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The Texas A&M University System

Result Demonstration Report

Evaluating Corn Row Spacing and Plant Population in theTexas Panhandle

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Summary

Studies were conducted in 1997, 1998, and 1999 in the Texas High Plains to determine the effect of row spacing and plant population on corn yield. Row spacings examined were 20, 30, and 40 inches. Plant populations ranged from 22,000 to 45,000 plants per acre. Studies were conducted near Hereford and Sunray, Texas.

In 1997, yields were highest in the 20 inch rows. Average yield increase for 20 inch vs. 30 inch rows was 11.1% under limited irrigation, and 13.9% with full irrigation. Yield was not significantly increased under limited or full irrigation by increasing plant population over approximately 27,000 plants/acre. In 1998 at Sunray, neither row spacing nor plant population had any effect on corn yield. It is possible that the lack of differences between treatments was due to the site's low yield potential in 1998. At Hereford, yields were extremely low due to the drought and lack of adequate irrigation capacity. Under these conditions the best plant population was at 22,000 plants/acre and the best row spacing was 40 inches. This was the opposite of what was observed in 1997. In 1999, yields were approximately 7% higher in the 30 inch rows compared to the 20 inch rows at both locations. At Sunray, yields were highest when plant population was at least 38,000 per acre. At Hereford, plant population did not significantly effect yield.

Of the six studies conducted in 1997, 1998, and 1999, only two of the studies, those conducted in 1997, showed a significant yield advantage of 20 inch rows over 30 inch rows. These results suggest that farmers in the Texas High Plains should not expect an automatic 5 to 10 percent increase in yield as has been reported from the midwest by converting from traditional 30 inch rows to 20 inch rows. Possible advantages of 20 inch rows is better weed control due to quicker shading of the soil, less lodging late in the season, and quicker canopy formation following a hail. However, some disadvantages are that the 20 inch rows make it more difficult to get back into the field with tillage equipment if needed, more difficult to scout for insects, and some leaf diseases may be worse.

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Objective:

To determine if 20 inch row corn production systems can more effectively and efficiently utilize environmental resources, resulting in increased yield compared to traditional row spacing systems.

Introduction:

The interest of Texas producers in narrow row corn has risen in recent years due partially to the success of narrow row corn in other regions of the country. Reports from the midwest have suggested yield can be increased 5 to 10% by decreasing row spacing from 30 to 20 inches.

Almost all of the corn in the Texas High Plains is irrigated, however, the amount of annual water applied will vary from farm to farm ranging from 16 to 26 inches. Conventional row spacing is 30 inches where corn is the primary crop. Where cotton is produced in rotation with corn the conventional row spacing is often 40 inches. In order to determine the influence of corn row spacing under Texas High Plains conditions, studies were conducted in 1997, 1998, and 1999 under full and limited irrigation and at different plant populations.

Pioneer 3394 corn hybrid was planted in all studies conducted. Row spacings compared were 20, 30, and 40 inch rows. Seeding rates examined ranged from 20,000 to 45,000 plants per acre. In addition, studies were conducted under both limited and full irrigation in two of the three years.

1997

Methods and Materials

Location: Hereford, TX

Date Planted:	May 12, 1997
Tillage:	Conventional
Soil Type:	Pullman silty clay loam
Previous Crop:	Wheat
Fertilizer:	20 tons cattle manure prior to planting wheat in 1995.
Herbicide:	Post application of 0.3 oz Basis+1.0 lb a.i. atrazine+1.0 pt Buctril+1.0 pt Dual.
Insecticide:	None
Variety:	Pioneer 3394
Irrigation:	Sprinkler system with drop nozzles.
Rainfall:	9 inches received during growing season.

Treatments:

Row Spacing	Planting Density (x 1000/acre)		
20-inch	22	30	38
30-inch	22	30	38
40-inch	22	30	38

Irrigation Levels:

Full irrigation – 21 inches
Limited irrigation – 16 inches

Experimental Design:	Factorial arrangement with six replicates.
Plot size:	20-ft by 200-ft

Results

All of the desired plant populations were not achieved. However, useful comparisons were found, especially between the 20 and 30 inch rows. Because the desired plant populations were not achieved in the 40 inch rows, statistical analysis was only conducted on the 20 and 30 inch rows. Under limited irrigation statistical analysis showed both main effects of row spacing and plant population to be significant as well as a significant interaction between the two. When examining row spacing, yields were 23.3% and 9.7% higher in the 20 inch rows compared to the 30 inch rows at plant populations of approximately 27,000 and 31,000 plants per acre, respectively (Table 1). Yields were not different between 20 and 30 inch rows at a plant population of 19,700 - 21,700/acre.

