TECHNOLOGY EVALUATION AND DEVELOPMENT SUB-PROGRAM

EVALUATION OF 58 COMMERCIAL CORN HYBRIDS (2850 TO 3450 C.H.U.)IN TWO CONSERVATION TILLAGE SYSTEMS COMPARED TO CONVENTIONAL TILLAGE IN KENT COUNTY, SOUTHWESTERN ONTARIO

FINAL REPORT

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EXECUTIVE SUMMARY

Various forms of mulch tillage systems, whether minimum, no-till (zone-tillage) or ridge-till, have increased rapidly in acreage across southwestern Ontario for corn production. Increased surface residue cover at planting time and earlier planting have been associated with both cooler seedbed environments and slower soil warming which have been shown to delay seed germination, emergence and crop development. It has been suggested that in a conservation tillage system uniquely different environmental stresses exist requiring corn hybrids with attributes uniquely different from those for conventional tillage systems. Currently all of the O.C.C. corn performance trial data is collected from conventional tillage systems insuring natural environmental stresses be maintained at a minimum.

Research from U.S.A. and Ontario has suggested that corn hybrids which perform well in conventional tillage systems may not perform satisfactorily under conservation tillage systems associating this difference to stresses due to increased residue and colder seedbed environment. Preliminary studies supported by TED and conducted by P.R.C. (Hope and Maamari) suggest the potential of developing a cold tolerance predictor for field emergence under conservation tillage management systems using the time to production of a 1 cm coleoptile under laboratory controlled cold (11° C til 1 cm coleoptile growth occurred) conditions.

The research reported in this report was initiated in 1991 at R.C.A.T. as a minimum 2-year study in co-operation with two local conservation tillage farming systems, Douglas Smith (ridge/strip) and Jack Rigby (zone-till). Fifty-eight corn hybrids from 18 seed companies were selected from the O.C.C. performance list which ranged from 2850 CHU to 3400 CHU and indexed 100 or better for yield in 1989 and 1990 O.C.C. performance trials. The hybrids were grouped into 3 maturity trials. Twenty-six in Early Season (2850-3050 CHU); 12 in Full Season (3075-3200 CHU); and 20 in Late Season (3300-3425 CHU). Each conservation tillage trial is being compared to the trial planted adjacent in a conventional tillage system. Seed from the same seed lot of each hybrid tested was made available to Hope at P.R.C. for cold tolerance predictor determination studies and also stored for 1992 field testing. Measured variables were: residue density, soil moisture, soil temperature, air temperature, time to coleoptile emergence, time to development of V-1 to V-5 leaves, percent emergence at V-3, percent final stand at harvest, days to 50% pollen shed and silk emergence, percent broken stalks, harvest grain moisture and grain yield.

The 1991 data is summarized within this report. The spring and early summer growing conditions for 1991 were unusually hot and dry failing to produce the required conditions to evaluate cold tolerance for emergence and early growth data. Consequently, the study will need to be continued a minimum of 2 more years (1992 and 1993) before field emergence data can be used to verify the usefulness of the Hope cold tolerance predictor for field emergence. The field data in this report is only one year's data from a very unusual growing season. This is considered a preliminary progress report and conclusions must not be made from such unusual and limited data.

The study is in progress for 1992 and 1993 with partial funding for 1993. In 1992, 28 new hybrids have been added for the field evaluation in separate trials under all four tillage systems. Seed from the same seed lots of these hybrids was sent to Hope at P.R.C. for cold tolerance testing.

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1.0 INTRODUCTION

Conservation tillage (residue management tillage systems) in Ontario has taken three main directions: (1) Minimum tillage; (2) Ridge-tillage; (3) No-tillage (zone till). The number of corn acres planted using some form of residue management tillage systems is rapidly increasing in Ontario.

In southwestern Ontario conservation-tilled corn acreage went from 18% in 1989 to 24.8% in 1990. Considering the reduced tillage category better than 1 out of every 10 corn acres were grown under some kind of conservation system. Forms of mulch tillage is the most popular system in Kent County where it surpasses conventional tillage, and in Elgin County almost one-third of the corn acreage is under conservation tillage (stats recently released by Soil and Water Conservation Information Bureau and O.M.A.F.'s Plant Industry Branch).

Regardless of tillage systems, increased surface residue cover at planting with adoption of conservation tillage practices has been shown to slow soil warming, which often reduces and/or delays seedling emergence and slows crop development compared to conventional (Al - Darby and Lowery).

Hybrid selection is one of the more important decisions facing a corn producer. Ontario, through the Ontario Corn Committee, conducts annual corn performance tests in which all the commercial hybrids licensed to be sold to the Ontario corn producer are evaluated for yield, stalk breakage and harvest moisture (O.C.P.R., 1991). All of these trials are conducted using conventional tillage systems on the best soil supplemented with excessive fertility programs at plant populations considered to be very moderate insuring stresses be maintained to a minimum if possible. Therefore, the Ontario corn producer wishing to improve hybrid selection decision in a no-tillage system currently must rely on the results from the conventional tillage trials of the Ontario Corn Committee. Research studies have shown that significant interactions between corn hybrids and tillage systems can exist (Brakke et al), (Carter and Barnett), (Wall and Strobbe). Likewise, several research studies have reported no hybrid x tillage system interactions for corn grain yield (Hesterman et al.), (Hallanauer and Calvin), (Newhouse and Crosbie).

Recent research (Fortin and Pierce) has shown that crop residue cover in no-till systems can result in significant delays in vegetative (emergence to V12) development of corn. Such growth delays were attributed to differences in average maxima temperatures of the seed zone between bare control and mulch treatments greater or equal to 2.2º C. They further showed the possible chemical effects of crop residues (oat straw mulch) retarding leaf development thus suggesting an existing interaction between the corn development and the kind of crop residue. Also, the effect of soil water content on the warming trends of the seed zone was suggested as part of the environmental stress on early corn development. These results are significant in drawing attention to the fact that cold temperature in the seed zone may not be the only source of stress affecting delay in germination of the corn seed, subsequent emergence and early growth, but other sources of stress may be contributing variability in field trials giving conflicting field trial results.

Graven and Carter report increased residue cover with no-till systems resulted in as much as 2.3º C cooler soil temperature at planting compared to conventional which reduced average percentage corn emergence by 3%, delayed emergence by 2 to 5 days, delayed silking by 5 to 7 days, increased grain moisture 1 to 5%, and reduced average grain yields by 9%. Seed quality was suspected to negatively influence the overall performance of commercial hybrids under the severe early stresses in the seedbed. However, seed quality effects were found to be smaller than the tillage system effects and they concluded that special concerns about seed quality under conservation tillage systems were unwarranted.

At the 1990 Northeast Corn Improvement Conference (NECIC, 1991) Dr. M. Smith, corn breeder, Cornell University, reported on the initiation of a research program developing breeding populations and early generation inbred lines development under 4 target environments (no-till, conventional till, interseeded by legume and low nitrogen). Cornell University has also begun evaluating commercial corn hybrids for the New York State corn producer under the 4 tillage environments listed above. Ohio State and other corn belt states have been conducting yield performance trials for several years under no-till systems for the purpose of making recommendations to the no-till corn producers.

Although the issue of corn hybrids x tillage system interactions has received a fair amount of attention, controversy remains over whether or not corn hybrid x tillage systems interactions are significant for grain yield performance.

The Ontario corn producer successfully practising some form of conservation tillage has had to give detailed attention to many input and management details including the selection of the most suitable corn hybrid capable of performing in the spring in no-till soils. These corn producers have had to rely on their own "on-farm" trials of candidate hybrids, or the O.C.C. performance recommendations, before committing them to large scale field production in their operation.

A study was initiated in 1988 in Ontario for Technology Evaluation and Development (TED) to begin to establish the relationship between corn hybrid performance and tillage method. Five corn hybrids were tested in a no-tillage and conventional tillage system. It was observed that weak performing hybrids under no-till conditions suffered from delayed emergence and slower seedling growth. Marked irregular reductions in plant populations under no-till conditions were also observed for certain hybrids. The data showed that grain yields were directly related to final plant populations.

These findings were interpreted to suggest that the variability in plant stands of certain corn hybrids in the no-till system reflected the hybrid's reduced ability to perform under stress conditions occurring within the system. These stresses in the no-till seedbed environment are suspected to be

1. cooler spring soil temperatures at planting time
2. higher soil density
3. micro-toxic conditions attributable to crop residues on the soil surface
4. slower soil warmup after planting due to the crop residue on the soil surface and retention of moisture

The results of the 1988 TED study based on only 5 corn hybrids showed that corn hybrids that performed well in the conventional tillage system were not necessarily the best performers in the no-till system.

