COMPARISON OF SUPER-THICK AND CONVENTIONAL GRAIN SORGHUM MANAGEMENT SYSTEMS

by

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Introduction

Grain sorghum is becoming an increasingly important crop to Kansas farmers. Many farmers are now realizing the economic advantages of using a sorghum - fallow - wheat rotation in areas where a wheat fallow system was once used.

Dryland grain sorghum in Kansas conventionally has been grown in 76 to 91 cm rows. Recommended plant populations range from 49,500 to 74,000 plants per hectare in western Kansas and from 74,000 to 110,000 plants per hectare in the eastern half of the state. Planting dates range from 20 May through 10 June for all areas.

Recent research at the Fort Hays Experiment Station located in west-central Kansas has shown much promise for a different management approach to grain sorghum production (10). This system developed by Carlyle Thompson is commonly referred to as "super-thick". The "super-thick" method of planting involves the use of an early or medium-early hybrid planted about three weeks later than conventional planting. Also, row-spacing is reduced from 76-91 cm to 25-30 cm. Seeding rate is increased 2-3 times the conventional rate.

Preliminary results from Hays show some very promising advantages of this system in that particular area of the state. These results have prompted interest in using the super-thick system in other parts of the state.

The primary purpose of this study was to test the super-thick system in as many different grain sorghum producing areas of the state as possible.

Literature Review

Grain sorghum planted in narrow rows has produced yields equal to or greater than grain sorghum planted in 76-91 cm wide rows at Hays. The advantage of a narrow row system lies in being able to use this system as a tool for soil conservation. Thompson (10) lists the following advantages and disadvantages in the overall system.

<u>Advantages</u>

1. Can be planted with a conventional disc or hoe grain drill. This saves the farmer the cost of owning two pieces of planting equipment.
2. Better weed control is obtained by later tillage and by thick stands of grain sorghum causing strong competition with weeds.
3. Provides a denser canopy over the soil surface during the growing season and after harvest. This will help to:
    a. shade the soil and reduce evaporation.
    b. reduce wind and water erosion.
    c. reduce water runoff, increasing intake.
    d. increase grazing potential with more leaf area and more palatable stalks.
4. Matures evenly as high seeding rate reduces tillering.

<u>Disadvantages</u>

1. Some hybrids under certain environmental stresses will lodge. High populations could contribute to this problem. Presently there are no pickup attachments for narrow rows.
2. Mechanical cultivation for weed control is not possible.
3. Increased production costs are incurred since more seed is planted.
4. Trash will create a problem for most grain drills if the producer is

using a no-till system.

A super-thick planting system consists of narrow rows, high seeding rates, delayed planting date, and selecting a hybrid maturity that takes full advantage of available soil moisture.

Planting Date

Praeger (6), Stickler and Pauli (8), and others found that an early to early-medium planting date gave a yield advantage in Kansas. Conversely, recommendations for the super-thick method call for a medium-late to late planting date to allow maximum storage of water and to reduce the vegetative growth period (9). This agrees with Blum's (1) observation that under limited moisture, late plantings increased the number of seeds per head which allowed compensation for decreased tillering.

Seeding Rate

A super-thick sorghum management system suggests seeding rates of 2-3 times the conventional rate. This seeding rate should be adjusted according to the amount of stored soil moisture and amount of anticipated growing season rainfall (9). In supporting this suggestion, previous research by Brown and Schrader (2) showed that as depth of initially moist soil changed from 213 cm to 91 cm, optimum plant population decreased from 296,500 pl/ha to 37,000 pl/ha. Under stressful conditions, optimum populations were further decreased. Karchi and Rudich (4) observed higher yields from the low population of 49,000 pl/ha when grain sorghum was grown on stored soil moisture.

Maturity

Hybrid maturity is affected by a delayed date of planting. The number of days to half-bloom are reduced which means the vegetative growth is shortened in later plantings. This should allow more moisture for grain development.

Due to the late planting date recommendation for super-thick planting, an early or early-medium hybrid (55 to 60 days to half-bloom) has been suggested (9). Stickler and Pauli (8) noted that early maturing hybrids had less change in yield over growing conditions when compared with late maturity hybrids. Blum (1) suggested yield potential was inversely relationed to duration under extreme competition. This statement seems to fit the super-thick sorghum management plan very well.

Row Spacing

Row spacing recommendations of the super-thick system suggest planting sorghum in 25-30 cm wide rows. These recommendations are based on results obtained by Thompson (9) at the Hays location. Karchi and Rudich (4) noted that with wider rows larger heads resulted but these were not sufficient to equalize the loss in yield caused by the decreased number of heads per unit area. They also found that by combining narrower rows with increased intrarow spacings they could increase yield due to the increased number of heads per unit area. Robinson et al. (7) found a linear trend for increased yield as rows narrowed from 101 to 25 cm. This same general statement has been repeatedly found to be true in many parts of the world.

Norwood (5) working with a super-thick system in southwest Kansas reported no definite effect of row width on the yield of continuous sorghum.

Materials and Methods

The experiment was conducted in 1983 at five locations throughout Kansas (Table 1). These locations were chosen based on soil types and historic rainfall patterns (Fig. 1). A modified split-plot design with dates as main plots stripped across hybrids, rates and row spacings as subplots was used at all locations. Treatments (hybrid x rate x row spacing) were randomized within blocks with 4 replications per date. Due to lack of available space only three replications were planted at Manhattan. Each plot was 3.05 m wide by 7.6 m long.

Two row spacings, 25 cm and 76 cm, were used. The plots consisting of 25 cm rows were planted with a double-disc opener drill. The 76 cm rows were planted with a vacuum planter equipped with runner type openers. In addition to the two row spacings, 3 hybrids of differing lengths of maturity and two seeding rates were used. The experiment was planted on two dates at each location (Table 1).

Weed control was obtained by a preplant shallow incorporation of Lasso (alachlor) plus atrazine or Lasso plus propazine depending on the specific location. Hand hoeing was also practiced as needed throughout the entire growing season. Granular Furadan 10-G (Carbofuran) was used at planting (1.12 kg/ha a.i.) for early season chinch bug control. No other pesticides were used on the plots throughout the season.

Soil samples in increments of 30 cm to a depth of 120 cm were taken before planting to determine soil moisture reserves. Moisture percentages were then determined gravimetrically.

Plant counts were taken about three weeks after planting to determine exact plant populations of each plot. Data for plant counts and yield were taken from the middle 4.5 m section of the center two rows of the plots with the 76 cm row spacing. Data were collected from the narrow row plots from the third, fourth, fifth, eighth, ninth and tenth rows so that data was collected from an equivilent land area in all plots.

Other observations recorded included: half-bloom dates, heads harvested/ha, yield (kg/ha), and seed weight (g/1000 seeds).

Statistical analysis was conducted with SAS on yield and yield components using ANOVA and GLM. Mean comparisons within a location were made using an LSD value calculated at the 5% level. No comparisons across locations were attempted due to the great variation in environments in which this experiment was conducted.

Table 1. Specific Location Data, 1983.

Location	Hybrids	Maturity	Seeding Rates (sds/ha) Low	High	Date of Planting 1	2	Soil Type
Hutchinson	O's Gold 492 Dekalb DK-46 NC+ 271	Early Medium Late	86,400	246,900	June 1	June 20	Clark-Ost Complex. Typic Calciustoll, Fine loamy, Mixed, Thermic.
Manhattan	O's Gold 492 Golden Acres T-E Dinero Dekalb DK-59	Early Medium Late	123,500	246,900	June 6	June 22	Chase Silty Clay Loam. Aquic Argiudoll, Fine, Montmorillonitic, Mesic.
Powhattan	O's Gold 492 Golden Acres T-E Dinero Dekalb DK-59	Early Medium Late	135.800	271,600	May 31	June 23	Grundy Silty Clay Loam, 4-7% Eroded. Aquic Argiudoll, Fine, Montmorillonitic, Mesic.
St. John	O's Gold 492 Dekalb DK-46 NC+ 271	Early Medium Late	86,400	246,900	June 7	June 29	Naron Loamy Fine Sand. Udic Argiustoll, Fine-loamy, Mixed, Thermic.
Tribune	O's Gold 492 Dekalb DK-46 NC+ 271	Early Medium Late	49,400	148,200	June 9	July 1	Ulysses Silt Loam, 0-1% Aridic Haplustoll, Fine-silty, Mixed Mesic.

