybrids	Average			109	22	169	102	177

† Transgenic traits are: Bt(Bacillus thuringiensis) insecticidal proteins with activity on European Corn Borer(CB), Corn Rootworm(RW), and herbicide tolerant corn with tolerance to glyphosate(RR) and glufosinate(LL).

‡ Relative yield was calculated by dividing the grain yield of a given hybrid (numerator) with the grain yield of the nearest check (denominator) and multiplying by 100.

Soybean Row Spacing and Population

Justification and Objective

During the mid to late 1990's Illinois soybean planted in row spacings between 10 to 19 inches was increasing while spacings between 29 to 35 inches were declining (Adee and Pepper, 2000). By 1998 soybean acreages in both categories were similar and combined to make up nearly half of the Illinois soybean crop. Soybean row spacing influences canopy light interception which becomes critical in determining seed yield during seed set (R3 - R5) (Andrade et al., 2002). Generally there are small increases in soybean yield as row spacing narrows below that of the traditional 30 inch spacing, and the benefit from reduced row spacing is maximized at row widths of 15 to 20 inches wide (Pepper, 2000). Since light interception during the R3 through R5 growth stages is critical for maximum seed yield, cultural practices that enhance canopy closure before seed set generally increase yield. Practices that enhance canopy closure are; early to normal planting dates, planting late season cultivars, and avoiding double cropping. Soybean plant densities greater than 150,000 plants per acre rarely increase seed yield in Illinois (Nafziger, 2002a). However, practices that delay canopy closure during early reproductive growth are scenarios likely to respond to populations greater than 150,000 plants per acre. Our objectives were to determine the impact of row spacing and harvest populations on the seed yield of soybean, and demonstrate these effects to students at Joliet Junior College.

Methods

Four target seeding rates (75, 125, 175, and 225 thousand seeds per acre*1.2) and two row spacings (15 and 30 inches) were planted on May 11th to determine the effect of both variables on soybean seed yield. Planting was accomplished with a kinze model 3000 planter using wavy colters for residue cutting in the zero-till environment. Weed control was accomplished with a Fall burndown that included herbicides with soil residual activity, followed by a postemerge application of Extreme. Excellent weed control was accomplished irrespective of row spacing or seeding rate. The crop was harvested in late October.

Treatments: 8
Replications: 4
Planting Date: 11 May
Soybean Cultivar: Pioneer 92M70
Previous Crop: Corn
Tillage: Zero
Soil Series: Symerton silt loam
Herbicides:
CanopyXL@2.5ounces+Express@0.10ounces+2,4-D@1pint per acre applied Fall preplant.
Extreme @ 48 ounces per acre applied postemerge (V2).
Insecticides: None

Soybean Row Spacing and Population

Results and Discussion

Both 15 (narrow) and 30 (wide) inch row spacings responded similarly to increasing soybean harvest populations. When averaged over both row spacings, yields were maximized at the 167,000 plants per acre increment (page 50, table 26). The 15 inch row spacing significantly (P=0.029) increased seed yield compared to soybean grown in the 30 inch rows when averaged over all harvest populations (15 inch rows 6 bu. /acre >30 inch rows). At each harvest population, soybean grown in 15 inch rows produced higher yields than 30 inch rows. Response to harvest population typically plateaus near 150,000 plants per acre in Illinois (Nafziger, 2002a). However, our results from the previous two years clearly indicate no yield improvement for populations greater than 75,000 plants per acre. A consistent response at Joliet Junior College for the past three years has been for narrow row soybean to produce higher yields than wide rows (2002, 3 bu/ac; 2003, 3bu/ac; and 2004, 6bu/ac). The narrow row yield advantage is consistent with findings of numerous soybean row spacings studies conducted throughout the North-Central U.S. (Dayton and Lowenberg-DeBoer, 2003).

Table 26.

Influence of row spacing and harvest population on the grain yield of soybean grown at Joliet Junior College in 2004. There is no significant interaction (P> 0.05) between row spacing and harvest population. Averaged over all seeding rates, 15" rows produced a significantly higher yield (6 bushels per acre) than 30" row spacings.

Harvest‡ Population 30"- 15"	Average† Harvest Population	Row Spacing 30"	15"	30" & 15"
		Grain Yield		
- - plants per acre- -		- - - - bushels per acre- - - -		
-1,750	74,000	51	54	52
-11,500	121,000	52	59	56
19,000	167,000	56	63	59
38,750	203,000	56	62	59
	LSD(0.05)	5	5	3

† Harvest population averaged over 30 and 15 inch row spacings.

‡ Difference in harvest population of 30 compared to 15 inch rows at each of the four populations.