In 1990 another TED study was initiated at the Plant Research Centre, Agriculture Canada, (P.R.C.), Ottawa to examine the performance of 14 commercial corn hybrids from 2 seed corn companies in conditions of laboratory cold germination (11º til 1 cm coleoptile growth occurred) and cold growth test (12º C for 4 weeks) (LCG/CGT). This study was an attempt to link the response of corn hybrids in the LCG/CGT to field observations of variable final plant stand, early spring vigour, and final grain yield performance (Hope and Maamari).

The results of this study suggested that the time to production of a 1 cm coleoptile was a promising predictor of successful field emergence under no-till management practices.

Both the 1988 and 1990 TED studies were based on a very narrow germ plasm base (5 and 14 commercial hybrids respectively) representing only 2 seed corn companies which severely limits the potential for broad application of these results to all the commercial hybrids sold in Ontario. Furthermore, the field supported research trials over one year for each study is simply inadequate to substantiate the LCG/CGT studies as a predictor of performance in conservation tillage systems.

The recommended list of corn hybrids for Ontario (O.C.P.R., 1991) has 250 plus hybrids ranging from the maturity of 2400 CHU to 3400 CHU distributed by 25 seed corn companies. Conservation tillage systems have become most popular in central and southwestern Ontario growing corn hybrids 2700 CHU to 3400 CHU. This includes about 75% of the hybrids on the O.C.C. recommended list. Two steps of research should be considered for further expansion and verification of the initial research begun by TED since 1988 and 1990.

1. Field verify the 1990 P.R.C., Ottawa laboratory results under the most extreme no-till early spring conditions possible comparing more than one no-till system (example: zone-till and ridge till) to conventional tillage.

2. Apply the 1990 LCG/CGT to all the corn hybrids on the O.C.C. performance recommended list in conjunction with field testing to establish the logistics of prediction between the LCG/CGT with the real field stress environment in several modifications of no-till systems (zone-till and ridge-till).

1.1 OBJECTIVES OF RESEARCH

1. Field test for 2 years the O.C.C. recommended corn performance hybrids over 2850 CHU and indexing 100% plus for yield in 1990 and 1989/1990 under:
   - (a) no-till system (zone-till) corn after soybeans
   - (b) ridge-till system, corn after wheat with hairy vetch cover crop
   - (c) conventional till system, fall chisel plough with spring disc (corn after soybeans and corn after corn).

1. Attempt to correlate the field stress environment results to the laboratory cold germ/cold growth results for the corn hybrids tested in collaboration with Dr. H. Hope, P.R.C., Ottawa. Raw data files of appropriate data will be shared to facilitate this objective.

2. In collaboration with Dr. H. Hope, P.R.C., Ottawa, to establish a reliable laboratory screening method of corn hybrids as a predictor for performance in no-till field stress environments.

3. To identify more clearly the sources of and kinds of stresses operating in the no-till seedbed which affect corn hybrid performances differently than in conventional tillage systems.

4. Determine the need for a regular no-till hybrid evaluation of all the corn hybrids licensed for sale in Ontario.

5. To collaborate these research field studies with, but independent from, Dr. Hugh Hope, Plant Research Center, Ottawa, laboratory cold germ/cold growth studies. This involves the sharing of raw data files between Scheifele and Hope as it applies to the support of each other's research.

6. Dr. H. Hope and G.L. Scheifele will collaborate for joint publication of research discoveries in the Journal of Canadian Plant Science combining field results with laboratory results.

2.0 MATERIALS AND METHODS

2.1 HYBRIDS

The 58 hybrids selected for 1991 field study ranged from 2850 CHU to 3400 CHU and had a yield performance index over 100% for 1990 and 1990-1989 (O.C.P.R., 1991). Seven hybrids were tested in 1990 by Dr. H. Hope for cold germ/cold growth and are identified by asterisk (*). The hybrids were grouped into 3 maturity groups for testing: 2850-3050; 3075-3200 CHU; 3250-3400 CHU. Seed from the same seed lot source use for all the hybrids listed below was supplied to Dr. H. Hope, Plant Research Center, Ottawa for LCG/CGT. The hybrids tested represented germ plasm from 18 seed corn companies in Ontario.

Early Trial (2850-3050 CHU) (26 Hybrids)

Hybrid	CHU
RX370	2850
*DK403	2850
*P3790	2850
*P3772	2900
P3831	2900
RX409	2900
*DK435	2925
G4140	2925
Cargill 3477	2925
*P3794	2950
RK602	2950
Garst 8882	2950
RX9214	2950
*DK415	2950
P3901	2975
Garst 8808	2975
DK445	3000
K337	3000
P3737	3000
P3751	3000
Ferg. 8855	3000
GH H2331	3000
Jacques 4900	3025
*DK485	3050
GH H2343	3050
Ferg. 8758	3050

Full Season Trial (3075-3200 CHU) (12 Hybrids)

Hybrid	CHU
G4299	3075
HL2570	3075
P3733	3075
Cargill 3637	3100
NK N4350	3100
MX 320	3100
GH 2404	3100
DK 524	3100
Super Crost 2277	3100
G4309	3200
GH H2410	3200
P3573	3200

Late Season Trial (3300-3425 CHU) (20 Hybrids)

Hybrid	CHU
G4385	3300
Cargill 4327	3300
P3475	3300
DK535	3300
HL2729	3350
MX335	3350
Agri 501	3350
Ferg. 8965	3375
FL1783	3375
Pickseed 8898	3400
Agri 502	3400
Jacques 7700	3400
HYL. 2803	3400
Pickseed 8877	3400
Garst 8555	3400
Super Crost 2989	3400
RK64	3400
Ferg. 8969	3425
GL582	3425
G4447	3425

2.2 TILLAGE SYSTEMS

2.2.1 Ridge-Tillage Systems (Douglas Smith, Co-operator) (DSRT)

The ridge-tillage system selected was an established ridge system for 6 years and was a 6-row strip system. The previous 1990 crop was wheat followed with a hairy vetch cover crop chemically burned off prior to planting. The soil type was a clay loam. The strip crop rotation was corn, soybeans and wheat. See Table 1 for detailed description of preplant soil analysis.

2.2.2 Conventional System (Douglas Smith, Co-operator) (DSCT)

The conventional-tillage system was located 500 m north from the ridge-till system. The field was fall chisel ploughed and disced 3 times in the spring preplant. See Table 1 for detailed description of preplant soil analysis.

2.2.3 Zone-Tillage System (Jack Rigby, Co-operator) (JRZT)

The zone-till system was an established zone-till system for 6 plus years. See Table 1 for detailed preplant description of soil analysis.

Table 1. Summary of 1991 Description of Tillage Systems.

Tillage System	Co-operator	Soil Type	Previous Crop	% Residue*		Preplant Soil Analysis							
				in Row	Across Row	pH 2"	pH 6"	P 2"	P 6"	K 2"	K 6"	OM 2"	OM 6"
Ridge-Till (DSRT)	Douglas Smith	Clay Loam	Wheat	26	46	7.4	7.5	38.6	40.7	220	208	5.4	5.3
Conventional (DSCT)	Douglas Smith	Sand Loam	Corn	14	24		6.5		50		200		3.4
Zone-Till (JRZT)	Jack Rigby	Clay Loam	Soybeans	20	35	6.4	6.4	22	16	200	110	3.2	3.2
Conventional (JRCT)	Jack Rigby	Clay Loam	Soybeans	10	12		6.4		18		122		2.5

* The line-transect method using a knotted rope was used to estimate percent residue cover.

2.2.4 Conventional System (Jack Rigby, Cooperator) (JRCT)

The conventional-tillage system was located directly adjacent to the zone-tillage system in the same field. It was spring disced preplant.

2.3 PLANTING

All the trials were planted using the co-operators planting setup modified by replacing the planter boxes with Almaco cones for planting short research plots. Both co-operators used 6-row no-till planters. The DS setup was a Kinzie planter with Hiniker ridge cleaners, whereas the JR setup was a New Idea planter with Kinzie units and 2-2" fluted coulters on each side of the row about 4" apart to give zone-till and apply starter fertilizer on either side. The planting unit had a 1" bubble coulter to cut any remaining residue in the seed zone. The plots were 2 rows, 20 feet long and 30" and 38" wide at Smith and Rigby respectively. The ridge-strip plots were planted with 1 border row on either side of 4 plot rows.

2.4 SEED

Adequate seed for 2 years field trials and laboratory testing of each hybrid was obtained in the spring of 1991 from the same seed lot used for the O.C.C. performance trials. The remnant seed for 1992 testing was stored under environmentally controlled conditions to assure maintenance of good seed quality for 1992 testing.