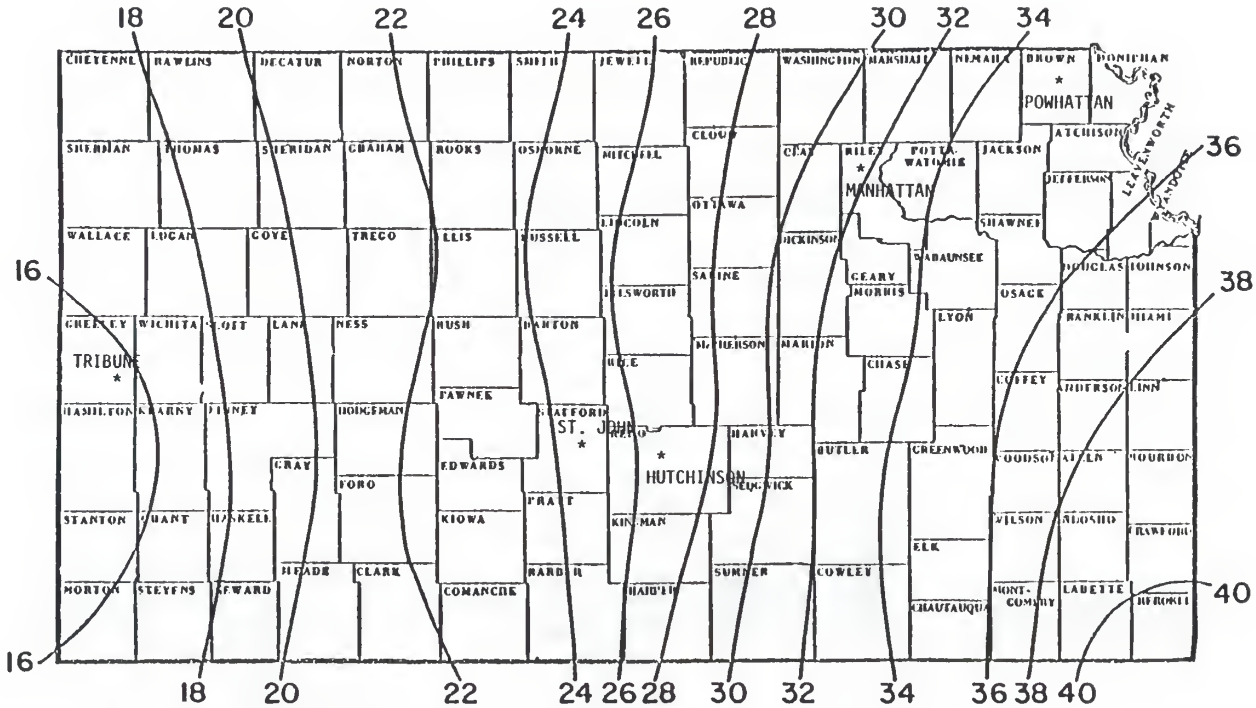

Figure 1. Average annual precipatation.
(L. D. Bark)

Results

The growing season of 1983 was one of severe extremes. An unusually cold and wet spring delayed sorghum planting in many areas of the state. These conditions caused emergence and stand establishment problems.

The remainder of the growing season was characterized by high temperatures and precipitation amounts well below normal at all locations.

Stored soil moisture was near field capacity on both planting dates at all locations (Table A-15).

Powhattan

Temperatures recorded during July and August were above average, and total rainfall for the months of June, July, August and September was 27.45 cm below average (Table A-12).

Yields at Powhattan ranged from 795 to 2599 kg/ha and were influenced by date of planting, rate of planting and date of planting x row spacing interaction (Table A-3).

Table 2. Rate of planting means for yield, number of heads harvested per hectare, and lodging percent, Powhattan 1983.

Rate (pl/ha)	Yield (kg/ha)	Number of heads/ha	Lodging Percent
115534	3704	125222	5.33
202664	3390	194890	3.56
LSD .05	211	8270	2.12

The higher rate of planting resulted in yield reduction (Table 2). The lower yield resulting from the high seeding rate was a reflection of the stress caused by high plant populations and the season-long drought.

Rate of planting had no effect on lodging percentage.

Table 3. Date of planting by row spacing means for yield and lodging percent, Powhattan 1983.

	Date 1		Date 2	
Spacing (cm)	Yield (kg/ha)	Ldg %	Yield (kg/ha)	Ldg %
25	2943	4.1	4027	2.8
76	3490	4.7	3728	6.2
LSD .05				
Within dates:	289	2.9		
Between dates:	344	3.2		

Date by spacing interaction on yield showed no significant yield difference between 25 cm and 76 cm row spacings with a later planting date. Also, date of planting had no effect on yield when a 76 cm spacing was used.

Early date of planting resulted in 76 cm spacings having a higher yield than 25 cm spacings. Conversely, later date of planting resulted in 25 cm spacing showing higher yields (Table 3, Figure 2). Lodging was not a severe problem overall. Seventy-six cm spacings planted on the second date had the highest lodging percent.

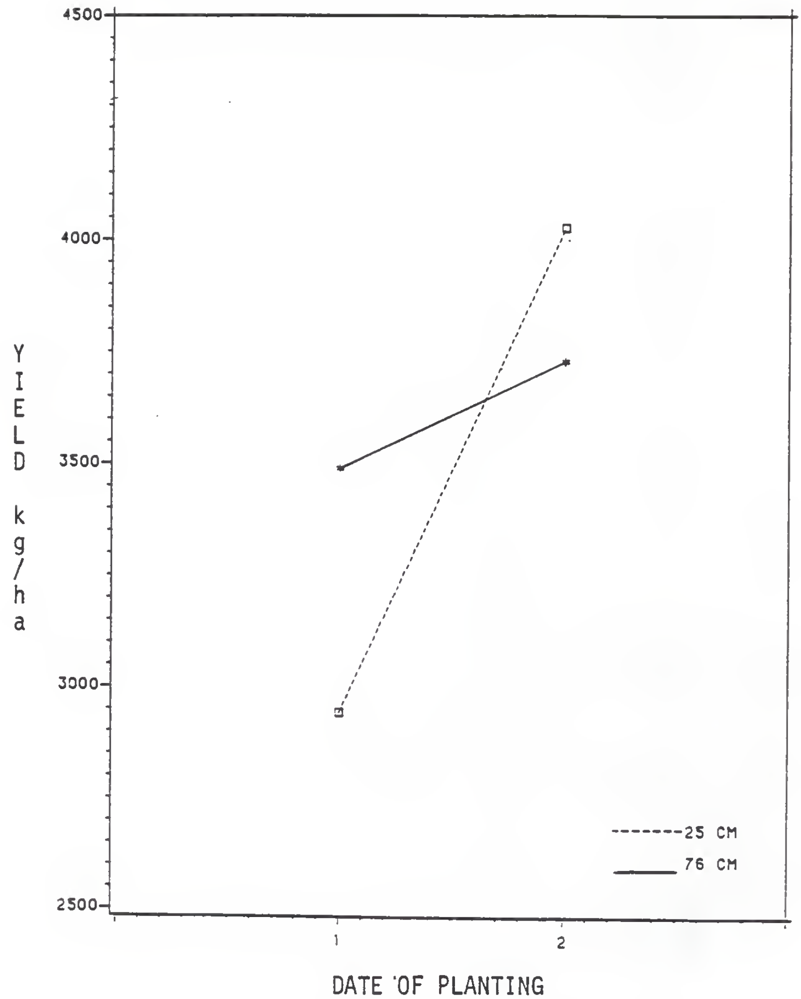

Figure 2. Interaction of Date X Row Spacing on Yield, Powhattan 1983.

Manhattan

Hot, dry conditions also prevailed at Manhattan. Rainfall was 22.15 cm below average. Temperatures were below normal in June and 2-3°C above normal for July, August and September (Table A-11).

Yield at Manhattan was affected by date x spacing, hybrid x spacing and rate x hybrid x spacing interactions (Table A-2).

Table 4. Interaction of date of planting and row spacing on yield and lodging percent, Manhattan 1983.

	Date 1		Date 2	
Spacing (cm)	Yield (kg/ha)	Ldg %	Yield (kg/ha)	Ldg %
25	4132	0.0	4408	0.0
76	3963	0.0	4878	0.2
LSD .05				
Within dates:				
	401	0.3		
Between dates:				
	557	—		

Planting date had no effect on yield when 25 cm row spacing was used. Delaying planting date increased yield of 76 cm rows.

The early date of planting showed no yield difference between spacings. A higher yield was achieved with 76 cm spacings than with 25 cm spacings on the second planting date (Table 4, Figure 3).

The lower planting rate coupled with 25 cm spacings gave a significant yield advantage to early and medium maturity hybrids over the late hybrid. Medium maturity hybrid significantly outproduced early and late hybrids planted in 76 cm rows at the low rate. No hybrids were affected by a change in row width alone (Table 5, Figure 4a and 4b).