Soybean Row Spacing and Population

Figure 22. Soybean planted at 175,000 (156,000 harvest population) seeds per acre and grown in 30 (top) and 15 (bottom) inch rows.

Tillage & Planting Date for Soybean

Justification and Objective

With modern farm equipment, numerous tillage systems are available for successful soybean production. Tillage types range from zero to clean tillage, with varying degrees of full-width tillage (entire soil surface is tilled) that vary by amount of crop residue remaining on the soil surface after planting. Ridge and Strip tillage systems both require soybean to be planted in 30 inch rows to take advantage of tillage and drainage benefits of these within-row tillage systems. The Conservation Technology Information Center (CTIC) reports that soybean is zero-tilled on 37%, mulch-tilled on 27%, and conventionally tilled (moldboard plow) on 17% of Midwestern soybean acres (CTIC, 2004). The three tillage systems listed above represent 71% of Midwestern soybean, with much of the balance considered reduced tillage (15 to 30% residue cover after planting.

Zero-till is defined as no tillage operations prior to planting, mulch-till is full width tillage with ≥ 30% residue cover after planting, and conventional tillage or moldboard plowing having little or no crop residue on the surface after planting. On average, tillage probably has little effect on soybean seed yield, however, soil productivity (water holding capacity) has been shown to be a good indicator of wether zero or full width tillage will produce a higher yield (Hoeft et al., 2000a). Optimum soybean planting date in Illinois has been found to range over a four week period that begins in late April and ends in late May (Nafziger, 2002a). Our objective is to determine the influence of tillage on optimum soybean planting date.

Methods

Three tillage systems (Zero, Chisel/Mulch, and Plow/Conventional) and three planting dates (April 13, May 5th and 28th) were selected to determine optimum soybean planting date in three tillage systems. Moldboard plowing was done in the Spring, followed by two shallow tillage operations with a disc. Chisel plowing was performed in the Fall, followed by two shallow tillage passes with a disc in the Spring. Zero-till had no tillage performed at any time, but for preplant (burndown) weed control CanopyXL, Express, and 2,4-D were Fall applied. The soybean cultivar Sieben 2806NRR was planted in 15 inch rows at a rate of 175,000 seeds per acre, and the average harvest population was 146,000 plants per acre (page 55, table 28). All tillage systems were planted on the same day for a given planting date. In tilled plots preplant weed control was accomplished with tillage, and Roundup WeatherMax was applied postemerge at 21oz per acre over the entire experimental area. Plant population was measured at maturity, and seed yield by machine harvest in late October.

Tillage & Planting Date for Soybean

Methods

Treatments: 9
Replications: 3
Planting Date: April 13th, May 5th, May 28th.
Soybean Cultivar: Sieben 2806NRR
Previous Crop: Corn
Tillage: Zero, Mulch, and Plow.
Soil Series: Symerton silt loam
Herbicides:
CanopyXL@2.5ounces+Express@0.10ounces+2,4-D@1pint per acre applied Fall pre-plant, for zero-till only.
RoundupWM @21 ounces per acre applied post-emerge (V2).
Insecticides: None

Figure 23. Soybean on June 21st, 2004 in a plowed plot. Left half was planted on April 13th, while right half was planted on May 5th. Far right was planted on May 28th.