Table 1. 1997 grain yield under limited irrigation of corn for three row spacings and three plant populations near Hereford, TX in the Texas High Plains.

Plant Population	Row Spacing		
	20 Inch	30 inch	40 inch
plants/acre	---------- Yield, (bu/acre)[1)] ----------		
19,700 - 21,700	141 c	140 c	---
25,700 - 28,300	169 a	137 c	---
30,400 - 32,700	170 a	155 b	153
*Average**	*160*	*144*	

[1)] Means followed by the same letter are not significantly different at P= 0.05. Statistical analysis did not include yield in the 40 inch row spacing.
* The main effect of row spacing was significant according to ANOVA at P=0.05.

Under full irrigation, both row spacing and plant population had a significant effect on yield. There was not a significant interaction between row spacing and plant population. Yield was highest in the 20 inch rows at all plant population levels (Table 2). The highest yield in the test of 190 bu/acre was achieved with 20 inch rows at a plant population of approximately 30,000/acre. This was 18% higher than the yield obtained in the 30 inch rows at the same plant population. When averaged across plant population levels the 20 inch rows yielded 172 bu/acre compared to 151 bu/acre in the 30 inch rows for a yield increase of 13.9%. Yields under full irrigation were increased from 145 bu/acre to 163 bu/acre when plant population was increased from approximately 21,000 plants/acre to approximately 27,000 plants/acre when averaged across row spacings (Table 3). There was not a significant increase in yield when plant population was increased to 31,000 plants/acre. A similar plant population effect was observed in the limited irrigated test.

Table 2. 1997 grain yield under full irrigation of corn for three row spacings and three plant populations near Hereford, TX in the Texas High Plains.

Plant Population	Row Spacing		
	20 Inch	30 inch	40 inch
plants/acre	---------- Yield, (bu/acre)[1)] ----------		
20,600 - 21,600	151	139	---
26,200 - 27,631	174	152	---
29,200 - 31,350	190	161	169
*Average**	*172*	*151*	

[1)] There were no differences between treatments base on ANOVA at P = 0.05.

* The main effect of row spacing was significant according to ANOVA at P=0.05.

Table 3. 1997 plant population effect on yield when averaged across row spacings under limited and full irrigation.

Limited Irrigation		Full Irrigation	
plants/acre	Yield, bu/acre[1)]	plants/acre	Yield, bu/acre[1)]
19,700 - 21,700	141 b	20,600 - 21,600	145 b
25,700 - 28,300	153 a	26,200 - 27,631	163 a
30,400 - 32,700	162 a	29,200 - 31,350	175 a

[1)] Means followed by the same letter in each column are not significantly different at P=0.05.

Materials and Methods

Location: Sunray, TX

Date Planted:	May 1, 1998
Tillage:	Conventional
Soil Type:	Pullman silty clay loam
Previous Crop:	Corn
Fertilizer:	150 lbs N/acre. Applied with irrigation water during the growing season.
Herbicide:	2.4 qt. Bicep Lite + 0.66 oz Accent + 8 oz Banvel.
Insecticide:	Capture and dimethoate. Applied August 4, 1998.
Variety:	Pioneer 3394
Rainfall:	7 inches during the growing season.
Irrigation:	32 inches during the growing season.
Harvest Date:	October 14, 1998

Treatments:

Row Spacing	Planting Density (x 1000/acre)			
20-inch	22	30	38	45
30-inch	22	30	38	45
40-inch	22	30	38	45

Experimental Design:	Factorial arrangement with six replicates.
Plot size:	20 ft by 200 ft

Location: Hereford, TX

Date Planted:	May 19, 1998
Tillage:	Conventional
Soil Type:	Pullman silty clay loam
Previous Crop:	Wheat
Fertilizer:	2 Tons Composted manure/acre
Herbicide:	Surpass 100
Insecticide:	Capture
Variety:	Pioneer 3394
Rainfall:	Less than 1 inch during the growing season.
Irrigation:	Full irrigation - 21 inches. Limited Irrigation 16 inches.
Harvest Date:	November, 1998

Treatments:

Row Spacing	Planting Density (x 1000/acre)			
20-inch	22	30	38	45
30-inch	22	30	38	45
40-inch	22	30	38	45

Experimental Design:	Factorial arrangement with six replications.
Plot size:	20 ft by 200 ft

Results

Weather conditions in 1998 were not favorable for corn production on the Texas High Plains. The summer was one of the driest and hottest on record. Planting went well at both sites where experiments were planned. Actual plant populations were very close to the desired populations of 22,000, 30,000, 38,000, and 45,000 plants per acre at Sunray. At Hereford, the planter being used to plant the 40 inch rows did not have the proper gears to plant higher than 38,000 seed/acre.