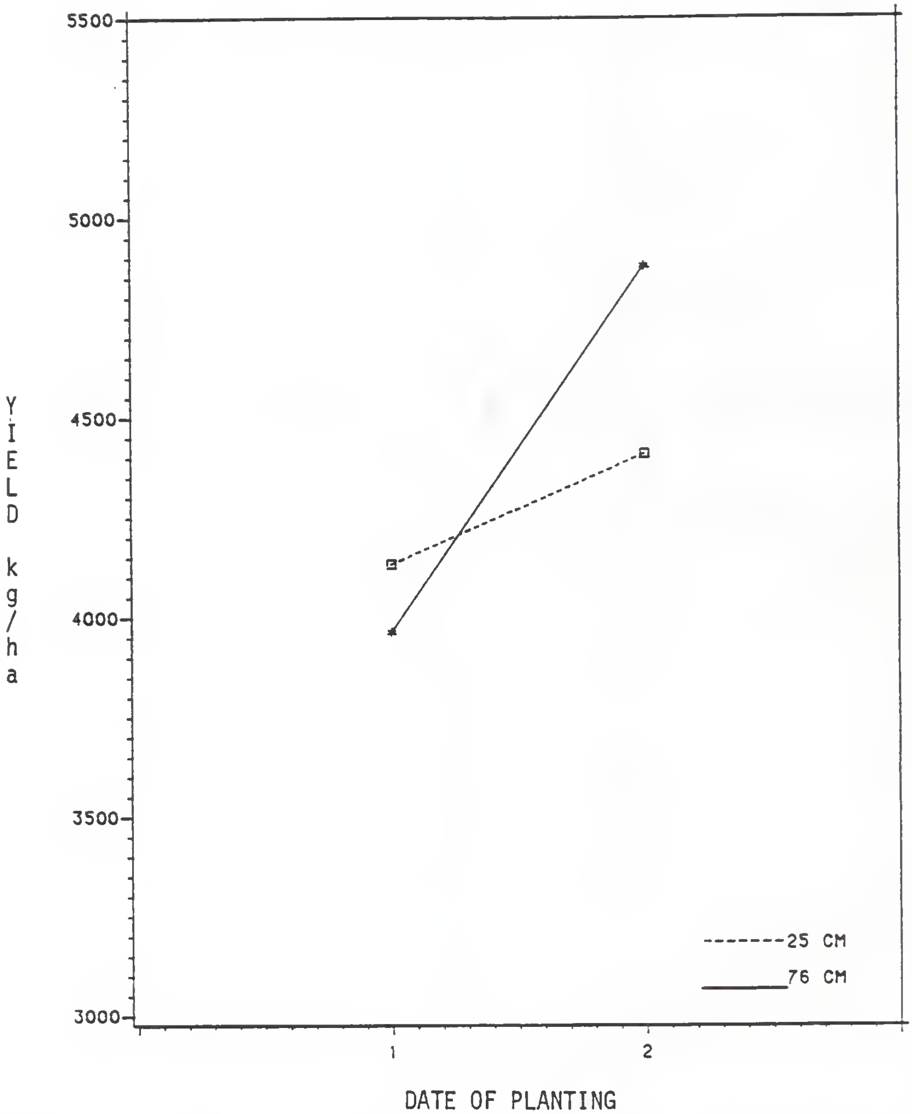

Figure 3. Interaction of Date X Row Spacing on Yield, Manhattan 1983.

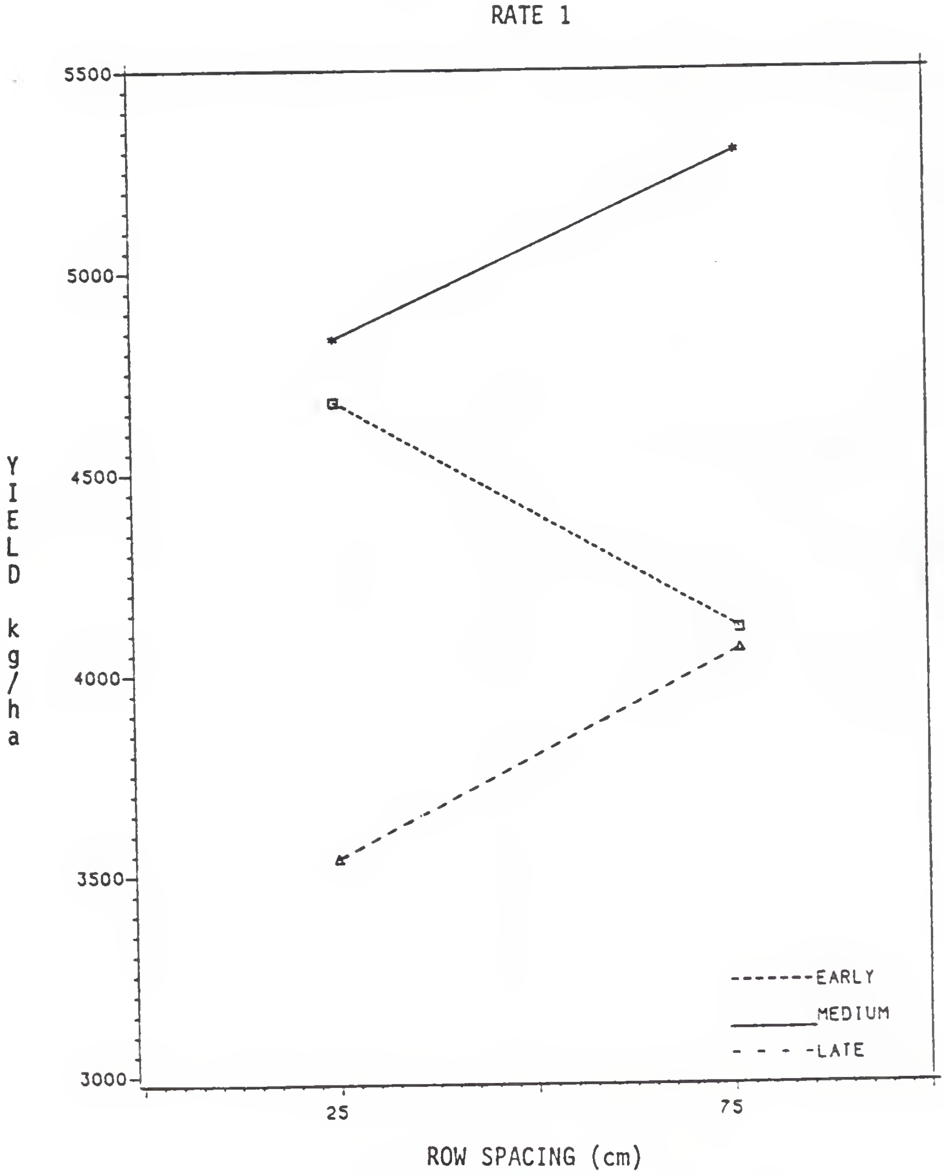

Figure 4a. Interaction of Rate X Hybrid X Spacing on Yield, Manhattan 1983.

Rate 1 = 123,500 seeds/hectare

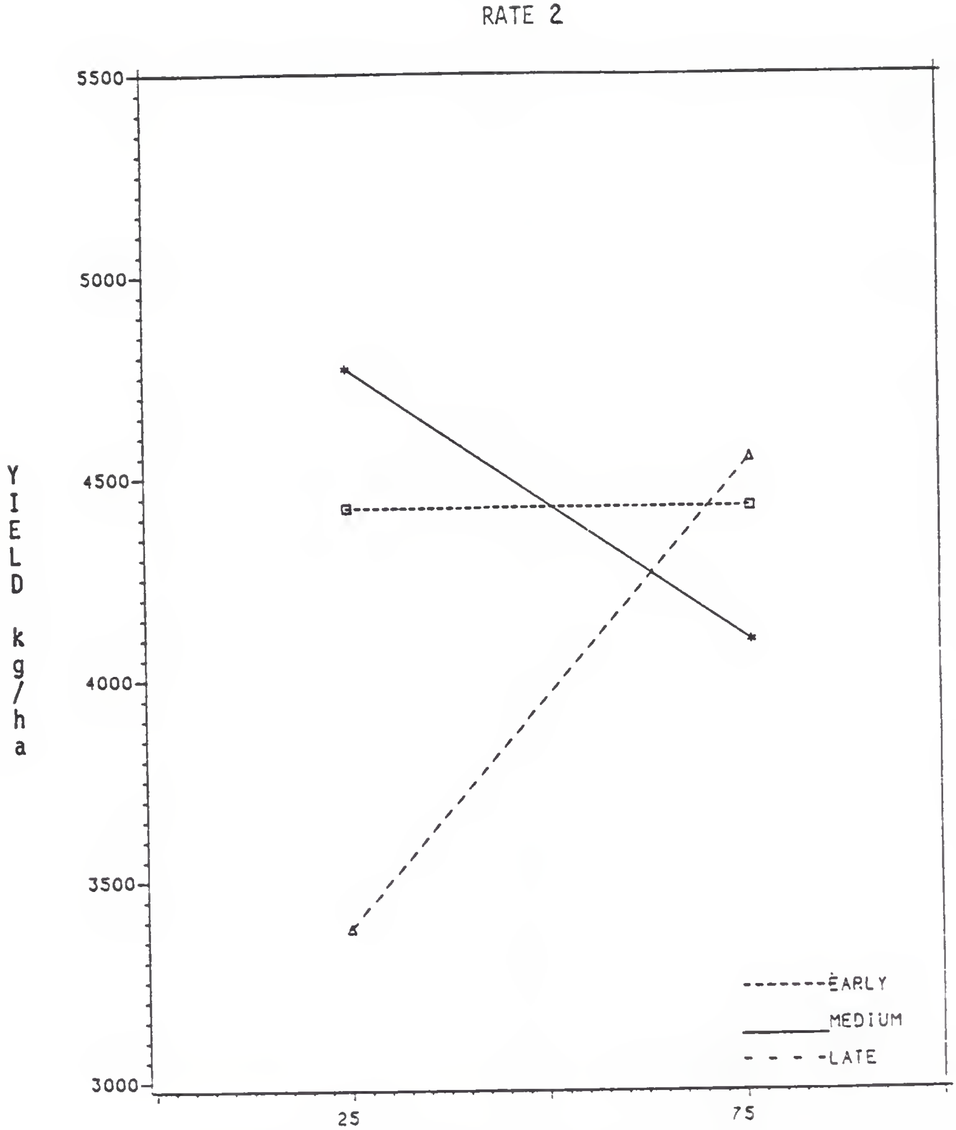

Figure 4b. Interaction of Rate X Hybrid X Spacing on Yield, Manhattan 1983.