2.5 PLANT POPULATION

Corn was planted using pre-counted seed such that maximum possible plant populations would be 30,800 ppa.

2.6 FINAL PLANT STAND

The plant stand for each plot was left as actual emerged and survived stand for harvest. Plots were not thinned to a constant density after emergence.

2.7 PLANTING TIME

Planting was completed for each tillage trial at the earliest possible time that soil conditions for planting permitted. See Table 2 for planting and harvest dates. Planting depth 1 ½ " below soil surface.

Table 2. Summary of Planting and Harvesting Dates for 4 Tillage Systems.

Tillage System	Planting Date	Harvest Date
DSRT	May 3rd	Oct. 7
DSCT	May 6th	Oct.7
JRZT	May 9th	Oct. 8
JRCT	May 9th	Oct. 8

2.8 FIELD PLOT DESIGN

The trials were set up and planted as randomized complete block-split plot design with tillage as the main split at 3 replications. The plots were 2 rows, 20' long with 3' alley breaks.

2.9 HARVESTING

Harvesting was completed on the dates recorded in Table 2 using a 2-row Almaco research combine set up for electronic weight and harvest moisture recording.

2.10 DURATION OF STUDY

The field research study is required to be repeated for a minimum of 2 years under cold seedbed conditions (1991 and 1992) even though the SWEEP funding for this project was only for 1991. The laboratory cold germ testing of the respective seed samples was only required for the summer of 1991 for the seed lots used.

2.11 FERTILITY AND HERBICIDE

Table 3. Summary of Fertility and Herbicide Program for 4 Tillage Systems (units are expressed in pounds per acre).

Tillage System	At Planting			Sidedress	Herbicide
	Nitrogen	P	K_2O	N	
DSRT	19	19	64	150	Banvel PE
DSCT	18	59	55	150	Banvel PE
JRZT	60	50	100	90	1 L Dual pp
JRCT	60	50	100	90	1 ½ L Marksman PE

2.12 MEASUREMENTS

1. Soil analysis of each trial site before planting at 2" and 6" depths.

2. Measure residue density at planting time across rows and within seedbed zone.

3. Measure daily maximum and minimum soil temperature.

4. Measure soil moisture at seedbed zone on daily intervals.

5. Determine length of time in growing degree days (GDD) for coleoptile emergence for each hybrid. GDD were calculated from soil temperature as: GDD = 0.5 (Min. + Max.) - 10 where min. is daily soil temperature minimum and where maximum is daily soil temperature maximum.

6. Determine length of time in growing degree days for V-1 development for each hybrid.

7. Determine length of time in days for V-2, V-3, V-4 and V-5 for each hybrid.

8. Determine percent emergence at V-3 for each hybrid.

9. Determine days to 50% pollen shed for each hybrid.

10. Determine days to 50% silk for each hybrid.

11. Determine percent final stand for each hybrid at harvest time.

12. Determine percent stalk breakage for each hybrid at harvest time.

13. Determine harvest moisture and yield in bushels per acre for each hybrid at harvest.

3.0 RESULTS

3.1 AIR TEMPERATURE

Table 4. Summary of Accumulated CHU* for Doug Smith (DS) and Jack Rigby (JR) Locations (RCAT is Ridgetown College of Agricultural Technology).

Month	1991			1990	1989
	DS	JR	RCAT	RCAT	RCAT
May	556.0	504.0	529.9	280.1	351.3
June	272.0	698.3	735.3	689.2	708.3
July	830.0	751.0	790.0	792.8	801.4
Aug.	805.0	729.0	767.2	770.7	735.0
Sept.	495.0	447.5	471.3	566.3	484.6
Total	3458.0	3129.8	3293.7	3299.1	3080.6

* CHU recordings started May 15.

3.2 PRECIPITATION

Table 5. Summary of Precipitation (mm) for Growing Seasons 1991 1990 and 1989 for RCAT, Doug Smith (DS) and Jack Rigby (JR)Locations.

Month	1991			1990	1989
	DS	JR	RCAT	RCAT	RCAT
May	129.0	95.5	129.5	71.0	132.3
June	30.0	20.6	29.2	47.0	88.6
July	90.0	75.4	84.8	93.0	34.8
Aug.	85.1	60.5	70.6	145.2	86.9
Sept.	26.0	19.1	25.9	123.4	52.1
Total	360.1	271.1	340.0	479.6	394.7

3.3 SOIL MOISTURE (% of Weight)

Mean soil moistures for the first 24 days after planting were significantly higher (17.0%) for DSRT than for DSCT (12.9%) (See appendix 1). The mean soil moistures between the JRZT and JRCT were both 14.4 (see appendix 2).

3.4 SOIL TEMPERATURE

Table 6 is a summary of soil temperature (ºC) within seedbed at 2 inch level listing minimum and maximum, GDD and accumulated GDD.

The daily soil growing degree days (GDD) were not significantly different between DSRT and DSCT from May 7 to 17 (see appendix 3), but were highly significant in difference between JRZT and JRCT (see appendix 4).

The average maximum soil temperatures in the DSRT and JRZT were 1.3º C and 1.6ºC higher and lower respectively than the respective conventional. Graven and Carter, and Fortin and Pierce showed that significant development delays took place when the difference in average maximum temperatures of the seed zone between bare and mulched treatments were greater or equal to 2.3 and 2.2º C respectively. The maximum temperature differences shown in Table 6 are considerably less than 2.2º C.

Table 6. Summary of Soil Temperatures (ºC) Within Seedbed at 2" Depth Listing Minimum and Maximum Daily GDD and Accumulated GDD.

Date	DSRT				DSCT				JRZT				JRCT			
1991	Min.	Max.	GDD	Accum.	Min.	Max.	GDD	Accum.	Min.	Max.	GDD	Accum.	Min.	Max.	GDD	Accum.
May 4	6.5	16.6	1.5	1.5												
5	12.5	12.2	2.35	3.85												
6	8.5	16.2	2.4	6.2												
7	9.2	20.2	4.7	10.9	10.0	20.0	4.9	4.9								
8	9.6	20.4	3.5	14.4	11.5	19.4	5.5	10.4								
9	7.4	24.4	5.9	20.3	8.4	22.9	5.7	16.0								
10	11.1	28.1	9.6	29.9	11.9	24.0	8.0	24.0	13.5	22.0	7.8	7.8	14.0	23.5	8.8	8.8
11	14.8	23.2	9.0	38.9	14.9	22.8	8.9	32.8	15.3	20.9	8.1	15.9	15.7	21.5	8.6	17.4
12	14.8	29.9	12.4	51.2	14.7	28.2	11.6	44.4	15.3	26.0	10.7	26.5	14.4	28.5	11.5	28.8
13	21.3	28.6	15.0	66.2	19.7	30.0	14.9	59.3	20.7	27.3	14.0	40.5	20.4	28.4	14.4	43.2
14	22.4	33.0	17.7	83.9	20.8	30.6	15.7	75.0	18.7	29.5	14.1	54.6	18.9	31.7	15.3	58.5
15	20.6	32.0	16.3	100.2	20.0	30.2	15.1	90.1	19.5	30.2	14.8	69.4	19.5	32.0	15.8	74.3
16	21.8	32.5	17.2	117.3	20.6	30.5	15.6	105.6	19.7	31.0	15.4	84.8	19.7	32.5	16.1	90.4
17	13.3	26.0	9.7	127.0	14.1	25.0	9.6	115.1	13.1				14.0			
Avg.	15.1	27.1	11.0		15.1	25.8	10.5		17.5	26.7	12.1		17.5	28.3	13.0	

3.5 COLEOPTILE EMERGENCE

Table 7. Summary of Mean Coleoptile Emergence of Hybrids in GDD. See appendix 5, 6, 7, 8, 9, and 10 for Analysis Summary.

Trial	Location		Signif. @ 0.05	Location		Signif. @ 0.05	No. of Hybrids
	DSRT	DSCT		JRZT	JRCT		
Early	91.8 (11.4)	89.2 (8.9)	* (**)	79.1 (6.6)	81.6 (6.4)	N.S. (N.S.)	26
Full Season	94.0 (11.4)	88.7 (8.9)	** (**)	80.0 (6.7)	78.5 (6.3)	N.S. (**)	12
Late	95.5 (11.6)	87.7 (8.8)	** (**)	77.8 (6.5)	81.1 (6.4)	** (N.S.)	20
Average	93.8 (11.5)	88.5 (8.9)		79.0 (6.6)	80.4 (6.4)		

( ) days from planting to coleoptile emergence.

See appendix 5a to 9a for analysis summary of mean coleoptile emergence in days from planting.

The days from planting to 50% of coleoptile emergence were recorded within a 1/1000 staked section within each plot.