At Sunray, the middle two rows were harvested with a plot combine from the 30 and 40 inch rows. The middle four rows were harvested from the 20 inch rows. Average yield of all treatments was 146 bu/acre (Table 4). This is considerably below the 220 bu/acre that is generally produced by the cooperating farmer. Part of the lower yield can be attributed to the extremely dry and hot weather conditions experienced in 1998. In addition, this was a new farm that our cooperator had recently purchased. The land had been chiseled and disked wet, which likely reduced the ability of the soil to absorb irrigation water. The cooperator also was under the false impression that the soil was high in residual nitrogen, as a result, he only applied 150 lbs N/acre during the growing season. This may also have limited yield. No differences were observed between row spacings or plant populations at the P=0.05 level of significance. It is possible that the yield potential was not high enough to bring out the differences in treatments.

Table 4. 1998 grain yield of corn for three row spacings and four plant populations near Sunray, TX in the Texas High Plains.

Plant Population	Row Spacing		
	20 inches	30 inches	40 inches
plants/acre	----------Yield, bu/acre[1)]----------		
22,000	144	149	147
30,000	153	151	146
38,000	150	151	141
45,000	147	142	139

[1)] There were no differences between treatments base on ANOVA at P = 0.05.

At Hereford, the plots were harvested in a similar manner to those at Sunray. Yields were extremely low due to the excessive drought and lack of adequate irrigation water (Table 5). The full irrigation study received 21 inches of irrigation which was well below what was needed by the crop. The interaction between plant population and row spacing was significant in both limited and fully irrigated studies. Best yield was achieved at the lowest plant population using the 40 inch rows. This was opposite of the results in 1997. These results were clearly affected by the extreme weather conditions experienced in the Hereford area in 1998.

Table 5. 1998 grain yield of corn for three row spacings and three plant populations near Hereford, TX in the Texas High Plains.

Plant Population	Limited Irrigation[1)]			Full Irrigation[1)]		
	Row Spacing			Row Spacing		
	20 inches	30 inches	40 inches	20 inches	30 inches	40 inches
plants/acre	-------Yield, bu/acre----------			-------Yield, bu/acre----------		
23,000	48 ab	43 b	61 a	110 abc	104 bcd	122 a
31,000	29 c	25 cd	50 ab	96 cd	97 cd	114 ab
36,000	20 cd	15 d	46 b	75 e	77 e	100 bcd

[1)] Means within each irrigation level followed by the same letter are not significantly different at P=0.05.

1999

Methods and Materials

Location: Sunray, TX

Date Planted: May 13, 1999
Tillage: Conventional
Soil Type: Pullman silty clay loam
Previous Crop: Corn
Fertilizer: 12 tons manure, 170 lb NH_3, 50 lb 28-0-0
Herbicide: Balance
Insecticide: Capture
Variety: Pioneer 3394
Rainfall: 2.2 inches
Irrigation: 24 inches
Harvest Date: October 20, 1999
Treatments:

Row Spacing	Planting Density (x 1000/acre)			
20-inch	22	30	38	45
30-inch	22	30	38	45
40-inch	22	30	38	45

Experimental Design: Factorial arrangement with six replicates.
Plot size: 20 ft by 200 ft

Location: Hereford, TX

Date Planted: May 5, 1999
Tillage: Conventional
Soil Type: Pullman silty clay loam
Previous Crop: Corn
Fertilizer: 250 lb N, 60 lb P, and 30 lb Potash
Herbicide: Balance

Insecticide:	Capture
Variety:	Pioneer 3394
Rainfall:	
Irrigation:	20 inches
Harvest Date:	September 28, 1999

Treatments:	Row Spacing	Planting Density (x 1000/acre)			
	20-inch	22	30	38	45
	30-inch	22	30	38	45
	40-inch	22	30	38	45

Experimental Design:	Factorial arrangement with six replicates.
Plot size:	20 ft by 200 ft

Results

Weather conditions in 1999 were unseasonably cool and wet during the early growing season. However, the later portion of the growing season was dry. Balance was applied pre-emergence at planting at both locations. Early season stand emergence was erratic due to the cool wet weather and possibly due to Balance injury. Because of the erratic stand, areas in each plot were identified early in season where good uniform stands were present. Yield was then collected from these areas at the end of the season by hand harvesting one thousandth of an acre.