Rate 2 = 246,900 seeds/hectare

Planting at a high seeding rate in 25 cm rows, early and medium maturity hybrids produced significantly greater yields than the late maturing hybrid. Seventy-six cm rows coupled with the high planting rate showed no yield difference among hybrids (Table 5).

At the high planting rate only the late maturing hybrid increased yield as row spacing was increased (Table 5).

Table 5. Interaction of rate, hybrid and row spacing on yield, Manhattan 1983.

Rate (pl/ha)	Hybrid Maturity	Spacing (cm)	Yield (kg/ha)
119361	Early	25	4675
143521	Early	76	4109
222457	Early	25	4423
234178	Early	76	4425
121992	Medium	25	4833
159547	Medium	76	5296
206192	Medium	25	4770
245182	Medium	76	4091
102617	Late	25	3541
143760	Late	76	4058
216238	Late	25	3380
215042	Late	76	4545
LSD .05			694

St. John

St. John experienced a lengthy drought period which began earlier in the growing season than that of other locations. Timely rains during July and early September helped maintain yields near expected levels. Temperatures were below normal for June, near normal in July, and above normal for August and September (Table A-13).

Yield at St. John was affected by hybrid maturity, spacing, date of planting x hybrid maturity, and date of planting x hybrid maturity x spacing interactions (Table A-4).

Combining early planting date and narrow row spacing no differences in yield of the three hybrids were found. The wider spacing on the early date increased yield of the late maturity hybrid. There were no yield differences between early and medium maturity hybrids when row spacing was increased (Table 6, Figure 5a and 5b).

The early maturing hybrid planted on the second date produced higher yield at both spacings than either medium or late maturing hybrids. In 25 cm spacings late maturity hybrid produced significantly greater yields than medium maturity hybrid. However, no yield differences were found between late and medium maturity hybrids in 76 cm spacings (Table 6, Figure 5a and 5b).

Medium maturing hybrid planted in 25 cm rows and late maturing hybrid planted in 76 cm rows decreased yield when planting date was delayed. No other hybrid x spacing combinations affected yield (Table 6, Figure 5a and 5b).

Table 6. Interaction of date of planting, hybrid maturity and row spacing on yield, St. John, 1983.

Date of Planting	Hybrid Maturity	Spacing (cm)	Yield (kg/ha)
1	Early	25	1584
1	Early	76	1685
1	Medium	25	1501
1	Medium	76	1537
1	Late	25	1582
1	Late	76	2365
2	Early	25	1988
2	Early	76	2267
2	Medium	25	799
2	Medium	76	969
2	Late	25	1418
2	Late	76	1289

LSD .05 Within dates: 470
Between dates: 659

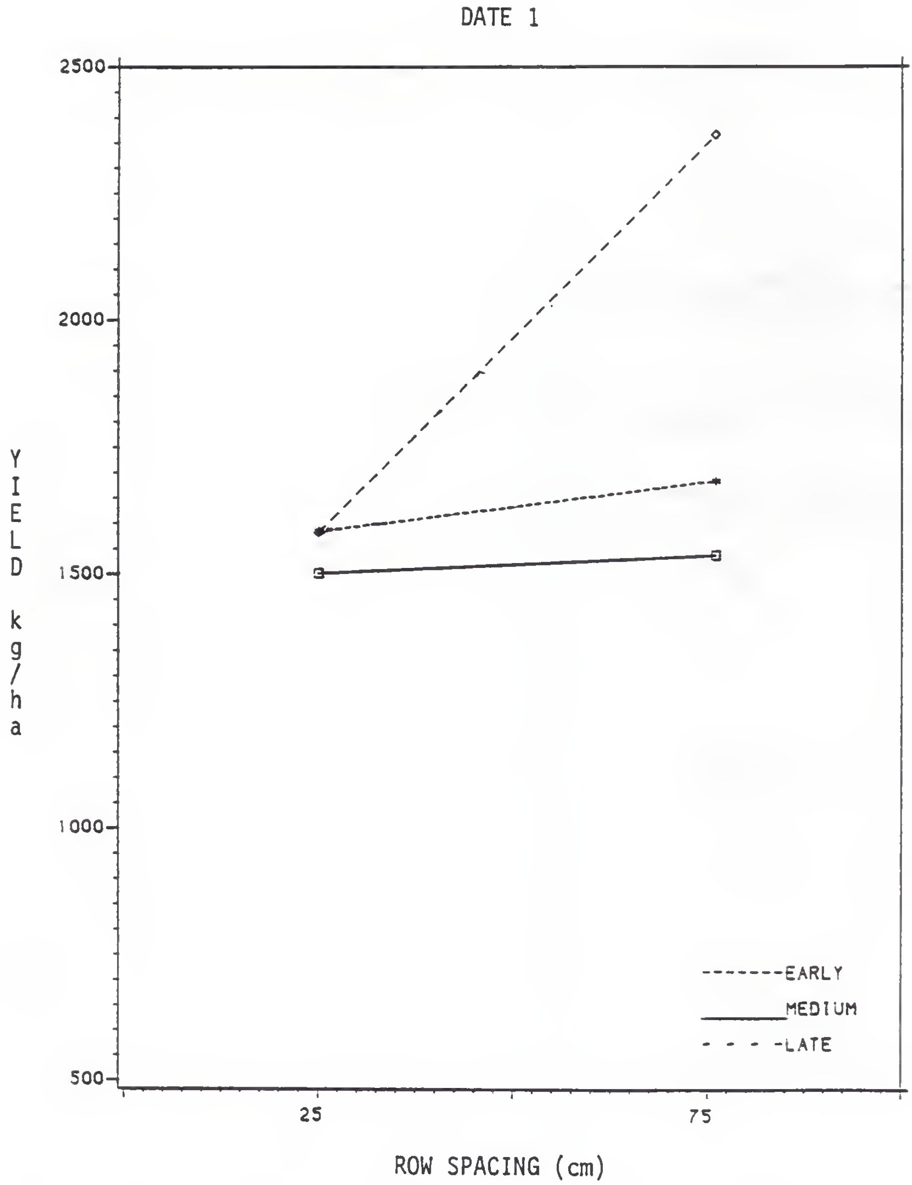

Figure 5a. Interaction of Date X Hybrid X Spacing on Yield, St. John 1983.