Tillage & Planting Date for Soybean

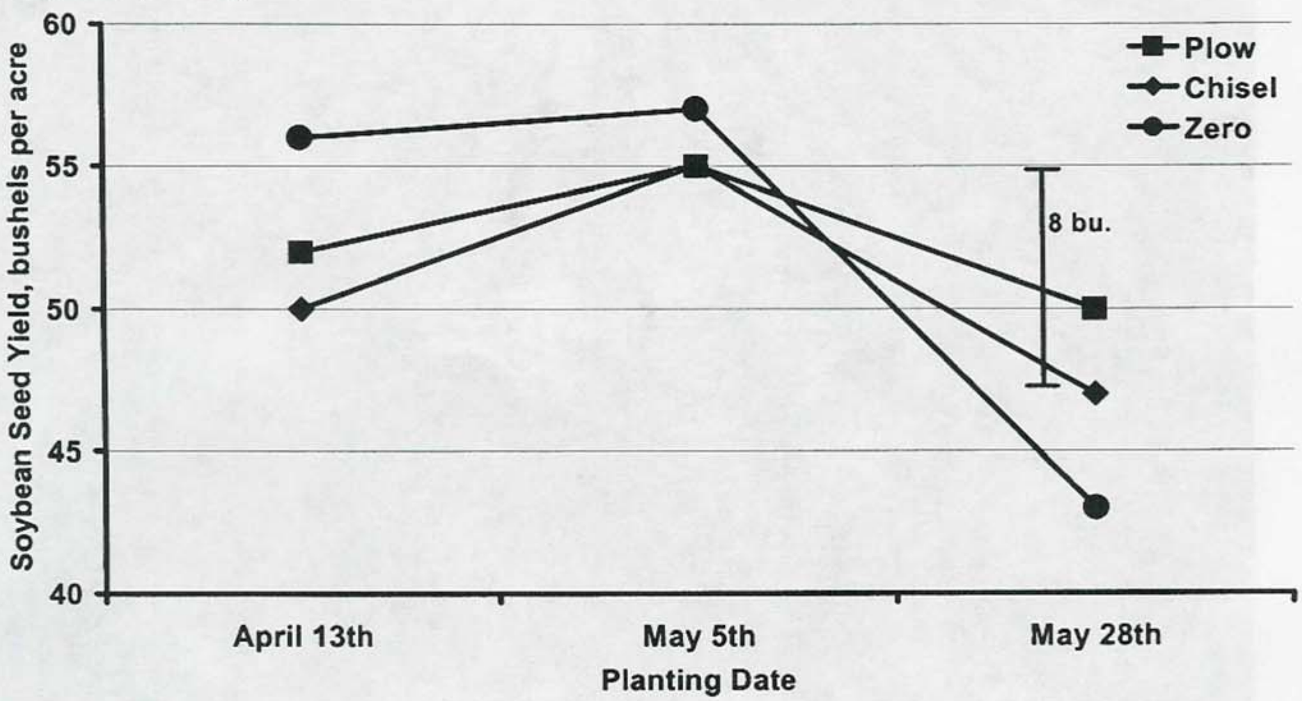
Results and Discussion

Within each of the three planting dates, tillage did not significantly (LSD, 0.05)=11) effect soybean seed yield (page 54, figure 24). Soybean planted on May 5th produced a similar yield to April 13th, regardless of tillage system. Soybean planted on May 28th however, significantly (LSD, 0.05) reduced yield relative to May 5th for zero and chisel tillage systems. Although no significant (P>0.05) interaction occurred between tillage and planting date, it appears that yield stability is enhanced with increasing tillage. When yield changes over planting date are viewed, variability tends to increase with decreasing tillage (yield variability: zero>chisel>plow). When yields from tillage are averaged over planting dates (tillage main effect, page 55, table 27), no significant differences were found. When planting dates are averaged over tillage systems (planting date main effect, page 55, table 27) however, soybean planted on May 28th produced significantly (LSD, 0.05) fewer bushels than either of the earlier two planting dates. The earlier two planting dates though, were not different. These results concerning both tillage and planting date effects on soybean yield, are in agreement with other Midwestern findings (Hoeft et al., 2000a; Nafziger, 2002a).

Table 28 on page 55 is a data set of harvest populations for all treatment combinations. Few differences or trends exist among treatments, with the possible exception of slightly lower populations for zero-till.

Figure 24.

Influence of planting date and tillage system on the seed yield of soybean grown at Joliet Junior College in 2004. Tillage systems are zero, chisel, and plow tillage. LSD (0.05) for comparing planting dates within a tillage system is 8 bu/acre. No significant (P>0.05) interaction between tillage and planting date.



Tillage & Planting Date for Soybean

Table 27.
Main effects (tillage averaged over planting dates, and planting date averaged over tillage systems) of tillage and planting date on the seed yield of soybean grown at Joliet Junior College in 2004.

Main Effects			
Tillage		Planting Date	
	bu. / ac		bu. / acre
Plow	52	April 13th	52
Chisel	51	May 5th	56
Zero	52	May 28th	47
LSD (0.05)	N/S	LSD (0.05)	5

Table 28.
Influence of planting date and tillage on the harvest population of soybean grown at Joliet Junior College in 2004.

	Tillage			
Planting Date	Zero	Chisel	Plow	Average
	Harvest Population			
	- - - - - - - plants per acre*1000- - - - - - -			
April 13th	140	156	147	148
May 5th	136	145	144	142
May 28th	143	146	154	148
Average	139	149	148	

Soybean Herbicides

Justification and Objective

Large numbers of herbicides and various combinations of herbicidal compounds are available to Mid-Western soybean growers for control of broadleaf and grassy weeds. Illinois Agricultural Statistical Service (2002a) lists 16 herbicides applied to soybean in Illinois in 2001. These herbicides range from Blazer applied to as little as 3% and roundup applied to 72% of soybean. Our objectives were three fold. First, provide a demonstration of the weed efficacy of commonly used soybean herbicide treatments in the Midwest to students at Joliet Junior College. Second, demonstrate the combination of the effects of weed efficacy and potential herbicide injury to crops. Finally, provide soybean growers with information concerning efficacy and crop injury of commonly used herbicides.

