WILD RICE PRODUCTION RESEARCH - 1997

E.A. Oelke, R.J. Kirsch, D.G. LeGare, and H.J. Schumar

The number of growing degree days during the growing season for 1996 and 1997 were very similar. The average number of growing degree days over the 4 locations for 1997 was only 9 fewer than in 1996 and 25 fewer than for the long term average (Tables 1 and 2). Thus, 1997 was only slightly cooler than 1996 and the long term average. However, the growing degree days distribution during the growing season was dramatically different in 1997 compared to 1996. April was much warmer, while May was much cooler compared to 1996. July and August were much warmer in 1997 at all locations compared to 1996. September was cooler at all locations in 1997 compared to 1996.

Compared to the long term average 1997 was cooler at Aitkin, Grand Rapids, and Crookston, but warmer at Waskish. Again in 1997, May and June were cooler than the long term average similar to the 1997 and 1996 comparison. June and July were warmer at all locations except for Crookston which was cooler compared to the long term average.

Table 1. Growing degree days[a] comparisons for 1996, 1997, and normal (61-90).

	Aitkin			Grand Rapids		
Month	1996	1997	Normal	1996	1997	Normal
	GDD					
April	38	100	127	34	118	130
May	335	236	417	359	291	434
June	690	798	646	712	798	674
July	769	804	779	789	840	858
August	800	678	683	856	732	768
Total	2632	2616	2652	2750	2779	2864

[a]Maximum + minimum temp. - 40°F; data from Mark Seeley, Department of Soil, Water and Climate,
2 U of MN.

Table 2. Growing degree days[a] comparisons for 1996, 1997, and normal (61-90).

Month	Waskish			Crookston		
	1996	1997	Normal	1996	1997	Normal
	GDD					
April	20	58	103	33	84	151
May	300	184	369	393	318	488
June	652	712	518	803	828	743
July	714	794	642	828	892	926
August	818	683	563	883	840	867
Total	2504	2431	2195	2940	2962	3175

[a] $\frac{\text{Maximum + minimum temp.}}{2}$ - 40°F; data from Mark Seeley, Department of Soil, Water and Climate, U of MN.

Total precipitation was more at all locations except for Waskish which was drier in 1997 compared to 1996 (Tables 3 and 4). April was drier at all locations except for Crookston which was much wetter in 1997 compared to 1996. At Aitkin in 1997 May was drier but June, July, and August were wetter than 1996. At Grand Rapids in 1997, April and July were drier than 1996, while wetter for the other three months. At Waskish in 1997, all the months were drier than in 1996. At Crookston in 1997, April and June , and August were considerably wetter, while May and July were drier than in 1996.

The weather during the growing season was generally favorable for wild rice production. The weather during harvest was favorable except for some storms toward the end of harvest.

Table 3. Precipitation comparisons for 1996, 1997, and normal (61-90)[a].

Month	Aitkin			Grand Rapids		
	1996	1997	Normal	1996	1997	Normal
	inches					
April	1.37	0.68	2.30	1.81	0.77	2.10
May	1.69	1.57	2.88	1.43	2.24	3.04
June	3.15	5.18	4.09	5.17	5.92	4.11
July	5.54	5.75	4.14	6.13	5.77	3.89
August	1.21	3.00	3.83	1.29	2.18	3.59
Total	12.96	16.18	17.24	15.83	16.88	16.73

[a] Data from Mark Seeley, Department of Soil, Water, and Climate, U of MN.

Table 4. Precipitation comparisons for 1996, 1997, and normal (61-90)[a].

Month	Waskish 1996	Waskish 1997	Waskish Normal	Crookston 1996	Crookston 1997	Crookston Normal
	inches					
April	1.28	1.22	1.70	0.42	4.24	1.45
May	1.90	1.69	2.33	3.17	1.41	2.45
June	3.47	3.11	4.25	1.73	5.09	3.44
July	4.84	4.11	3.42	5.57	4.33	2.77
August	2.50	1.43	3.32	0.33	1.88	2.88
Total	13.99	11.56	15.02	11.22	16.95	12.99

[a] Data from Mark Seeley, Department of Soil, Water, and Climate; U of MN.

The total processed wild rice produced in Minnesota in 1997 was almost the same as in 1969 with about 6,000,000 pounds produced (Table 5).

Table 5. Minnesota and California paddy wild rice production[a] (1000 processed pounds).

Year	Production Minnesota	Production California	Year	Production Minnesota	Production California
1968	36	0	83	3200	2500
69	160	0	84	3600	2500
70	364	0	85	4200	7900
71	608	0	86	5100	9000
72	1496	0	87	4200	4200
73	1200	0	88	4000	3500
74	1036	0	89	3978	4000
75	1233	0	90	4800	4200
76	1809	0	91	5500	5500
77	1031	0	92	6100	7500
78	1761	100	93	5300	7500
79	2155	200	94	5300	5000
80	2320	400	95	4500	6440
81	2274	500	96	6000	7600
82	2697	880	97	6002	----

[a] 1968-1982 Minnesota values from Winchell and Dahl and 1983-1995 from Minnesota Department of Agriculture; California values from Marcum, Cooperative Extension Service, University of California.