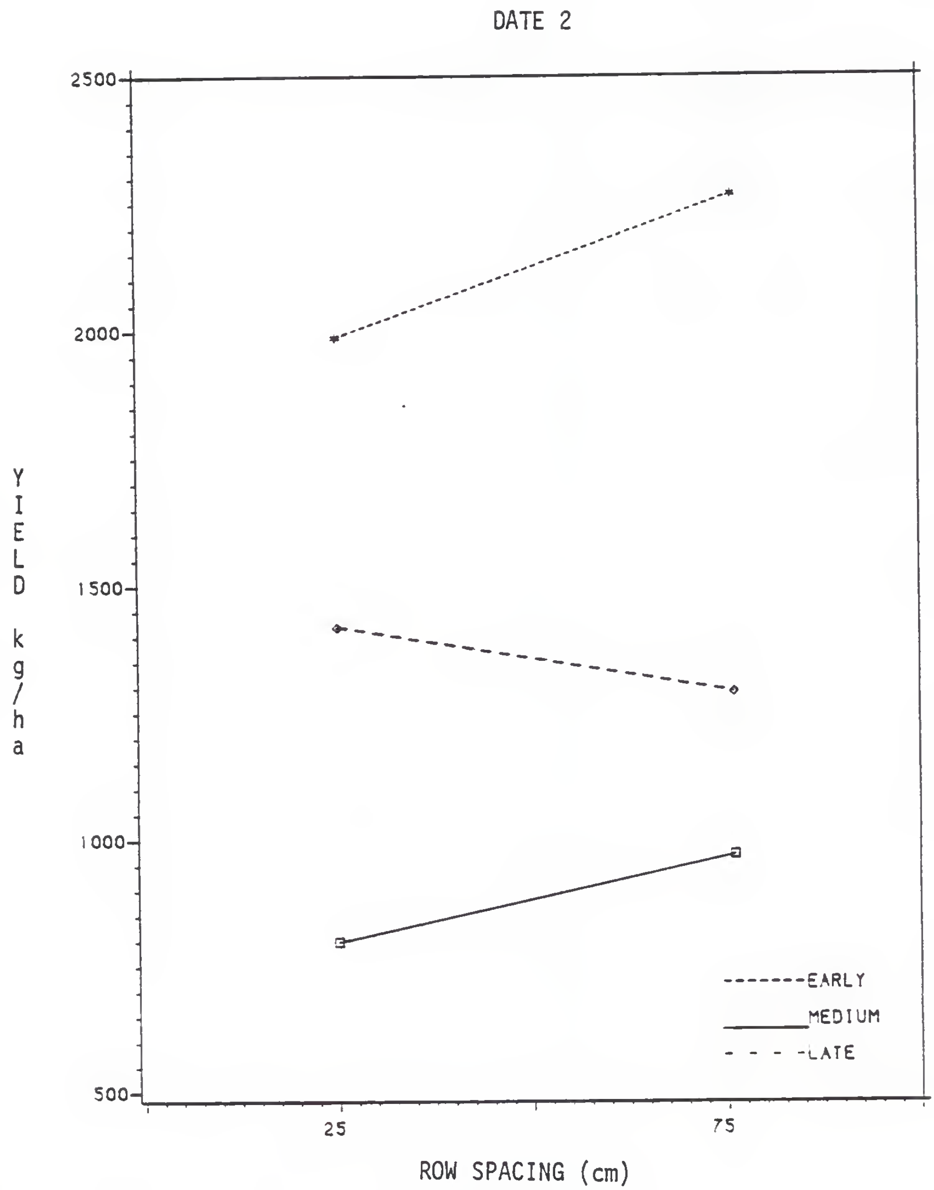

Figure 5b. Interaction of Date X Hybrid X Spacing on Yield, St. John 1983.

Tribune

At Tribune, total precipitation for the 1983 growing season was slightly above normal. This is misleading because 20.35 cm were recorded in June and only 2.73 cm fell from 1 July through 30 September (Table A-14). The excessive rainfall and cool temperatures during June caused some stand establishment problems. Although soil water content was near field capacity before the first date of planting, the severe drought substantially reduced yields to levels well below expected. A killing frost in early September reduced yields of the late maturing hybrid to nearly zero. Since a large percentage of the late maturity plots were not harvested no data were taken for that hybrid. High winds after the early frost caused serious lodging in most treatments.

Yields, which ranged from 1091 to 2191 kg/ha were affected by date of planting x hybrid maturity, date of planting x rate of planting and hybrid maturity x row spacing interactions (Table A-5).

Table 7. Interaction of date of planting and hybrid maturity on yield and lodging percent, Tribune 1983.

	Date 1		Date 2	
Hybrid	Yield (kg/ha)	Ldg %	Yield (kg/ha)	Ldg %
Early	1264	32.5	1732	37.5
Medium	1700	20.1	1303	18.8
LSD .05				
Within dates:	358	11.3		
Between dates:	416	12.5		

Planting on the early date, the medium maturity hybrid held a significant yield advantage over the early maturing hybrid. Planting on the second date, the early maturing hybrid held a yield advantage over the medium maturity hybrid (Table 7, Figure 6).

Yield of the early maturing hybrid was increased by delaying planting date whereas planting date had no effect on medium maturity hybrid.

Date of planting had no effect on lodging percentage, however, significant difference between hybrids within a date was found. The early maturing hybrid had the higher lodging percentage on both dates of planting.

Table 8. Interaction of row spacing and hybrid maturity on yield and lodging percent, Tribune 1983.

	25 cm		76 cm	
Hybrid	Yield (kg/ha)	Ldg %	Yield (kg/ha)	Ldg %
Early	1701	25.6	1294	44.4
Medium	1447	7.1	1556	31.8
LSD .05	358	11.3	358	11.3

The row spacing and hybrid interaction on yield showed the early maturing hybrid had greater yield when planted in 25 cm rows. The wider spacing reduced yield of the early maturing hybrid, but did not change the yield of the medium maturity hybrid (Table 8, Figure 7). Once again the early maturity hybrid had a significantly higher lodging percentage across both spacings. Within both hybrids lodging percentage was higher for the wide rows than for the narrow rows (Table 8).

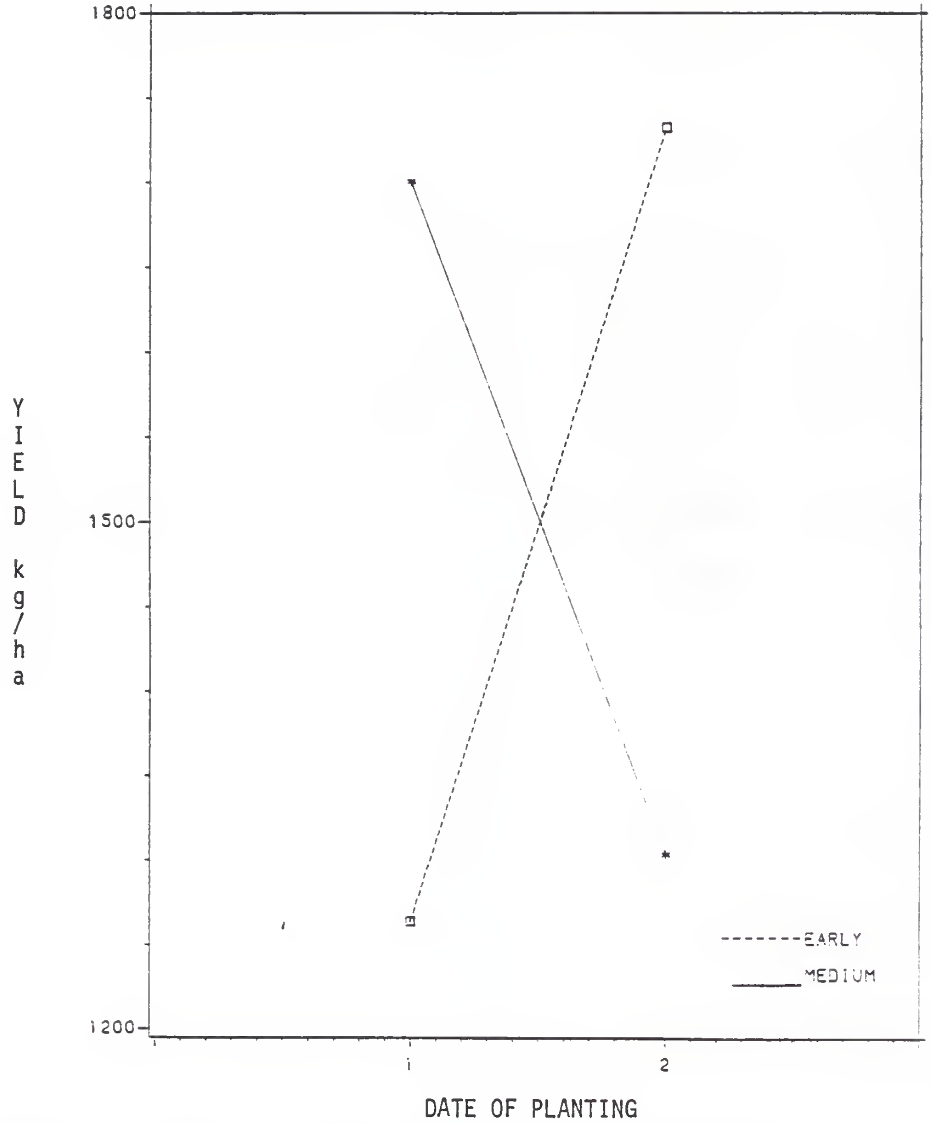

Figure 6. Interaction of Date X Hybrid on Yield, Tribune 1983.