At the Sunray location, ANOVA indicated a significant effect of row spacing and plant population on yield. In addition, the interaction of row spacing and plant population was also significant. At Hereford, only the main effect of row spacing was significant.

When examining row spacing effect, highest yield was obtained at both locations with 30 inch rows (Table 6). At Sunray, yield in the 20 inch rows was higher than in the 40 inch rows. At Hereford, there was no difference in yield between 20 and 40 inch rows.

Table 6. 1999 Row spacing effect on yield when averaged across plant populations at each location.

Location	Row Spacing		
	20 inch	30 inch	40 inch
	----------Yield, (bu/acre)[1)]----------		
Sunray	222 b	237 a	209 c
Hereford	199 b	214 a	196 b

[1)] Means from each location (row) followed by the same letter are not significantly different at P=0.05.

A plant population effect was observed at Sunray (Table 7). Plant populations of 38,000 and 45,000 per acre resulted in the highest yields when averaged across row spacing. Plant population had no effect at Hereford.

Table 7. 1999 plant population effect on yield when averaged across row spacings at each location.

Location	Plant Population/acre			
	22,000	30,000	38,000	45,000
	----------Yield, (bu/acre)[1)]----------			
Sunray	200 c	217 b	236 a	238 a
Hereford	195 ns[2)]	202 ns	206 ns	208 ns

[1)] Means from the Sunray location followed by the same letter are not significantly different at P=0.05.
[2)] ns denotes no significant difference.

Highest yields were obtained at Sunray with plant populations of at least 38,000/acre with row spacings of 20 and 30 inches (Table 8). Yields were generally not as high in the 40 inch rows as compared to the 20 or 30 inch rows. Yields from each treatment at Hereford are reported in table 9.

Table 8. 1999 grain yield of corn for three row spacings and three plant populations near Sunray, TX in the Texas High Plains.

Plant Population	Row Spacing		
	20 inch	30 inch	40 inch
plants/acre	---------- (bu/acre)[1)] ----------		
22,000	191 g	205 efg	206 efg
30,000	223 cde	234 bc	195 fg
38,000	244 abc	252 ab	213 def
45,000	231 cd	259 a	225 cde

[1)] Means followed by the same letter are not significantly different at P=0.05.

Table 9. 1999 grain yield of corn for three row spacings and three plant populations near Hereford, TX in the Texas High Plains.

Plant Population	Row Spacing		
	20 inch	30 inch	40 inch
plants/acre	---------- (bu/acre)[1)] ----------		
22,000	188	205	192
30,000	198	215	195
38,000	203	220	194
45,000	205	217	201

[1)]ANOVA indicated no significant interaction between row spacing and plant population.

Conclusions

In the Texas High Plains studies in 1997, yields were highest in the 20 inch rows. Average yield increase over 30 inch rows was 11.1% under limited irrigation, and 13.9% with full irrigation (Tables 1 and 2). Yield was not significantly increased under limited or full irrigation by increasing plant population over approximately 27,000 plants/acre (Table 3). In 1998, at Sunray, neither row spacing nor plant population had any effect on corn yield (Table 4). It is possible that the lack of differences between treatments was due to the site's low yield potential in 1998. At Hereford, yields were extremely low due to the drought and lack of adequate irrigation capacity. Under these conditions the best plant population was at 22,000 plants/acre and the best row spacing was 40 inches (Table 5). This was the opposite of what was observed in 1997. In 1998, the Texas High Plains experienced the driest growing season on record. In 1999, yields were highest in the 30 inch rows at both locations (Table 6). At Sunray, yields were highest when plant population was at least 38,000 per acre (Table 7). At Hereford, plant population did not significantly effect yield.

SUMMARY

Of the six studies conducted in 1997, 1998, and 1999, only two of the studies, those conducted in 1997, showed a significant yield advantage of 20 inch rows over 30 inch rows. These results suggest that farmers in the Texas High Plains should not expect an automatic 5 to 10 percent increase in yields as has been reported from the midwest from converting from traditional 30 inch rows to 20 inch rows. One possible advantage in 20 inch rows is better weed control due to quicker shading of the soil. However, a disadvantage is that the 20 inch rows make it more difficult to get back into the field with tillage equipment if needed.