Methods

Seven soybean herbicide systems and a no-herbicide control were used to determine their effect on weed efficacy and seed yield of soybean. Each treatment was replicated three times and planted in 15 inch wide rows on May 6th with the Great Lakes cultivar GL2819RR. The previous crop was corn and soybean was planted at a rate of 180,000 seeds per acre. The entire experimental area was zero-tilled and preplant burndown herbicides were either applied in the Fall, (CanopyXL @ 2.5oz + Express @ 0.10oz + 2,4-D @ 16oz + COC @ 1% by volume) or Spring (Roundup Weather Max @ 11oz + 2,4-D @ 16oz + COC @ 1% by volume + AM.S. @ 2% by mass) to control existing vegetation. Herbicides were broadcast with flat fan spray nozzles (XR11004) on a Hardy sprayer applying 20 gallons per acre of spray solution and 20 pounds per square inch nozzle tip pressure. Weed efficacy was measured at R8 by visual assessment (% control), and the crop was harvested in early October.

Treatments: 8
Replications: 3
Planting Date: 6 May
Soybean Cultivar: Great Lakes GL2819RR
Previous Crop: Corn
Tillage: Zero
Soil Series: Will silty clay loam
Herbicides: Many
Insecticides: None

Soybean Herbicides

Results and Discussion

All seven soybean herbicide systems produced similar seed yields, and the no-herbicide control significantly reduced yield (LSD, 0.10). All herbicide treatments that included glyphosate (first five in table 29) provided excellent weed control regardless of application time and burndown type. The Raptor, and Dual II Mag. ect. had reduced weed efficacy relative to the other five treatments. Despite various burndown types and RoundupWM application timing, weed efficacy and yield was similar for treatments containing glyphosate (page 57, table29). The lack of response to burndown type is somewhat surprising. Our 2003 results showed sizeable yield and weed efficacy reductions when soybean was grown without a burndown herbicide, and with a non-residual herbicide containing burndown. Additionally in 2003, late-post (V4) applied RoundupWM decreased yield relative to a post (V2) application.

In 2004 the earliest RoundupWM postemerge application was delayed until V5, and a later application was made at V7. These relatively late application times are likely the reason for a lack of difference in weed efficacy among the three burndown types and two application times, and may also be the explanation for similar yields.

Table 29.

Influence of seven herbicide systems on the weed efficacy and seed yield of soybean grown at Joliet Junior College in 2004. Herbicide efficacy was evaluated at soybean maturity.

Herbicide - Application time + Burndown type	Application Rate	Weed Efficacy	Seed Yield
	oz (lbs) / acre	% Control	bushels/acre
No Herbicide	——	0	45
RoundupWM - V5+None	21	99	64
RoundupWM - V5+Spring‡	21	98	65
RoundupWM - V5+Fall†	21	97	63
RoundupWM - V7+Spring	21	100	67
Extreme - V5+Spring	48	98	63
Raptor - V5+Spring	5	80	63
Dual II Mag., SencorDF, PursuitDG - Pre + Spring	27 - (0.67) - 0.72	92	60
LSD (0.10)	——	——	10

†Fall burndown consisted of: CanopyXL at 2.5oz./acre + Express at 0.10oz./acre+2,4-D at 1pt./acre and COC at 1% by volume.

‡Spring burndown consisted of: Roundup at 11oz./acre+2,4-D at 1pt./acre, and COC at 1% by volume.

Soybean Herbicides

Figure 25. Image of a no-herbicide control (right half) and a post applied herbicide (left half) in soybean at Joliet Junior College in 2004.

Table 30.
Herbicide trade name, active ingredient, and application rate of soybean herbicide systems evaluated at Joliet Junior College in 2004. The seven herbicide systems are listed in the same order as they appear in table x on page x.

Herbicide Trade Name	Active Ingrediant†	Application Rate lbs a.i.(a.e.) / acre
RoundupWM	Glyphosate	(0.75)
RoundupWM	Glyphosate	(0.75)
RoundupWM	Glyphosate	(0.75)
RoundupWM	Glyphosate	(0.75)
Extreme	Glyphosate & Imazethapyr	(0.55) & (0.064)
Raptor	Imazamox	(0.039)
Dual II Magnum+SencorDF+PursuitDG	S-metolachlor+Metribuzin+Imazethapyr	1.59+0.50+(0.032)

† An acitive ingrediant followed by a "&" indicates two or more active ingrediants per trade name (pre-mix). A "+" indicates a herbicide added to the spray tank solution (tank-mix).