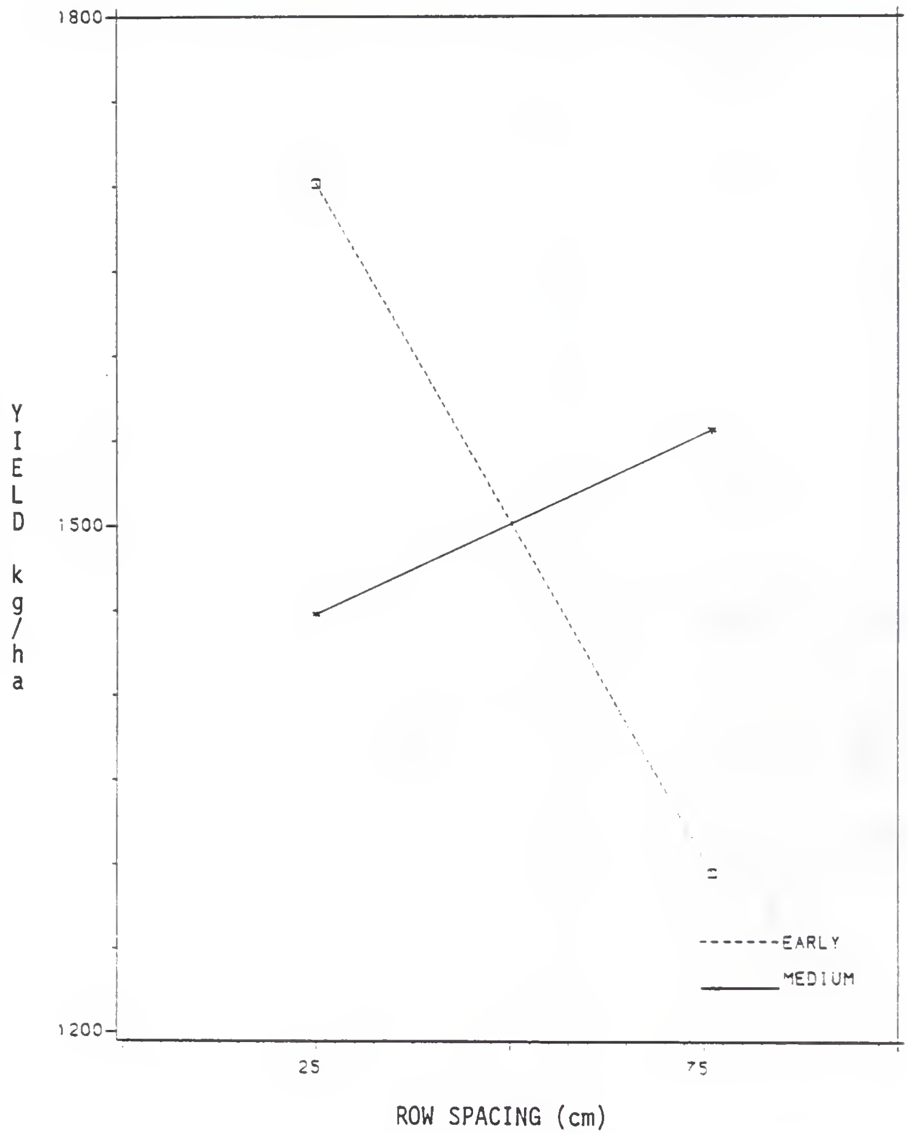

Figure 7. Interaction of Hybrid X Spacing on Yield, Tribune 1983.

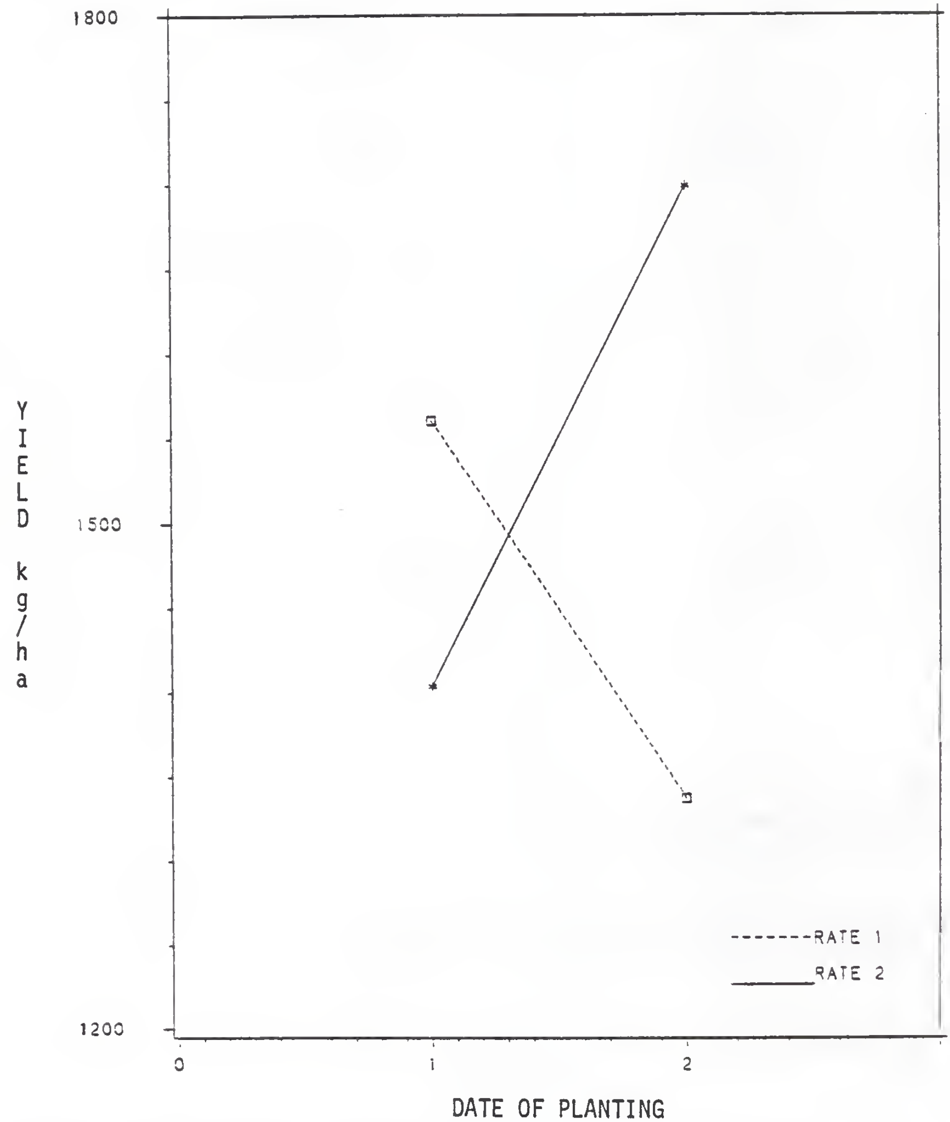

Figure 8. Interaction of Date X Rate on Yield, Tribune 1983.

Table 9. Interaction of date and rate on yield and lodging percent, Tribune 1983.

Date 1			Date 2		
Rate (pl/ha)	Yield (kg/ha)	Ldg %	Rate (pl/ha)	Yield (kg/ha)	Ldg %
60906	1560	31.3	49873	1337	23.1
94903	1403	21.2	71849	1699	33.3
LSD .05					
Within dates:					
	358	11.3			
Between dates:					
	416	12.5			

Planting on the later date showed an increase in yield with the higher seeding rate. Rate of seeding had no effect on yield of the early planting date (Table 9, Figure 8).

The higher seeding rate shows increased lodging percent when planted on the later date (Table 9). No other rate and date effects contributed to lodging.

Hutchinson

Total rainfall at Hutchinson from 1 June to 30 September was 19.0 cm below normal. Low rainfall combined with higher than normal temperatures severely limited yield.

The first date of planting was not harvested due to total devastation of these plots by birds. Sorghum yield of the second date of planting ranged from 598 to 1608 kg/ha. There were no significant yield differences among treatments (Table A-1).

Summary

Yield comparisons were made based on specific system definitions outlined in the introduction.

Table 10. Comparison of Yield (kg/ha) of Super-Thick[1] and Conventional[2] Management Systems.

	Manhattan	Powhattan	St. John	Tribune
Super-Thick[1]	4422	4011	2087	2191
Conventional[2]	3631	3707	2599	1931
LSD .05	1365	842	932	833

[1]Super-Thick = 2X-3X Rate, Early Maturity, Later Planting Date, Narrow Row Spacing.

[2]Conventional = Recommended Rate, Late Maturity, Early Planting Date, Wide Row Spacing.

Despite the unusually hot and dry growing season, yields of the super-thick system were higher than the conventional at every location except St. John (Table 10). Because of the large LSD values, the differences were not significant, however, this may indicate a trend to watch for in later studies.

Conclusions

Yields of both management systems were well below expected at all locations. Nonetheless, both maintained yields that were quite comparable. On each planting date, soil water content was near field capacity at all locations. The adequate water supply probably contributed greatly to maintaining yields of high plant population treatments. When planting in narrow rows, intra-row and inter-row spacing becomes nearly equal. The equa-distant spacing may also have helped maintain yields of the super-thick system.

Powhattan was the only location that showed a yield decrease across all components due to the high rate of planting. It should be noted, however, the high planting rate at Powhattan was nearly 10% higher than the highest rate used at St. John and Manhattan. In a "normal" year the rate may not have been too high when considering the average expected rainfall. The high planting rate did not decrease yields at the other locations.

As was expected a later planting date caused yield of early maturing hybrid to be higher than the medium or late maturing hybrid. The use of an early maturing hybrid is mandatory since delaying the planting date appears to be crucial to allow late tillage operations for weed control.

Row spacing effects varied with date of planting, planting rate, and hybrid maturity. No general trends from location to location were found.

Based upon a single seasons results the super-thick system appears to have promise as an effective erosion control tool without decreasing yield.

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APPENDIX

Table A-1. Analysis of variance for yield and yield components, Hutchinson 1983, Mean Squares.

Source of variation	Degrees of freedom	Yield (kg/ha)	Number of heads/ha	Seed weight
Rep	2	1632832	117101452	32.6 *
Hybrid	2	334414	3288579959 *	42.4 *
Rate	1	1236784	13190563062 *	42.5 *
Hybrid x Rate	2	152676	18357603	2.9
Spacing	1	60690	144469229	1.9
Hybrid x Spacing	2	106626	15050982	1.1
Rate x Spacing	1	262472	1596066	13.9 *
Hybrid x Rate x Spacing	2	380159	308484685	1.0
Error	19	307932	157011641	3.0

*Significant at .05 level

Table A-2. Analysis of variance of yield and yield components, Manhattan 1983, Mean Squares.