3.6 V-1 DEVELOPMENT

Table 8. Summary of mean V-1 development of hybrids in days from planting. See Appendix 11, 12, 13, 14, 15, and 16 for analysis summary.

Trial	Location		Signif. @ 0.05	Location		Signif. @ 0.05	No. of Hybrids
	DSRT	DSCT		JRZT	JRCT		
Early	13.3 (120.2)	10.6 (111.4)	**	8.8	8.6	N.S.	26
Full Season	13.3 (120.2)	10.4 (109.4)	**	8.8	8.6	N.S.	12
Late	13.2 (119.2)	10.6 (111.4)	**	8.6	8.4	N.S.	20
Average	13.3	10.5		8.7	8.5		

( ) Soil GDD for V-1 development.

The days from planting to 50% of plants at respective stage of leaf development were recorded within a 1/1000 staked section within each plot.

3.7 V-2 TO V-5 DEVELOPMENT

Table 9. Summary of Stages V-2 to V-5 Leaf Development Measured in Days From Planting. See Appendix 17 to 37 For Detailed Analysis.

Stage of Leaf Develop.	Trial	Location					
		DSRT	DSCT	Signif. at 0.05	JRZT	JRCT	Signif. at 0.05
V-2	Early	17.7	15.2	**	13.3	13.1	**
	Full Season	17.4	15.1	**	13.3	13.2	N.S.
	Late	18.5	15.5	**	13.7	13.5	**
	Average	17.9	15.3		13.4	13.3	
V-3	Early	21.2	18.4	**	16.0	16.0	N.S.
	Full Season	21.1	18.3	**	16.0	16.0	N.S.
	Late	21.6	18.4	**	16.0	16.0	N.S.
	Average	21.3	18.4		16.0	16.0	
V-4	Early	23.8	21.9	**	19.4	19.9	**
	Full Season	23.5	21.9	**	19.5	19.9	**
	Late	24.7	21.7	**	19.7	19.8	N.S.
	Average	24.0	21.8		19.5	19.9	
V-5	Early	26.4	24.4	**	24.4	24.8	**
	Full Season	26.3	24.5	**	24.3	24.8	**
	Late	26.8	24.2	**	24.5	24.7	N.S.
	Average	26.5	24.4		24.8	24.8	

3.8 PERCENT EMERGENCE AT V-3 AND FINAL HARVEST STAND.

See appendix 38 to 43 for analysis summary for percent emergence and 44 to 49 for percent final stand. The percent final stand data was taken as actual plant count at harvest time from the entire 2-row plot. Thus the possibility of a higher final plant stand than percent emergence.

Table 10. Summary of Percent Emergence at V-3 and Percent Final Stand at Harvest For Trials in 4 Tillage Systems.

Trial	Percent Emergence						Percent Final Stand					
	Tillage						Tillage					
	DSRT	DSCT	Signif. at 0.05	JRZT	JRCT	Signif. at 0.05	DSRT	DSCT	Signif. at 0.05	JRZT	JRCT	Signif. at 0.05
Early	81.9	88.0	**	78.6	78.7	N.S.	85.8	90.0	**	73.6	72.6	N.S.
Full Season	86.2	91.7	**	79.8	77.8	N.S.	87.7	91.3	**	76.9	71.1	**
Late	80.7	90.0	**	74.9	77.0	N.S.	85.8	92.0	**	79.1	69.2	**
Average	82.9	89.9		77.8	77.8		86.4	91.1		76.5	71.0	

3.9 DAYS TO 50% POLLEN SHED AND 50% SILK EMERGENCE.

See Table 11.

3.10 HARVEST MOISTURE AND YIELD PERFORMANCE

See Table 12.

Table 11. **Summary of Days to 50% Pollen Shed and 50% Silk Emergence for 3 Trials in 4 Tillage Systems.**
(See Appendix 50 to 55 For Analysis Summary of 50% Pollen, and 56 to 61 for 50% Silk.)

Trial	Days to 50% Pollen Shed						Days to 50% Silk Emergence					
	Tillage Systems						Tillage Systems					
	DSRT	DSCT	Signif. at 0.05	JRZT	JRCT	Signif. at 0.05	DSRT	DSCT	Signif. at 0.05	JRZT	JRCT	Signif. at 0.05
Early	65.6	66.7	**	57.8	59.2	**	66.4	67.2	**	58.5	59.4	**
Full Season	66.1	69.9	**	60.4	60.9	N.S.	67.1	69.8	**	60.9	61.3	N.S.
Late	71.9	72.3	N.S.	63.9	63.1	**	72.3	72.4	N.S.	63.8	63.3	N.S.
Average	67.9	69.6		60.7	61.1		68.6	69.8		61.1	61.3	

Table 12. **Summary of Harvest Moisture and Yield Performance for 3 Trials in the 4 Tillage Systems.**
(See Appendix 62 to 67 for Analysis Summary of Harvest Moisture, and 68 to 73 For Yield Performance.)

Trial	Harvest Moisture						Yield Performance					
	Tillage Systems						Tillage Systems					
	DSRT	DSCT	Signif. at 0.05	JRZT	JRCT	Signif. at 0.05	DSRT	DSCT	Signif. at 0.05	JRZT	JRCT	Signif. at 0.05
Early	15.0	14.1	**	14.8	15.2	N.S.	134.5	119.7	**	158.6	138.5	**
Full Season	16.9	16.3	*	17.0	17.4	*	142.2	146.2	N.S.	164.2	161.5	N.S.
Late	21.8	18.6	**	21.9	22.0	N.S.	140.5	141.7	N.S.	164.4	163.2	N.S.
Average	17.9	16.3		17.9	18.2		139.2	135.9		162.4	154.4	

3.11 PERCENT BROKEN STALKS AT HARVEST TIME

Table 13. Summary of percent broken stalks at harvest time for 3 trials in the 4 tillage systems. (See appendix 74 to 79 for analysis summary.)

Trial	Percent Broken Stalks					
	Tillage Systems					
	DSRT	DSCT	Signif. at 0.05	JRZT	JRCT	Signif. at 0.05
Early	1.2	6.6	**	1.8	1.9	N.S.
Full Season	0.7	7.9	**	2.2	2.8	N.S.
Late	1.8	8.4	**	3.5	1.9	**
Average	1.2	7.6		2.5	2.2	

3.12

Table 14. Trial Summary of 1991 Early Season (2850-3050 CHU) for All Variables Measured.

Variables	JRZT	JRCT	Signif. t.05	DSRT	DSCT	Signif. t.05	CV	LSD .05	EMS	d.f.	# Obs / $\overline{x}$
Coleoptile Emergence	79.1	81.6	N.S.	91.8	89.2	*	5.0				
V-1 (days)	8.8	8.6	N.S.	120.6	111.0	**	4.6	0.15	0.226	204	78
V-2 (days)	13.3	13.1	**	17.7	15.2	**	3.4	0.16	0.261	204	78
V-3 (days)	16.0	16.0	N.S.	21.2	18.4	**	1.5	0.08	0.069	204	78
V-4 (days)	19.4	19.9	**	23.8	21.9	**	2.4	0.16	0.253	204	78
V-5 (days)	24.4	24.8	**	26.4	24.4	**	1.7	0.13	0.179	204	78
% Emergence	78.6	78.7	N.S.	81.9	88.0	**	9.8	2.5	64.092	204	78
% Final Harvest Stand	73.6	72.6	N.S.	85.8	90.0	**	10.3	2.6	68.339	204	78
Days From Planting to 50% Pollen Shed	57.8	59.2	**	65.6	66.7	**	2.97	0.58	3.421	204	78
Days From Planting to 50% Silking	58.5	59.4	**	66.4	67.2	**	2.9	0.58	3.379	204	78
% Harvest Moisture	14.8	15.2	N.S. (*0.08)	15.0	14.1	**	5.4	0.25	0.628	204	78
% Broken Stalks	1.8	1.9	N.S.	1.2	6.6	**	92.1	0.83	7.03	204	78
Yield (Bu./A)	158.6	138.5	**	134.5	119.7	**	10.8	4.6	219.956	204	78

Significance at $t_{0.05}$ is based on paired-t test made for variable measured comparing the conservation tillage to the conventional. The C.V. and L.S.D. $_{0.05}$.; was determined from the analysis of variance combining all four tillage systems.

3.13

Table 15. Trial Summary of 1991 Full Season (3075-3200 CHU) for All Variables Measured.