Soybean Fungicidal/*Rhizobium spp.* Seed Treatments

Justification and Objective

Zero-tillage represents 37% of Midwestern soybean acres (CTIC, 2004). One reported disadvantage of zero and reduced tillage soybean is a greater propensity for seedling diseases, and thus fungicidal seed treatments. It is thought that zero and reduced tillage systems having higher soil water contents, increase the incidence of diseases such as the fungal watermold *Pythium* spp. (Pederson et al., 2001). Currently there are two main combinations of fungicidal seed treatments for soybean growers to choose from, they are; Maxim (fludioxonil) + Apron XL (mefenoxam), and Rival (Captan, TBZ, and PCNB) + Allegiance (metalaxyl).

Rhizobium japonicum is a biological N_2 fixing bacterium that is responsible for supplying about 1/3 (80lbs N/acre/year) of soybean total N, and as such plays an important role in soybean production (Stevenson, 1986). Seed treatment products such as "Optimize" that contain R. *japonicum* are being offered to growers to ensure adequate N fixation. However, soil microorganisms are known to be quite ubiquitous, and therefore it may not be necessary to add R. *japonicum* for adequate soybean N fixation. In addition to the ubiquity of R. *japonicum*, population densities can be relatively high, especially when soybean has been grown within several years. Our objective was to determine the responsiveness of soybean to fungicidal (ApronXL) and R. *japonicum* (Optimize) seed treatments.

Methods

Two rates (1&2X) of ApronXL (mefenoxam), one of Optimize (*Rhizobium japonicum)*, and an untreated control were used to evaluate the efficacy of both soybean seed treatments. Treatments were replicated three times and planted on May 17th under zero-till conditions with the soybean cultivar FS 2826 at a rate of 150,000 seeds per acre. Row spacing was 30 inches and weed control was achieved with CanopyXL + Express + 2,4-D applied Fall preplant, followed by Extreme applied postemerge. The crop was harvested in early October.

Treatments: 4
Replications: 3
Planting Date: 17 May
Soybean Cultivar: FS 2826 with and without seed treatments.
Previous Crop: Corn
Tillage: Zero
Soil Series: Symerton silt loam
Herbicides:
  CanopyXL@2.5oz + Express@0.10oz + 2,4-D @ 1pint per acre applied preplant.
  Extreme @ 48oz per acre applied postemerge(V3).
Insecticides: None

Results and Discussion

None of the seed treatments significantly increased soybean seed yield (P≥ 0.10). Optimize (*Rhizobium japonicum*, N fixing bacterium) and both rates of the fungicidal seed treatment ApronXL (mefenoxam) tended to improve yield. However, the yield improvement is probably a random event, as it is unlikely both seed treatments would improve yield, and to the same extent. Soybean fungicidal seed treatments have increased yield at Joliet Junior College in the past (2002&2003), so it is somewhat surprising ApronXL did not improve yield in 2004.

Table 31.

Influence of fungicidal and Rhizobium spp. treated seed on the seed yield of soybean grown at Joliet Junior College in 2004.

Fungicidal and Rhizobium spp. Seed Treatments	Soybean Seed Yield
	bushels per acre
Untreated	45
Optimize†	50
ApronXL 1X	50
ApronXL 2X	49
LSD (0.10)	N/S

† Seed inoculated with Rhizobium japonicum, a biological nitrogen(N^2) fixing bacterium.

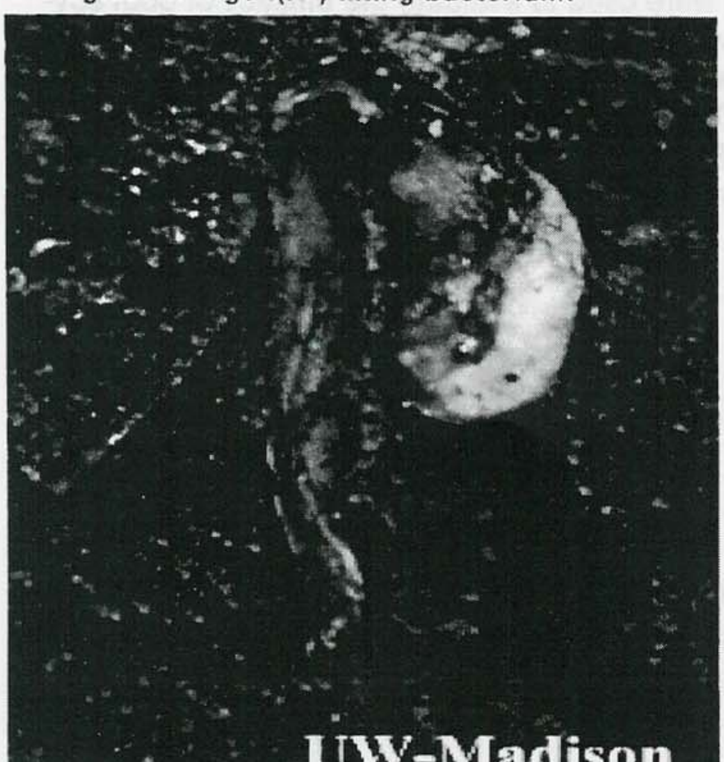


Figure 26. Damping off of soybean caused by the water mold fungus *Pythium*. This type of seedling injury can also be caused by *Phytophthora*. Injury from *Pythium* and *Phytophthora* is common when soybean is planted into cool wet environments that reduce seedling growth rates and allow greater infection of fungi.