Source of variation	Degrees of freedom	Yield (kg/ha)	Lodging %	Number of heads/ha	Seed weight
Date	1	6382211	0.3	8342401393	44.7
Error (A)	4	4347720	0.27	145019528	5.6
Hybrid	2	4573946 *	0.025	4520740539 *	259.3 *
Date x Hybrid	2	795263	0.025	210365683	16.3 *
Rate	1	385588	0.3	123535647296 *	22.6 *
Date x Rate	1	21046	0.3	454199753	1.1
Hybrid x Rate	2	1095613	0.025	652820557	0.0
Date x Hybrid x Rate	2	153039	0.025	427158074	0.15
Spacing	1	408608	0.3	13306731626 *	5.2 *
Date x Spacing	1	1838339 *	0.3	274763682	2.5
Hybrid x Spacing	2	2191457 *	0.025	464687031	1.4
Date x Hybrid x Spacing	2	277023	0.025	73667022	.03
Rate x Spacing	1	2765	0.3	132285956	0.1
Date x Rate x Spacing	2	646498	0.3	37071790	0.1
Hybrid x Rate x Spacing	2	1532271 *	0.025	522896853	0.2
Date x Hybrid x Rate x Spacing	2	59115	0.025	353859945	0.2
Error (B)	44	356066	0.26	390699143	1.16

*Significant at the .05 level

Table A-3. Analysis of variance for yield and yield components, Powhattan 1983, Mean Squares.

Source of variation	Degrees of freedom	Yield (kg/ha)	Lodging %	Number of heads/ha	Seed weight
Date	1	10510641	0.23	152047065109	6.15
Error (A)	6	1332334	63.90	671371582	2.84
Hybrid	2	494476	188.00 *	6146351512 *	185.9 *
Date x Hybrid	2	557067	480.44 *	1138726905	27.91 *
Rate	1	2383321 *	75.43	116486219693 *	26.77
Date x Rate	1	35878	47.46	12328150795 *	2.50
Hybrid x Rate	2	391010	14.69	1590605934 *	1.36
Date x Hybrid x Rate	2	39927	31.56	52034596	0.53
Spacing	1	367252	93.81	5278634695 *	28.93 *
Date x Spacing	1	4295692 *	51.77	1277434755	0.41
Hybrid x Spacing	2	120892	12.40	47144684	3.59
Date x Hybrid x Spacing	2	338205	26.00	600073036	3.61
Rate x Spacing	1	63999	1.14	151400755	0.01
Date x Rate x Spacing	1	57913	30.94	67289782	0.09
Hybrid x Rate x Spacing	2	30399	23.22	200646727	2.21
Date x Hybrid x Rate x Spacing	2	129131	29.73	250041342	0.67
Error (B)	66	268214	27.14	411839258	1.19

*Significant at .05 level

Table A-4. Analysis of variance for yield and yield components, St. John 1983, Mean Squares.

Source of variation	Degrees of freedom	Yield (kg/ha)	Lodging %	Number of heads/ha	Seed weight
Date	1	1548714	100.7	9718322358	853.2
Error (A)	6	2804841	2.7	1730220888	6.2
Hybrid	2	3854584 *	1.8	9447631478 *	343.3 *
Date x Hybrid	2	3347835 *	0.8	1157014278	46.6 *
Rate	1	26198	93.8 *	79015243808 *	40.8 *
Date x Rate	1	99362	111.6 *	133906504	0.3
Hybrid x Rate	2	408461	5.1	1823235972 *	0.45
Date x Hybrid x Rate	2	208930	5.3	77517774	4.1
Spacing	1	1023847 *	10.6	5959139835 *	0.8
Date x Spacing	1	239370	17.1	133911228	2.0
Hybrid x Spacing	2	101889	16.3	267148752	2.9
Date x Hybrid x Spacing	2	761121 *	31.8	448942392	3.6
Rate x Spacing	1	125144	35.4	750289837	1.7
Date x Rate x Spacing	1	45487	13.0	26288080	0.2
Hybrid x Rate x Spacing	2	26860	27.7	48424465	0.45
Date x Hybrid x Rate x Spacing	2	103566	26.6	602798223	2.2
Error (B)	66	222298	20.7	481844536	3.18

*Significant at .05 level

Table A-5. Analysis of variance for yield and yield components, Tribune 1983, Mean Squares.

Source of variation	Degrees of freedom	Yield (kg/ha)	Lodging %	Number of heads/ha	Seed weight
Date	1	20607	57.0	341436484	39.5
Error (A)	6	957986	699.0	617253686	6.25
Hybrid	1	215	3871.9 *	4287892324	99.2 *
Date x Hybrid	1	3000083 *	161.3	341454962	21.9 *
Rate	1	168428	0.03	7696070392 *	3.2
Date x Rate	1	1076925 *	1648.4 *	354841987	3.1
Hybrid x Rate	1	87690	103.5	90406818	1.2
Date x Hybrid x Rate	1	159340	2647.1 *	27068607	0.9
Spacing	1	356110	7564.7 *	1487741326 *	0.007
Date x Spacing	1	51166	770.1	65177365	3.0
Hybrid x Spacing	1	1064043 *	138.7	9300975	0.04
Date x Hybrid x Spacing	1	135958	1.0	382388247	6.1
Rate x Spacing	1	447	0.1	1900480430 *	11.8
Date x Rate x Spacing	1	35929	85.6	3892729	0.6
Hybrid x Rate x Spacing	1	14926	27.8	243594056	1.1
Date x Hybrid x Rate x Spacing	1	20628	12.3	302812202	13.1 *
Error (B)	42	251088	248.1	269142564	2.99

*Significant at .05 level

Table A-6. Plants/ha, yield, heads/ha, lodging percent and seed weight means, Manhattan 1983.

Date of Planting	Hybrid Maturity	Seeding Rate (sds/ha)	Row Spacing (cm)	Plants/Ha	Yield (kg/ha)	Heads/Ha	Lodging Percent	Seed weight (g/1000)
June 6	Early	123,500	25	116731	4542	123428	0.0	20.6
			76	135867	3977	134431	0.0	19.0
		246,900	25	209062	4424	212889	0.0	19.0
			76	232504	4276	234896	0.0	17.5
	Medium	123,500	25	110989	4600	100464	0.0	27.6
			76	150219	4819	145434	0.0	26.8
		246,900	25	188491	4552	180358	0.0	26.3
			76	239202	3162	200929	0.0	25.6
	Late	123,500	25	100464	3261	91853	0.0	26.5
			76	129647	3631	101899	0.0	26.0
		246,900	25	202365	3415	182271	0.0	25.2
			76	209540	3917	213368	0.0	24.7
June 22	Early	123,500	25	121993	4808	149740	0.0	20.1
			76	151175	4242	150697	1.5	19.3
		246,900	25	235853	4422	217195	0.0	19.3
			76	235853	4575	254511	0.0	18.8
	Medium	123,500	25	132996	5067	128212	0.0	24.1
			76	168876	5773	167441	0.0	25.0
		246,900	25	223893	4987	203800	0.0	23.7
			76	251162	5022	240159	0.0	23.5
	Late	123,500	25	104770	3822	110032	0.0	23.7
			76	157873	4487	150697	0.0	23.5
		246,900	25	230112	3345	188012	0.0	22.7
			76	220544	5174	220065	0.0	22.5
LSD .05	Within dates:			21864	981	32504	NS	1.6
	Between dates:			22354	1365	31641	NS	2.0

Table A-7. Plants/ha, yield, heads/ha, lodging percent and seed weight means, Powhattan 1983.

Date of Planting	Hybrid Maturity	Seeding Rate (sds/ha)	Row Spacing (cm)	Plants/Ha	Yield (kg/ha)	Heads/Ha	Lodging Percent	Seed weight (g/1000)
May 31	Early	135,800	25	71760	2691	87189	12.0	18.8
			76	95800	3245	114099	11.5	18.8
		271,600	25	152132	2749	143880	8.8	17.0
			76	182989	3117	179760	11.2	16.5
	Medium	135,800	25	67095	3208	82524	1.9	24.4
			76	115175	3780	113022	1.5	21.5
		271,600	25	158232	2609	130963	0.0	22.8
			76	159308	3616	149262	3.5	20.5
	Late	135,800	25	73554	3495	86112	0.0	24.9
			76	103335	3707	97594	0.0	24.4
		271,600	25	137062	2903	124504	0.0	24.4
			76	159667	3471	134192	0.0	23.3
June 23	Early	135,800	25	139933	4214	155361	3.7	20.0
			76	152132	3640	155361	2.0	19.3
		271,600	25	241833	4011	266231	0.0	19.0
			76	253674	3590	265873	2.5	18.8
	Medium	135,800	25	122351	4283	166125	6.5	22.6
			76	172943	4002	172943	16.2	21.1
		271,600	25	250085	4092	245780	4.8	20.9
			76	257620	3573	257261	4.2	20.8
	Late	135,800	25	123787	4119	121992	0.0	22.7
			76	148544	4067	150338	6.2	21.9
		271,600	25	247215	3443	221022	0.0	23.1
			76	232145	3494	219946	5.1	20.7
LSD .05	Within dates:			24686	730	28614	7.4	1.1
	Between dates:			25062	842	29355	7.7	1.6

Table A-8. Plants/ha, yield, heads/ha, lodging percent and seed weight means, St. John 1983.