Variables	JRZT	JRCT	Signif. t.05	DSRT	DSCT	Signif. t.05	CV	LSD .05	EMS	d.f.	# Obs / $\bar{x}$
Coleoptile Emergence	80.0	78.5	N.S.	94.0	88.7	**					
V-1 (days)	8.8	8.6	N.S.	13.3	10.4	**	4.95	0.24	0.26	92	36
V-2 (days)	13.3	13.2	N.S.	17.4	15.1	**	2.92	0.20	0.186	92	36
V-3(days)	16.0	16.0	N.S.	21.1	18.3	**	1.41	0.12	0.063	92	36
V-4(days)	19.5	19.9	**	23.5	21.9	**	3.36	0.23	0.249	92	36
V-5(days)	24.3	24.8	**	26.3	24.5	**	1.71	0.20	0.182	92	36
% Emergence	79.8	77.8	N.S.	86.2	91.7	**	12.35	4.85	107.2	92	36
% Final Harvest Stand	76.9	71.1	**	87.7	91.3	**	8.89	3.40	52.839	92	36
Days From Planting to 50% Pollen Shed	60.4	60.9	N.S.	66.1	69.9	**	2.6	0.77	2.728	92	36
Days From Planting to 50% Silking	60.9	61.3	N.S.	67.1	69.8	**	2.7	0.82	3.058	92	36
% Harvest Moisture	16.96	17.4	*	16.9	16.3	*	4.86	0.38	0.675	92	36
% Broken Stalks	2.2	2.8	N.S.	0.7	7.9	**	74.34	1.19	6.420	92	36
Yield (Bu./A)	164.2	161.5	N.S.	142.7	146.2	N.S.	10.66	7.66	267.977	92	36

3.14

Table 16. Trial Summary of 1991 Late Season (3300-3425 CHU) for All Variables Measured.

Variables	JRZT	JRCT	Signif. t.05	DSRT	DSCT	Signif. t.05	CV	LSD .05	EMS	d.f.	# Obs / $\bar{x}$
Coleoptile Emergence	77.8	81.1	**	95.5	87.7	**	6.0	0.18	0.248	156	60
V-1 (days)	8.6	8.4	N.S.	13.2	10.6	**	4.23	0.15	0.186	156	60
V-2 (days)	13.7	13.5	**	18.5	15.5	**	3.67	0.20	0.315	156	60
V-3(days)	16.0	16.0	N.S.	21.6	18.4	**	2.62	0.17	0.223	156	60
V-4(days)	19.7	19.8	N.S.	24.7	21.7	**	2.09	0.16	0.202	156	60
V-5(days)	24.5	24.7	N.S.	26.8	24.2	**	1.68	0.15	0.177	156	60
% Emergence	74.9	77.0	N.S.	80.7	90.0	**	10.1	2.91	66.19	156	60
% Final Harvest Stand	79.1	69.2	**	85.8	92.0	**	8.65	2.52	49.715	156	60
Days From Planting to 50% Pollen Shed	63.9	63.1	**	71.9	72.3	N.S.	2.28	0.55	2.397	156	60
Days From Planting to 50% Silking	63.8	63.3	N.S.	72.3	72.4	N.S.	2.18	0.53	2.198	156	60
% Harvest Moisture	21.9	22.0	N.S.	21.8	18.6	**	5.91	0.45	1.55	156	60
% Broken Stalks	3.5	1.9	**	1.8	8.4	**	78.8	1.09	9.328	156	60
Yield (Bu/A)	164.4	163.2	N.S.	140.5	141.7	N.S.	9.86	5.38	226.1	156	60

SECTION 3.15 Individual Trial By Tillage Summary

Table 17. Summary of individual hybrid agronomic performances. Hybrids are ranked on basis of yield performance.

EARLY SEASON SWEEP TRIALS 1991 (2850 -3050 CHU)

TILLAGE TYPE	LOC.	HYBRID	% Final STAND	% B.S.	% H2O	YIELD BU\AC	YIELD INDEX
RIDGE	SMITH	DEKALB DK-485	80	1	15.4	156	1.16
		PIONEER 3831	89	1	14.6	156	1.16
		JACQUES 49O0	88	1	15.6	154	1.15
		CARGILL 3477	84	1	14.5	146	1.09
		GOLDN. HAR. H2331	89	2	16.6	145	1.08
		PIONEER 3751	89	2	15.0	144	1.07
		PIONEER 3772	89	1	14.3	140	1.04
		PIONEER 3794	90	1	15.4	139	1.04
		DEKALB DK-445	85	1	15.2	139	1.04
		DEKALB OK-415	93	2	13.5	138	1.03
		PIONEER 3737	84	1	15.5	138	1.03
		DEKALB DK-403	88	1	14.2	137	1.02
		RENK RK602	86	0	15.5	136	1.01
		GARST 8808	84	0	15.3	136	1.01
		GOLDN.HAR. H2343	89	0	15.2	135	1.01
		FUNK G-4140	95	0	14.2	134	1.00
		N.K. PX9214	87	3	14.0	132	0.99
		GARST 8882	88	1	15.6	132	0.99
		FERGUSON 8758	85	1	15.7	131	0.98
		PIONEER 3790	87	1	15.2	130	0.97
		ASGROW RX370	88	3	15.4	129	0.96
		PIONEER 3901	83	1	14.8	127	0.95
		ASGROW RX409	91	1	13.8	122	0.91
		DEKALB DK-403	83	1	14.7	119	0.89
		PRIDE K337	93	2	15.1	109	0.81
		FERGUSON 8855	55	2	15.2	92	0.69
		AVERAGE	86	1	15.0	134	

Table 18. **Summary of individual hybrid agronomic performances. Hybrids are ranked on basis of yield performance.**

EARLY SEASON SWEEP TRIALS 1991 (2850 -3050 CHU)

TILLAGE TYPE	LOC.	HYBRID	% Final STAND	% B.S.	% H2O	YIELD BU\AC	YIELD INDEX
CONV.	SMITH	DEKALB DK-403	91	5	13.6	149	1.24
		RENK RK602	93	7	14.3	146	1.22
		PIONEER 3751	92	7	14.2	136	1.13
		PIONEER 3794	89	4	14.3	135	1.13
		PIONEER 3831	92	3	14.0	135	1.13
		PIONEER 3737	93	10	14.2	134	1.12
		PIONEER 3901	90	6	14.0	131	1.09
		GOLDN. HAR. H2343	89	7	14.0	129	1.08
		PIONEER 3790	93	6	14.7	128	1.07
		GOLDN. HAR. H2331	85	20	14.5	123	1.03
		N.K. PX9214	95	4	14.7	121	1.01
		ASGROW RX409	86	3	14.0	121	1.01
		CARGILL 3477	93	4	13.8	120	1.00
		GARST 8808	93	8	14.0	118	0.98
		DEKALB DK-415	94	5	13.8	116	0.97
		GARST 8882	90	9	13.5	116	0.97
		FUNK G-4140	89	5	14.2	114	0.95
		PIONEER 3772	92	5	14.2	113	0.94
		DEKALB DK-485	87	6	15.3	113	0.94
		FERGUSON 8758	90	7	14.9	113	0.94
		PRIDE K337	91	6	14.6	110	0.92
		FERGUSON 8855	63	12	13.9	103	0.86
		JACQUES 4900	90	6	14.3	102	0.85
		DEKALB DK-445	90	9	14.1	99	0.83
		DEKALB DK-403	95	3	12.5	96	0.80
		ASGROW RX370	94	7	13.7	90	0.75
		AVERAGE	90	7	14.1	120	

Table 19. **Summary of individual hybrid agronomic performances. Hybrids are ranked on basis of yield performance.**

EARLY SEASON SWEEP TRIALS 1991 (2850 - 3050 CHU)

TILLAGE TYPE	LOC.	HYBRID	% Final STAND	% B.S.	% H2O	YIELD BU\AC	YIELD INDEX
ZONE TILL	RIGBY	FERGUSON 8758	71	1	16.5	179	1.13
		FUNK G-4140	77	2	15.1	178	1.12
		N.K. PX9214	80	2	14.7	172	1.08
		PIONEER 3751	70	2	15.0	172	1.08
		GOLDN. HAR. H2343	69	2	15.5	171	1.08
		PIONEER 3831	82	0	14.2	171	1.08
		GARST 8808	74	1	14.9	169	1.06
		PIONEER 3737	74	2	14.2	168	1.06
		JACQUES 4900	79	2	15.7	167	1.05
		DEKALB DK-403	69	3	15.0	166	1.04
		GOLDN. HAR.H2331	81	1	15.6	163	1.03
		PIONEER 3790	71	1	15.4	162	1.02
		PIONEER 3901	73	1	14.5	160	1.01
		RENK RK602	77	3	14.2	158	0.99
		PIONEER 3794	76	2	14.9	156	0.98
		DEKALB DK-485	62	3	16.8	154	0.97
		DEKALB DK-415	82	0	14.4	154	0.97
		PIONEER 3772	71	0	14.5	153	0.96
		ASGROW RX370	82	2	13.7	151	0.95
		CARGILL 3477	76	2	14.3	151	0.95
		DEKALB DK-403	79	1	12.6	150	0.94
		DEKALB DK-445	70	1	15.2	145	0.91
		ASGROW RX409	69	1	14.5	143	0.90
		FERGUSON 8855	61	4	14.1	139	0.87
		PRIDE K337	67	2	15.3	138	0.87
		GARST 8882	71	5	14.0	135	0.85
		AVERAGE	74	2	14.8	159	

Table 20. Summary of individual hybrid agronomic performances. Hybrids are ranked on basis of yield performance.