Soybean Insecticidal Seed Treatment

Justification and Objective

Considerable interest has developed in recent years for improving seed yield of soybean. There is a perception (wether real or not) among many producers and ag professionals that soybean yield has stagnated. In a response to the perceived stagnation, some manufacturers of crop protection and production chemicals are advocating their use for yield enhancement. Additionally, the outbreak of soybean aphid in 2003 has sparked greater interest in control of insect pests. Some insecticidal seed treatments in corn (Gaucho, imidacloprid; Cruiser, thiamethoxam) are being evaluated for their potential use in soybean, and may be registered by U.S. EPA in the future as such. Our objective was to evaluate the effect of two insecticidal seed treatments (Gaucho and Cruiser) and a foliar insecticide (Mustang Max) on soybean seed yield.

Methods

Two rates (1&2X, or 0.09mg a.i./seed & 0.18mg a.i./seed) of Gaucho (imidacloprid), one (0.076mg a.i./seed) of Cruiser (thiamethoxam), a foliar insecticide (Mustang Max at 3.5oz/acre, 0.022lbs a.i./acre) and an untreated control were used to determine the effect of insecticides on soybean seed yield. Mustang Max was broadcast over the canopy on August 5th (R4-5)using a spray volume of 15 gpa. Treatments were replicated four times and planted on May 17th under zero-till conditions with the soybean cultivar Asgrow 2801 at a rate of 130,000 seeds per acre. Row spacing was 30 inches and weed control was achieved with CanopyXL + Express + 2,4-D applied Fall preplant, followed by Extreme applied postemerge. The crop was harvested in early October.

Treatments: 5
Replications: 4
Planting Date: 17 May
Soybean Cultivar: Asgrow 2801 with and without seed treatments.
Previous Crop: Corn
Tillage: Zero
Soil Series: Symerton silt loam
Herbicides:
CanopyXL@2.5oz + Express@0.10oz + 2,4-D @ 1pint per acre applied preplant.
Extreme @ 48oz per acre applied postemerge(V3).

Soybean Insecticidal Seed Treatment

Results and Discussion

None of the insecticides (Cruiser, Gaucho, Mustang Max) increased soybean seed yield when compared to the untreated control (page 62, table 32). Very little foliar feeding was noted throughout the entire growing season, and at R4-5 defoliation was estimated to be about 2%. A few species of adult insect pests were noted during the growing season (Japanese Beetle, Corn Rootworm, Bean leaf Beetle), but populations remained relatively low. It is not surprising the various insecticides had no yield enhancing effect, as the estimated defoliation was approximately 10-fold < the economic threshold for defoliation. Although defoliation of each experimental unit was not measured, only estimated to be 2%, no obvious differences between the untreated control plots and the insecticidal seed treatments was noted during the growing season. In 2003, soybean aphid was detected at Joliet Junior College at the end of May, and by late July populations were high. In 2004 however, soybean aphid was not detected until mid August, and populations remained very sparse until maturity.

Table 32.

Influence of insecticidal seed treatments and a foliar insecticide on the seed yield of soybean grown at Joliet Junior College in 2004.

Insecticidal Seed Treatment	Soybean Seed Yield
	bushels per acre
Untreated	56
Cruiser	54
Gaucho 1X	55
Gaucho 2X	56
Foliar†	56
LSD (0.10)	N/S

†Mustang Max was applied at 3.5oz per acre on August 5th (R4-5).

Soybean Insecticidal Seed Treatment-2

Justification and Objective

Refer to page 61 for justification and objective.

Methods

Two treatments, an untreated control and a Gaucho (imidacloprid) seed treatment applied at 0.19mg a.i. per seed were used to determine the effect of the insecticidal seed treatment Gaucho on soybean seed yield. Treatments were replicated three times and planted on May 17th under zero-till conditions with the soybean cultivar FS 2736 at a rate of 150,000 seeds per acre. Row spacing was 30 inches and weed control was achieved with CanopyXL + Express + 2,4-D applied Fall preplant, followed by Extreme applied postemerge. The crop was harvested in late October.