Date of Planting	Hybrid Maturity	Seeding Rate (sds/ha)	Row Spacing (cm)	Plants/Ha	Yield (kg/ha)	Heads/Ha	Lodging Percent	Seed weight (g/1000)
June 7	Early	86,400	25	83959	1350	69607	6.3	25.1
			76	93288	1551	94365	0.0	24.4
		246,900	25	177966	1819	163614	0.0	24.4
			76	171507	1818	152850	1.3	23.4
	Medium	86,400	25	33009	1443	37674	9.7	21.0
			76	70325	1657	68531	1.0	20.1
		246,900	25	132756	1559	88265	0.0	18.6
			76	146750	1417	107281	0.0	19.2
	Late	86,400	25	56331	1748	58484	2.3	22.6
			76	77501	2599	77142	6.9	23.4
		246,900	25	158590	1416	113022	0.0	21.0
			76	157514	2131	139215	0.0	21.6
June 2	Early	86,400	25	48079	1890	47720	0.0	21.7
			76	63149	2225	64225	0.0	22.8
		246,900	25	123428	2087	119122	0.0	19.3
			76	157873	2309	137421	1.0	20.6
	Medium	86,400	25	35162	803	35162	0.0	13.5
			76	49873	818	57408	0.0	12.9
		246,900	25	91853	795	83242	0.0	13.2
			76	106564	1120	100823	1.3	12.4
	Late	86,400	25	35521	1323	39826	1.0	14.8
			76	54537	1379	54896	0.0	14.7
		246,900	25	103694	1512	99029	0.0	12.8
			76	86471	1199	89700	0.0	14.8
LSD .05	Within dates:			30829	664	30950	6.4	2.5
	Between dates:			32309	932	34128	6.5	2.6

Table A-9. Plants/ha, yield, heads/ha, lodging percent and seed weight means, Tribune 1983.

Date of Planting	Hybrid Maturity	Seeding Rate (sds/ha)	Row Spacing (cm)	Plants/Ha	Yield (kg/ha)	Heads/Ha	Lodging Percent	Seed weight (g/1000)
June 9	Early	49,400	25	53461	1361	75707	39.3	13.5
			76	83242	1150	72836	51.1	14.7
		148,200	25	86830	1425	75348	14.0	15.3
			76	125939	1119	109793	25.4	12.0
	Medium	49,400	25	48796	1800	51667	6.1	13.3
			76	58126	1932	57049	28.7	13.3
		148,200	25	80012	1528	65660	16.0	11.7
			76	86829	1542	75348	29.5	12.0
July 1	Early	49,400	25	34444	1830	63507	15.6	12.9
			76	63866	1299	54537	38.9	14.0
		148,200	25	62072	2191	82883	33.5	13.0
			76	95800	1610	95800	62.1	14.0
	Medium	49,400	25	39467	1091	50232	4.1	9.3
			76	61713	1127	51667	33.7	10.3
		148,200	25	57049	1371	61355	2.1	10.6
			76	72477	1623	86471	35.3	9.0
LSD .05	Within dates:			22730	716	23445	22.4	2.5
	Between dates:			24652	833	25269	24.9	2.6

Table A-10. Climatic data for Hutchinson 1983.

	Temperature Degrees Celcius				Precipitation (cm)			
Month	Average Max.	Average Min.	Average	Departure from Normal	Total	Departure from Normal	Greatest Day	Date
June	27.4	15.4	21.4	- 2.81	9.26	- .56	1.67	3
July	35.4	20.0	27.8	.75	5.66	- 4.46	5.66	4
August	37.1	21.8	29.4	3.10	3.70	- 6.56	3.09	20
September	30.3	14.6	22.4	1.23	1.47	- 7.41	.68	15

Table A-11. Climatic data for Manhattan 1983.

	Temperature Degrees Celcius				Precipitation (cm)			
Month	Average Max.	Average Min.	Average	Departure from Normal	Total	Departure from Normal	Greatest Day	Date
June	26.8	15.6	21.3	- 2.60	10.66	- 2.76	4.11	14
July	34.2	20.3	27.2	NA	1.42	- 8.63	1.39	NA
August	36.5	22.6	29.6	3.60	2.41	- 5.63	1.39	21
September	30.0	16.0	23.0	2.10	5.10	- 5.15	2.43	12

Table A-12. Climatic data for Powhattan 1983.

Month	Temperature Degrees Celcius				Precipitation (cm)			
	Average Max.	Average Min.	Average	Departure from Normal	Total	Departure from Normal	Greatest Day	Date
June	28.8	15.6	22.2	- 1.00	12.44	- 1.65	3.50	18
July	34.6	20.2	27.4	1.50	.40	-10.92	.40	4
August	36.9	21.3	29.1	4.30	2.41	- 8.33	.63	24
September	30.3	14.3	22.3	2.30	4.72	- 6.55	3.42	20

Table A-13. Climatic data for St. John 1983.

Month	Temperature Degrees Celcius				Precipitation (cm)			
	Average Max.	Average Min.	Average	Departure from Normal	Total	Departure from Normal	Greatest Day	Date
June	30.0	16.4	23.0	- 1.20	5.53	- 5.29	2.31	9
July	34.4	21.0	27.9	.85	5.56	- 3.71	4.49	28
August	36.8	21.9	29.3	3.20	1.67	- 4.84	.99	27
September	29.5	14.9	24.7	3.13	8.61	3.01	5.84	12

Table A-14. Climatic data for Tribune 1983.

	Temperature Degrees Celcius				Precipitation (cm)			
Month	Average Max.	Average Min.	Average	Departure from Normal	Total	Departure from Normal	Greatest Day	Date
June	27.8	12.1	20.0	− 2.10	20.35	13.80	6.65	26
July	35.0	16.7	25.9	.60	.64	− 5.30	.30	27
August	36.4	17.0	26.7	2.80	.18	− 5.60	.10	24
September	31.4	11.0	21.1	2.10	1.91	− 1.50	1.06	30

Table A-15. Soil Moisture Percent, Super-Thick Study 1983.

Location	Date	Depth (cm)				
		0-15	15-30	30-60	60-90	90-120
Hutchinson	June 1	19.0	21.7	24.1	17.8	14.1
	June 20	17.4	21.4	22.1	18.9	14.3
Manhattan	June 6	22.5	22.2	26.4	29.4	25.2
	June 22	21.9	22.4	25.4	29.5	26.9
Powhattan	May 31	23.1	25.7	31.5	30.2	26.1
	June 23	24.5	29.9	33.2	27.4	25.4
St. John	June 7	6.5	11.2	15.1	14.0	14.5
	June 29	5.7	10.7	14.8	14.7	17.4
Tribune	June 9	22.0	23.8	23.5	22.8	19.6
	July 1	21.1	22.6	22.6	20.2	17.1

COMPARISON OF SUPER-THICK
AND CONVENTIONAL GRAIN SORGHUM
MANAGEMENT SYSTEMS

by

LARRY L. LOCKHART

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AN ABSTRACT OF A MASTER'S THESIS

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Abstract

Dryland grain sorghum conventionally has been grown in wide row spacings and at relatively low plant populations. A major drawback of this system is large areas of exposed soil surface which often is subjected to wind and water erosion. A new management system called "Super-Thick" would reduce the exposed soil surface by decreasing row width and increasing plant population. Previously, the Super-Thick system had only been tested in the western half of Kansas, however, much interest has evolved in using this system in other grain sorghum producing areas of the state.

In order to expand research to new areas, studies were conducted at five locations throughout Kansas. The objective of the experiment was to compare yields of the conventional and Super-Thick systems over a broad range of environmental conditions.

Three hybrid maturities (early, medium, and late), two row spacings (25 and 76 cm), and two seeding rates (X and 2-3X) were planted in early June and again in late June.

The growing season of 1983 was unusually hot and dry leading to yields well below average. Results showed high populations reduced yield at Powhattan, but had little or no effect on yield at other locations. Generally, yields were highest when planting date was delayed, particularly when using the early maturing hybrid. Yields of medium and late maturing hybrids were similar regardless of planting date.

Row spacing effects were found varying with location, date of planting, rate of planting, and hybrid maturity. There were no strong trends giving either spacing an overall yield advantage.

When limiting comparison to the specific systems as defined in the literature, no differences in yield were found. This was surprising

considering the lack of adequate rainfall during the growing season. Results of this study seem to show that Super-Thick could be an adequate erosion control tool without concern of yield loss.