EARLY SEASON SWEEP TRIALS 1991 (2850 - 3050 CHU)

TILLAGE TYPE	LOC.	HYBRID	% Final STAND	% B.S.	% H2O	YIELD BU\AC	YIELD INDEX
CONV.	RIGBY	DEKALB DK-485	74	3	16.0	168	1.21
		JACQUES 4900	71	1	16.5	161	1.16
		PIONEER 3790	74	1	15.4	152	1.09
		PIONEER 3831	80	0	15.1	151	1.09
		PIONEER 3794	79	1	16.3	151	1.09
		PIONEER 3751	75	3	15.1	149	1.07
		GARST 8882	70	2	14.6	149	1.07
		N.K. PX9214	71	1	15.6	148	1.06
		GOLDN. HAR. H2343	73	3	15.8	145	1.04
		GOLDN. HAR. H2331	80	5	15.1	145	1.04
		ASGROW RX370	76	1	16.0	144	1.04
		RENK RK602	68	1	15.7	142	1.02
		DEKALB DK-415	82	1	13.4	142	1.02
		CARGILL 3477	74	1	15.5	141	1.01
		PIONEER 3737	75	3	16.4	140	1.01
		FUNK G-4140	65	3	13.7	136	0.98
		DEKALB DK-445	72	2	15.7	136	0.98
		PIONEER 3772	78	1	14.8	132	0.95
		DEKALB DK-403	74	1	13.1	132	0.95
		ASGROW RX409	66	2	14.7	131	0.94
		GARST 8808	73	0	14.2	127	0.91
		PRIDE K337	68	3	15.7	126	0.91
		FERGUSON 8855	50	9	17.6	123	0.88
		PIONEER 3901	70	1	15.1	121	0.87
		DEKALB DK-403	66	1	14.4	112	0.81
		FERGUSON 8758	84	1	14.5	98	0.71
		AVERAGE	73	2	15.2	139	

Table 21. **Summary of individual hybrid agronomic performances. Hybrids are ranked on basis of yield performance.**

FULL SEASON SWEEP TRIALS 1991 (3075 - 3200 CHU)

TILLAGE TYPE	LOC.	HYBRID	% Final STAND	% B.S.	% H2O	YIELD BU\AC	YIELD INDEX
RIDGE	SMITH	FUNK G-4309	86	1	17.8	160	1.12
		PIONEER 3573	91	0	17.8	159	1.11
		PIONEER 3733	91	0	16.3	154	1.08
		DEKALB DK-524	86	1	18.2	152	1.06
		GOLDN. HAR. H2410	83	2	17.3	151	1.06
		CARGILL 3637	93	1	16.7	141	0.99
		SUPERCROST 2277	84	0	16.3	138	0.97
		FUNK G-4299	88	1	16.2	138	0.97
		CARDINAL MX320	91	2	16.8	136	0.95
		GOLDN. HAR. H2404	86	0	17.5	131	0.92
		N.K. N4350	88	1	15.3	126	0.88
		HYLAND HL2570	87	0	17.1	125	0.87
		AVERAGE	88	1	16.9	143	

Table 22. **Summary of individual hybrid agronomic performances. Hybrids are ranked on basis of yield performance.**

FULL SEASON SWEEP TRIALS 1991 (3075— 3200 CHU)

TILLAGE TYPE	LOC.	HYBRID	% Final STAND	% B. S.	% H2O	YIELD BU\AC	YIELD INDEX
CONV.	SMITH	PIONEER 3573	99	11	17.0	180	1.23
		PIONEER 3733	87	4	16.7	159	1.09
		DEKALB DK-524	95	7	16.6	156	1.07
		GOLDN. HAR. H2410	86	9	17.2	148	1.01
		GOLDN. HAR. H2404	92	7	17.1	147	1.01
		SUPERCROST 2277	84	7	16.4	146	1.00
		FUNK G-4299	90	11	15.9	143	0.93
		HYLAND HL2570	90	7	17.5	141	0.97
		FUNK G-4309	94	7	16.5	140	0.96
		N.K. N4350	90	8	14.9	140	0.96
		CARGILL 3637	97	10	14.5	133	0.91
		CARDINAL MX32O	91	6	15.7	120	0.82
		AVERAGE	91	8	16.3	146	

Table 23. **Summary of individual hybrid agronomic performances. Hybrids are ranked on basis of yield performance.**

FULL SEASON SWEEP TRIALS 1991 (3075 — 3200 CHU)

TILLAGE TYPE	LOC.	HYBRID	% Final STAND	% B.S.	% H2O	YIELD BU\AC	YIELD INDEX
ZONE TILL	RIGBY	FUNK G-4309	74	2	18.9	176	1.07
		HYLAND HL2570	84	2	17.6	176	1.07
		PIONEER 3733	77	1	16.4	174	1.06
		GOLDN. HAR. H2410	70	4	17.1	170	1.04
		PIONEER 3573	77	1	17.4	167	1.02
		N.K. N4350	77	1	14.6	166	1.01
		FUNK G-4299	77	2	15.7	166	1.01
		CARGILL 3637	80	5	16.6	165	1.01
		SUPERCROST 2277	74	2	17.7	160	0.98
		DEKALB DK-524	73	4	17.3	158	0.96
		GOLDN. HAR. H2404	79	2	17.5	153	0.93
		CARDINAL MX320	81	2	16.7	138	0.84
		AVERAGE	77	2	17.0	164	

Table 24. Summary of individual hybrid agronomic performances. Hybrids are ranked on basis of yield performance.

FULL SEASON SWEEP TRIALS 1991 (3075 — 3200 CHU)

TILLAGE TYPE	LOC.	HYBRID	% Final STAND	% B.S.	% H2O	YIELD BU\AC	YIELD INDEX
CONV.	RIGBY	GOLDN. HAR. H2410	68	8	17.8	176	1.09
		PIONEER 3573	74	3	17.3	175	1.09
		GOLDN. HAR. H2404	87	0	18.3	173	1.07
		FUNK G-4309	70	2	18.2	167	1.04
		HYLAND HL2570	71	3	17.3	166	1.03
		PIONEER 3733	67	1	17.3	164	1.02
		FUNK G-4299	73	1	16.4	157	0.98
		CARGILL 3637	66	8	17.2	156	0.97
		SUPERCROST 2277	67	1	17.3	154	0.96
		DEKALB DK-524	70	3	18.4	151	0.74
		CARDINAL MX320	70	2	18.3	149	0.93
		N.K. N4350	71	3	15.6	149	0.93
		AVERAGE	71	3	17.5	161	

Table 25. **Summary of individual hybrid agronomic performances. Hybrids are ranked on basis of yield performance.**

LATE SEASON SWEEP TRIALS 1991 (3300 - 3425 CHU)

TILLAGE TYPE	LOC.	HYBRID	% Final STAND	% B.S.	% H2O	YIELD BU\AC	YIELD INDEX
RIDGE	SMITH	AGRISEED 501	99	2	22.4	173	1.23
		GREAT LAKES GL582	87	1	23.0	171	1.21
		HYLAND HL2729	89	2	20.2	165	1.17
		PIONEER 3475	91	1	20.1	164	1.16
		GARST 8555	86	1	21.8	158	1.12
		FUNK G-4385	91	0	20.8	150	1.06
		FERGUSON 8965	92	2	19.5	147	1.04
		AGRISEED 502	81	1	22.8	146	1.04
		CARGILL 4327	87	3	18.6	146	1.04
		DEKALB DK-535	88	0	22.1	142	1.01
		CARDINAL MX335	87	3	22.3	141	1.00
		HYLAND HL2803	88	6	21.9	140	0.99
		FIRST LINE 1793	83	2	21.8	135	0.96
		PICKSEED 8898	84	2	21.6	132	0.94
		FERGUSON 8969	87	3	24.6	127	0.90
		FUNK G-4447	85	2	23.6	126	0.89
		RENK RK64	79	2	21.5	126	0.89
		SUPERCROST 2989	80	1	22.6	119	0.84
		JACQUES 7700	83	2	23.8	117	0.83
		PICKSEED 8877	72	1	20.6	86	0.61
		AVERAGE	89	5	20.1	141	