Treatments: 2
Replications: 3
Planting Date: 17 May
Soybean Cultivar: FS 2736, with and without Gaucho on the seed.
Previous Crop: Corn
Tillage: Zero
Soil Series: Will silty clay loam
Herbicides:
CanopyXL@2.5oz + Express@0.10oz + 2,4-D @ 1pint per acre applied preplant.
Extreme @ 48oz per acre applied postemerge(V3).

Results and Discussion

Gaucho (imidacloprid) did not significantly (P≥ 0.10) effect soybean seed yield. Similar to the discussion concerning the previous study (page 63, table 33), little foliar damage occurred to the crop and as such we would not expect a yield enhancement.

Table 33.
Influence of the insecticidal seed treatment Gaucho480 on the seed yield of soybean grown at Joliet Junior College in 2004.

Insecticidal Seed Treatment	Soybean Seed Yield
	bushels per acre
Untreated	46
Gaucho	45
LSD (0.10)	N/S

†Gaucho was applied at 0.19mg a.i. per seed.

Soil Fertility-Soybean

Justification and Objective

Optimum soil phosphorous (P), potassium (K), and acidity levels are critical for corn and soybean production in the Mid-Western United States. Soil P and K, and pH levels for crop production in Illinois have been well established (Hoeft and Peck, 2002). However, many Illinois crop producers maintain soil fertility well above levels considered sufficient. Corn grain yields in Illinois over the last five years have averaged 144 and soybean 43 bushels per acre (University of Illinois, 2002). Average annual removal of P_2O_5 and K_2O given current yields in a corn soybean rotation is 49 and 48 lbs per acre P_2O_5 and K_2O, however, additions of fertilizer P and K over a similar time period (1998 - 2000) was 74 and 111 lbs per acre P_2O_5 and K_2O (Illinois Agricultural Statistical Service, 2001a). Excess fertilizer application is a misallocation of resources and should be corrected. Our objectives are two fold. First, as an educational tool we will demonstrate production of corn and soybean with fertilizer applications equal to crop removal, and demonstrate corn and soybean production without fertilizer P and K and the accompanying deficiency symptoms to students at Joliet Junior College. Finally we will provide information to crop producers demonstrating crop production with fertilizer applications similar to crop removal.

Methods

Six soil fertility treatments were implemented in the Fall of 2001 with the intention of maintaining them for long-term evaluation. The 2004 crop is the third harvested since the study was implemented. The normal treatment consists of a typical soil fertility program for row crops which includes soil pH maintained between 6.0 to 6.5 and annual applications of maintenance fertilizer P and K (50lbs/acre P_2O_5 and K_2O). Two additional treatments are similar to the normal but are missing either the maintenance P or maintenance K, and a fourth treatment has no P or K applications. The fifth and sixth treatments were included with the intention of reducing and increasing soil pH. The acidic treatment receives no liming material while the basic receives threefold the recommended lime.

Soil samples were taken and analyzed in the Fall of 2001. Soil K levels (363 lbs/acre exchangeable K+), are considered sufficient for row crops in North Eastern Illinois, requiring only maintenance K (Hoeft and Peck, 2000). Soil P levels (44 lbs/acre available P) are slightly below the point at which only maintenance P would be necessary. Soil pH ranges from 5.9 to 7.4, somewhat high because of the calcareous nature of the parent material which is a loamy gravel with rock fragments of dolomitic limestone (Wascher et al., 1962). The depth to the parent material is fairly shallow (2 to 3.5 feet) and in a few areas may only be covered with 15 inches of solum. The course textured and shallow parent material reduces the soil water holding capacity and makes the crop very susceptible to water stress when less than normal rainfall occurs.

Soil Fertility-Soybean

Methods

Treatments: 6
Replications: 2
Planting Date: 6 May
Cultivar: Crows C3117R
Previous Crop: Corn
Tillage: Zero
Soil Series: Will silty clay loam
Herbicides:
CanopyXL@2.5oz + Express@0.10oz + 2,4-D @ 1pint per acre applied pre-plant.
RoundupWM @ 21 ounces per acre applied post-emerge.
Insecticides: None

Results and Discussion

No significant differences ($P \geq 0.10$) were found among the six soil fertility treatments (page56, figure31). This finding is similar to the corn in 2004 (page 65, table 34), and similar to our findings for both crops in 2002 and 2003. Treatments of this study were begun in the Fall of 2001, three crops have been produced with the current soil fertility regimes and it is thought that over time differences between treatments will occur.

Table 34.
Influence of soil fertility treatments on the seed yield of soybean grown at Joliet Junior College in 2004.