Table 26. **Summary of individual hybrid agronomic performances. Hybrids are ranked on basis of yield performance.**

LATE SEASON SWEEP TRIALS 1991 (3300 - 3425 CHU)

TILLAGE TYPE	LOC.	HYBRID	% Final STAND	% B.S.	% H2O	YIELD BU\AC	YIELD INDEX
CONV.	SMITH	PIONEER 3475	97	5	18.2	176	1.24
		CARGILL 4327	95	7	18.5	172	1.21
		GARST 8555	82	14	19.1	162	1.14
		FIRST LINE 1783	94	7	19.2	159	1.12
		CARDINAL MX335	91	12	18.6	157	1.11
		FUNK G-4447	91	6	19.4	146	1.03
		GREAT LAKES GL582	90	7	20.9	144	1.01
		FERGUSON 8969	92	11	20.7	144	1.01
		DEKALB DK-535	95	4	16.9	144	1.01
		JACQUES 7700	92	11	18.1	141	0.99
		FERGUSON 8965	95	12	15.8	139	0.98
		AGRISEED 502	93	8	20.3	138	0.97
		HYLAND HL2803	97	5	18.0	137	0.96
		AGRISEED 501	96	12	19.7	136	0.96
		RENK RK64	91	7	20.1	134	0.94
		FUNK G-4385	93	4	16.2	128	0.90
		SUPERCROST 2989	88	12	18.6	126	0.89
		PICKSEED 8898	84	7	17.3	118	0.83
		HYLAND HL2729	92	7	16.4	118	0.83
		PICKSEED 8877	84	8	19.2	117	0.82
		AVERAGE	92	8	18.6	142	

Table 27. **Summary of individual hybrid agronomic performances. Hybrids are ranked on basis of yield performance.**

LATE SEASON SWEEP TRIALS 1991 (3300 - 3425 CHU)

TILLAGE TYPE	LOC.	HYBRID	% Final STAND	% B.S.	% H2O	YIELD BU\AC	YIELD INDEX
ZONE TILL	RIGBY	AGRISEED 501	87	5	22.3	186	1.22
		GREAT LAKES GL582	67	2	22.8	183	1.20
		DEKALB DK-535	79	1	21.2	176	1.16
		FERGUSON 8969	76	1	22.6	176	1.16
		HYLAND HL2803	85	4	23.0	173	1.14
		PIONEER 3475	75	2	19.7	170	1.12
		GARST 8555	83	3	23.1	168	1.11
		FERGUSON 8965	79	3	18.9	167	1.10
		JACQUES 7700	79	5	23.1	166	1.09
		AGRISEED 502	84	4	25.7	165	1.09
		HYLAND HL2729	82	5	16.8	165	1.09
		FUNK G-4385	85	1	20.3	164	1.08
		PICKSEED 8898	82	4	22.2	160	1.05
		CARGILL 4327	81	4	20.7	158	1.04
		SUPERCROST 2989	80	6	23.3	157	1.03
		RENK RK64	74	4	21.4	157	1.03
		FIRST LINE 1783	76	2	22.8	155	1.02
		FUNK G-4447	78	4	23.2	154	1.01
		PICKSEED 8877	79	2	22.5	144	0.95
		CARDINAL MX335	71	6	23.0	143	0.94
		AVERAGE	82	4	21.0	152	

Table 28. Summary of individual hybrid agronomic performances. Hybrids are ranked on basis of yield performance.

LATE SEASON SWEEP TRIALS 1991 (3300 - 3425 CHU)

TILLAGE TYPE	LOC.	HYBRID	% Final STAND	% B.S.	H2O	YIELD BU\AC	YIELD INDEX
CONV.	RIGBY	AGRISEED 501	78	2	23.5	178	1.20
		PICKSEED 8898	71	3	22.2	174	1.18
		FIRST LINE 1783	77	2	23.2	173	1.17
		RENK RK64	72	1	22.8	173	1.17
		FUNK G-4385	72	1	20.4	172	1.16
		HYLAND HL2729	68	4	17.2	171	1.16
		FERGUSON 8965	77	1	19.0	171	1.16
		CARDINAL MX335	76	2	23.5	169	1.14
		JACQUES 7700	69	0	23.2	167	1.13
		AGRISEED 502	71	2	25.0	166	1.12
		FERGUSON 8969	63	2	23.4	165	1.11
		GREAT LAKES GL582	63	3	24.1	164	1.11
		DEKALB DK-535	64	0	20.0	160	1.08
		PICKSEED 8877	69	2	22.6	158	1.07
		CARGILL 4327	62	3	20.0	158	1.07
		PIONEER 3475	55	0	20.0	158	1.07
		SUPERCROST 2989	64	1	22.0	156	1.05
		GARST 8555	74	1	23.0	152	1.03
		FUNK G-4447	69	3	22.3	140	0.95
		HYLAND HL2803	69	4	23.4	138	0.93
		AVERAGE	83	4	20.7	148	

4.0 DISCUSSION

4.1 PRECIPITATION AND CHU FOR THE 1991 GROWING SEASON

The growing season of 1991 developed into a most unusual one. Early planting was delayed due to wet field conditions and did not get started until about May 3rd. Once planting was underway, less than average precipitation was received for the remainder of the growing season (Table 5). Actual drought conditions did develop for the region.

Similarly the air temperatures increased rapidly and by the 7th of May were reaching daily highs of over 20º C. Correspondingly the soil temperatures warmed up rapidly and reached daily maximums of 20º C plus by May 7th and daily minimums were in the double digit teens by May 10th (Table 6).

The total CHU accumulations for May and June were 529.9 and 735.3 respectively for R.C.A.T. which was 170% and 105% of normal. Through the remainder of the growing season the CHU accumulation continued more normal and July, August and September were 98%, 102%,and 92% respectively of normal (Table 4).

Soil moistures for the first 24 days based on weight are referred to in section 3.3. They were the same for JRZT and JRCT, however, the DSRT did maintain a higher soil moisture level than the DSCT.

4.2 SOIL TEMPERATURES

Differences in average daily maximum temperatures of the seed zone between the conservation tillage systems and conventional need to be equal to or greater than 2.2º C (Fortin and Pierce, Graven and Carter) to give significant delay in early plant growth.

The average maximum soil temperatures for the DSRT were 1.3º C higher (not significant) and the JRZT were 1.6º C lower (highly significant) than the respective CT. Not only were the differences less than referred research has shown is required to give real plant growth differences, but the average daily minimum and maximum were in mid teens and mid to high twenties respectively (excessively high). The seedbed conditions required to establish whether a relationship exists between field coleoptile emergence and the cold tolerance predictor determined by Hope definitely did not exist in 1991.

4.3 RESIDUE

Residue management systems for conservation tillage in southwestern Ontario vary considerably. The amount of across-row residue measured and recorded in Table 1 was 46% and 35% respectively for DSRT and JRZT, which is about 45-50% of that referred to by Graven and Cater

(82-68%), and Hallower and Calvin (75-85%). Fortin and Pierce worked with 100% residue cover applied to the plots after plant emergence.

It is estimated that the major proportion of conservation tillage systems used in southwestern Ontario have a 3" to 4" band tilled for the seedbed leaving minimal residue in this zone. The in-between row residue density will vary based on the previous crop and level of tillage.

4.4 COLEOPTILE EMERGENCE

Table 7 summarizes the coleoptile emergence for the respective tillage systems in both days from planting and GDD.

The DCRT was planted 3 days earlier than the DSCT and had accumulated 6.2 GDD by the time the DSCT was planted. Therefore, the average difference of 2.6 days or 6.2 GDD can be accounted for due to 3 days earlier planting and cooler soil temperatures during these first 3 days.

It can be assumed that the differences measured in rate of coleoptile emergence were probably due to the genetic differences for vigour or seed quality affecting vigour and not due to cold seedbed conditions due to the fact they did not exist.

4.5 V-1 TO V-5 DEVELOPMENT

The V-1 to V-5 data is summarized in Tables 8 and 9. As discussed in section 4.4 the rate of leaf development was affected more by excessive warm soil conditions and seedling vigour which was due to either factors genetically controlled or seed quality.

4.6 PERCENT EMERGENCE AND FINAL STAND

The methodology for determining percent emergence and final stand was described in sections 3.6 and 3.8 respectively.

The lower DSRT percent emergence and final stand, 7.0 and 4.7 respectively, compared to the conventional is typical of other research comparing conservation tillage systems to conventional(Graven and Carter). The higher percent final stand of JRZT compared to JRCT was due to more severe cutworm activity in the conventional tillage system. The JRZT had a heavy infestation of chickweed which also attributed to the cutworm activity.

The excessive low final plant stand in the JRZT and JRCT trials certainly attributed to the higher variability in the yield performance values.

Seed quality in certain hybrids was also apparent as a contributing factor to percent emergence and final stand, example Ferguson 8855 (Table 17, 18, 19 and 20).

4.7 DAYS TO 50% POLLEN SHED AND SILK EMERGENCE

The trend indicated slightly earlier inflorescence development in the DSRT compared to the DSCT and also JRZT compared to the JRCT (see Table 11). The differences were slight (1.7 and 0.4 days respectively for pollen shed; 1.2 and 0.2 days for silk development). Attention must again be made to the excessive CHU accumulation up to and through florescence development which greatly affected hybrid development. During this period of time small amounts of precipitation did occur which relieved drought stresses enough for adequate pollen shed and silk emergence. Graven and Carter reported a 5 to 7 day delay in silking in the conservation tillage compared to the conventional tillage system.

4.8 PERCENT HARVEST GRAIN MOISTURE

The harvest grain moistures are summarized in Table 12. The DSRT harvest moistures averaged 1.6% wetter than those of the DSCT and the JRZT were 0.3% drier than those of the JRCT. The ridge till harvest moisture differences compared to the conventional show the same trend as reported by Graven and Carter.

The JRZT compared to JRCT difference of slightly drier harvest moistures for zone-tillage is not significant and was probably due to both drought and excessive heat conditions up to harvest time.

4.9 YIELD PERFORMANCE

The yield in bushels per acre at 15.5% moisture are summarized in Table 12 for the 4 tillage systems and 3 trials. Only the early season trial had a significantly greater yield in the DSRT and JRZT than compared to the conventional. Both the full season and late trials showed no significant difference in yield compared to the conventional. Graven and Carter reported 9% reduced grain yields under no-till compared to conventional for 1986 and no significant difference for 1987 and 1988.

Individual hybrid yield performances are summarized in Tables 17 to 28 by trial and tillage system. Differences in hybrid performance did occur, however, conclusions should not be made based on data from only one growing season. Attention should be drawn to the fact that the early season trial yielded significantly greater in both the DSRT and JRZT than the conventional. This probably reflects the performance interaction of the earlier hybrids in response to the drought and excessive heat.

4.10 PERCENT BROKEN STALKS

Table 13 summarizes the percent broken stalks for the 3 trials at each of the 4 tillage systems.

The DSRT had significantly lower stalk breakage than the DSCT (6.4% less). The JRZT had no significant difference in percent stalk breakage for both early and medium season trials compared to the JRCT, however, the late season hybrid trial had significantly higher stalk breakage (1.6% greater) in the JRZT compared to the JRCT. No real explanation can be given for the latter. The higher stalk breakage in the DSCT than DSRT was due to the lower plant stand and less moisture stress (Table 10 and Section 3.3).

4.11 HYBRID DIFFERENCES

The 1991 data did give significant hybrid by tillage differences for all variables measured. However, it is advised not to make any conclusions based on one year's data due to the unusually hot and dry growing season. As referred to earlier (Section 4.1), the early spring seedbed conditions to exemplify cold tolerance characteristics did not develop.

4.12 COLD TOLERANCE PREDICTOR FOR FIELD EMERGENCE

The cold tolerance predictor for field emergence (CTPfFE) developed and reported by Hope (Hope and Maamari, 1991) is strictly based on very sterile laboratory controlled conditions. Both the germination and early coleoptile growth conditions are very severe to detect and measure cold tolerance. The laboratory evaluations were made using seed from the identical seed lots used for 1991 and 1992 field evaluation. It is very tempting to make correlations of the CTPfFE with field yield performance of 1991. It has been referred to several times before that the early spring seedbed conditions did not develop to exemplify the potential hybrid by coleoptile emergence by tillage interactions for cold tolerance. It is anticipated that the 1992 field data will be more suitable for this use and hopefully 1993 will allow 2-year data to verify the usefulness of the CTPfFE.

The same hybrids tested in 1991 from the same seed lots were planted with the same co-operators in ridge-till, and zone-till compared to be compared to conventional at each location plus 28 new hybrids. Funding was obtained through Land Stewardship II, Ontario Corn Producers, Kent County Soil and Crop Improvement Association and seed corn companies for 1992 and in part for 1993.

4.13 YIELD PERFORMANCE CORRELATION WITH PERCENT FINAL STAND

This study did not hand-thin the plots to a constant density due to the fact that the true final performance required by a corn producer requires the corn hybrid to establish itself successfully from seeding time to harvest without any man induced alterations. The practice of hand-thinning for this type of evaluation was considered as a bias and thus was avoided. Testing accuracy in the 1991 trials was within that reported by Graven and Carter and other researchers who thinned.

The 1991 final stand did vary considerably both within and across the 4 tillage systems. It was anticipated that the final yield performance of the hybrids would be strongly correlated with the percent final stand. The correlation of final yield with percent final stand for each of the 4 tillage systems was DSRT = 56%, DSCT = 11%, JRZT = 35%, and JRCT = 11%. Each tillage system had 58 comparisons. Factors other than stand were involved in yield performances. It is not suggested that final stand cannot directly affect yield performance because it is recognized to be very important, however, in these trials in 1991 other factors contributed more to yield performance than final stand.

5.0 CONCLUSION SUMMARY

The attempt has been made to report the status of the research project for 1991 emphasizing that it is only one year of field data from 4 totally different environments which were all highly unusual from previous years.

It is emphasized that no conclusions should be made from these data. The data from 1992 and 1993 will be required to address the effectiveness of the cold tolerance predictor for field emergence.

The 1991, 1992, and 1993 field data will be supplied to Dr. H. Hope of the PRC and results from field trials will be based on the same seed sources. Every possible effort is being made to control potential differences due to seed quality for the laboratory testing by Dr. H. Hope and field testing at R.C.A.T.

In 1992, 28 new hybrids were added to the field evaluation in separate trials and were included in all four tillage systems.

RESEARCH REFERENCES

Aidun, V.L., W.N. Migus, and R.I. Hamilton. 1991. Use of inbred seedling cold tolerance to predict cold tolerance in maize (Zea mays L.). Can. J. Plant Sci. 71:663-667.

Al-Darby, A.M., and B. Lowery. 1986. Evaluation of corn growth and productivity with 3 conservation tillage systems. Agron. J. 78:901-907.

Brakke, J.P., C.A. Francis, L.A. Nelson, and C.D. Gardner. 1983. Genotype by cropping systems interactions in maize grown in a short season environment. Crop Sci. 23:868-870.

Carter, P.R., and K.H. Barnett. 1987.Corn hybrid performance under conventional and no-tillage systems after thinning. Agron. J. 79:919-926.

Fortin, M.C., and F.J. Pierce. 1991. Timing and nature of mulch retardation of corn vegetative development. Agron. J. 83:258-263.

Graven, L.M. and P.R. Carter. 1991. Seed quality effect on corn performance under conventional and no-tillage systems. J. Prod. Agric. 4:366-373.

Hallauer, A.R. and T.S. Calvin. 1985. Corn hybrids response to four methods of tillage. Agron. J. 77:547-550.

Hesterman, O.B., F.J. Pierce, and E.C. Rossman. 1988. Performance of commercial corn hybrids under conventional and no-tillage systems. J. Prod. Agric. 1:202-206.

Hope, H.J. and R. Maamari. 1990. Field emergence predictors for grain corn under no-till management. A report submitted to the Technology Evaluation and Development subprogram of the Soil and Water Environmental Enhancement Program in December, 1990.

Hope, H.J. and R. Maamari. 1991. A simplified screening test for field emergence of grain corn under no-till management. A report submitted to the Technology Evaluation and Development subprogram of the Soil and Water Environmental Enhancement Program. Sept. 1991.

North East Corn Improvement Conference, 1991. Report re personal attendance. Feb. 14-15, 1991.

Newhouse, K.E. and T.M. Crosbie. 1986. Interactions of maize hybrids with tillage systems. Agron. J. 78:951-954.

Wall, D.A. and E.H. Strobbe. 1983. The response of eight corn (Zea Mays L.) hybrids to zero-tillage in Manitoba. Can. J. Plant Sci. 63:753-757.

Corn Hybrid Response to Type of Tillage - TED, issue 9. Feb., 1991. Research Progress Summary: Ecological Services For Planning Ltd., Guelph, Ontario.

Ontario Corn Performance Recommendations, (OCPR) 1991. Published by the Ontario Corn Committee.

APPENDIX

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