Soil Fertility Treatment	Seed Yield
	bushels/acre
Normal	70
Basic	64
Acidic	70
No-P	72
No-K	70
No-P or K	65
LSD (0.05)	N/S

Soybean Varieties

Justification and Objective

Numerous soybean cultivated varieties (cultivars) are available to Mid-Western soybean producers. In Illinois soybean growers spend $19 per acre acquiring soybean seed from dozens of seed supplying companies (University of Illinois, Dept. of Agriculture and Consumer Economics, 2002). Our objective is to aid Mid-Western soybean growers in choosing cultivars most profitable in their operations, and to demonstrate to students different morphological characteristics of various soybean cultivars.

Methods

Soybean varieties were planted in a timely manner and seeded at 175,000 seeds per acre in 15 inch rows. Thirty cultivars were entered in this unreplicated varietal demonstration. The check variety (Becks, 323) was entered five times in the demonstration which was 595 feet wide, and each entry consisted of 14 15-inch rows or 17.5 feet wide and 418 feet in length. The checks were separated by six varieties, as such any given variety was never more than three entries (52.5 feet) from a check. Each variety was evaluated on a relative scale by comparing it to the nearest check. Soybean was harvested with a International Harvester (IH) 1460 combine and yield was measured using weigh wagons and hand held grain moisture meters. The demonstration area was zero-tilled and weeds were controlled with a Fall applied preplant burndown followed by a postemerge application of RoundupWM. The crop was harvested on October 12th.

Number of entries: 30
Replications: None
Planting Date: 11 May
Soybean Cultivar: Many
Previous Crop: Corn
Tillage: Zero
Soil Series: Symerton silt loam
Herbicides:
CanopyXL@2.5ounces+Express@0.15ounces+2,4-D@1pint per acre applied Fall preplant.
RoundupWM @ 21 ounces per acre applied postemerge.
Insecticides: None

Soybean Varieties

Results and Discussion

Soybean yield ranged 21 bushels per acre, the maximum was 64 and minimum 43 with an average of 52 bushels per acre. For cultivars that were evaluated in 2003 and 2004, a two year average is given. Cultivars in 2004 produced the second highest yield in JJC farm history, being surpassed only by 1998 when 56 bushels per acre were produced.

Table 34.
Demonstration of the grain moisture, grain yield, and relative yield of 30 soybean varieties grown at Joliet Junior College in 2004. The two year average grain yield includes 2003 and 2004. The check variety Becks 323 (bold font) averaged 57 bushels per acre and was entered five times and is seperated by 6 entries. The average yield of all varieties is 52 bushels per acre. The variety with the highest relative yield is underlined.

Company Name	Varietal Nomenclature	Grain Moisture	Grain Yield	Relative† Yield	Grain Yield 2-Yr Avg
		- %-	Bu. / Acre	- %-	Bu. / Acre
Golden Harvest	2811RR	12.4	61	95	
Garst	2332RR	12.8	46	72	
Hughes	852	12.9	47	73	
Becks	**323**	**12.2**	**64**	**100**	**58**
Crows	3117R	12.2	55	86	
Sieben	2806NRR	12.3	52	81	
Dekalb	31-51	12.3	59	92	
Dairyland Seed	268RR	12.3	48	89	49
LG	2844NRR	12.1	54	100	
Pioneer	92M70	12.2	51	94	50
Becks	**323**	**12.5**	**54**	**100**	**58**
Adler	296RRN	12.0	50	93	
<u>FS</u>	<u>HS3236</u>	<u>12.2</u>	<u>59</u>	<u>109</u>	
Dekalb	DKB31-51	12.0	51	94	
Garst	2903RR	12.1	55	95	56
Sieben	SS2805NRR	12.3	51	88	
Golden Harvest	2646RR	12.3	46	**79**	
Becks	**323**	**12.1**	**58**	**100**	**58**
Great Lakes	2705RR	12.2	50	86	
Crows	C2615	12.5	46	79	51
Asgrow	AG2801	12.1	53	91	
Garst	2603RR	12.2	46	82	
LG	C3110RR	12.4	55	98	
Dairyland Seed	301RR	12.4	54	96	52
Becks	**323**	**12.1**	**56**	**100**	**58**
Great Lakes	2819RR	12.2	46	82	
Pioneer	92M92	12.1	51	91	
Hughes		12.3	47	84	
Sieben	SS2304NRR	12.2	43	**78**	
Crows	C2915R	12.2	44	80	50
Becks	274NRR	12.2	51	93	
Becks	**323**	**12.4**	**55**	**100**	**58**
Great Lakes	2525RR	12.3	50	91	
Dairyland Seed	3261RR	12.5	48	87	

† Relative yield was calculated by dividing the grain yield of a given hybrid (numerator) with the grain yield of the nearest check (denominator) and multiplying by 100.

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