The estimated value of the Minnesota production was again about $9,000,000 which is more than it was for the previous 3 years before 1996 (Table 6). The higher value in 1996 and 1997 is due to the higher production in 1996 and 1997 compared to the three years before 1996.

Table 6. Processed wild rice harvested and value from cultivated fields in Minnesota.

Year	Production	Price to Producer	Value
	1,000 lb	$/lb	$ Millions
1968	36	3.30	0.12
1969	160	2.55	0.41
1970	364	2.80	1.02
1971	608	2.70	1.64
1972	1,496	2.30	3.44
1973	1,200	2.05	2.46
1974	1,036	2.37	2.46
1975	1,233	2.50	3.08
1976	1,809	2.70	4.88
1977	1,031	4.35	4.48
1978	1,761	5.10	8.98
1979	2,155	5.01	10.80
1980	2,320	4.47	10.37
1981	2,274	3.79	8.62
1982	2,697	3.41	9.20
1983	3,200	3.35	10.72
1984	3,600	3.30	11.88
1985	4,200	2.97	12.47
1986	5,100	2.60	13.26
1987	4,200	1.50	6.30
1988	4,000	1.65	6.60
1989	3,978	1.65	6.56
1990	4,800	1.70	8.16
1991	5,300	1.70	9.01
1992	6,100	1.70	10.37
1993	5,300	1.65	8.74
1994	5,300	1.65	8.74
1995	4,300	1.50	6.45
1996	6,000	1.50	9.00
1997[a]	6,002	1.50	9.00

[a]Estimated values for 1997.

Research

Simulated Hail on Wild Rice

Introduction

The previous simulated hail research was summarized in the 1996 Minnesota Wild Rice Research. Generally there was little yield reduction when 33, 67, and 100% of each leaf blade was removed at the floating, aerial, and tillering stages of growth. In the 1996 report a table (Table 9) was presented with estimated yield losses. The several years of yield loss due to simulated hail was consistent for all years except for the three early stages when leaf blades were removed. Thus in 1997, a study was done only for the floating, aerial and tillering stages of growth to get some final data to include in the yield loss chart from simulated hail injury.

Materials and Methods

Wild rice, variety 'Franklin,' was planted with a cone planter on May 28, 1997, at the University of Minnesota, North Central Experiment Station. Before planting, the paddy was fertilized with 75 lbs/A nitrogen to give a total of 96 lbs/A of nitrogen. In addition, 3 lbs/A of boron and 20 lbs/A of sulfur were added preplant. After planting, the paddy was immediately flooded to a depth of 6 inches. Individual plots consisted of 4 rows, 1 foot apart and 10 feet long with each treatment replicated 4 times. Plant population was about 4 plants/ft^2.

To simulate hail damage, 33, 67 and 100% of each leaf blade in a plot was cut off with a scissors at the floating, aerial and tillering stage of growth. The treatment dates were: floating, 6/17; aerial, 6/27; and tillering,7/14. Plots were harvested on 9/10/97.

Results and Discussion

No statistical difference in processed grain yield was observed for the various percentages of leaf removal at the three growth stages (Table 8). However, the 100% leaf blade removal generally had lower yields than less levels of leaf removal. These data will be incorporated into the final yield loss table for simulated hail loss.

Table 8. Wild rice yield and other characteristics as influenced by various percentages of leaf blade removal at three growth stages, Grand Rapids, 1997.

Growth Stage	Leaf Removal %	Panicles /sq ft	Yield 40% moist lbs/A	Yield Finished lbs/A	Recovery perc.	Harvest Moist. %	Straw lbs/A	Hulls lbs/A	Losses from hulls %	Harvest Index %
Floating	33	7.03	1056	500	50.6	35.7	3072	165	24.8	13.4
Floating	67	7.10	1109	534	51.9	35.3	3198	164	23.4	13.7
Floating	100	6.68	925	432	48.8	37.1	2913	150	26.0	12.2
Aerial	33	8.25	1272	606	50.6	36.2	3710	195	24.2	13.4
Aerial	67	6.95	1106	525	50.7	35.7	3188	172	24.7	13.5
Aerial	100	7.75	1210	574	50.2	36.4	2975	189	24.6	15.3
Tillering	33	6.65	1015	485	51.5	34.9	3027	155	24.4	13.2
Tillering	67	8.10	1009	487	51.3	36.0	2781	149	23.4	14.2
Tillering	100	8.38	940	450	50.6	36.5	2618	142	23.9	14.0
Check	0	6.60	1069	521	53.0	34.5	3165	153	22.6	13.5
LSD 0.05		1.43	306	144	2.7	1.9	539	51	2.2	2.4

Seed Storage

Introduction

Storing wild rice seed in cold water for three months does not always give good germination. In order to investigate other storage techniques an experiment was started in the fall of 1996 and completed in the spring of 1997.

Materials and Methods

Mature dark seeds of wild rice, variety 'Franklin', were hand harvested from a field on the Kosbau farm near Aitkin on August 27, 1996. The seed was transported the same day in a covered container to St. Paul. The containers with the seeds were put into a cooler (38°F). Two days later only good plump seeds were sorted into lots of 50 seeds and each lot put into squares of mesh cloth and tied. Some seed lots at harvest moisture were placed into peat soil at field moisture capacity, flooded peat soil, water or dry. All lots were in sealed plastic freezer bags. These treatments were placed either in a freezer (28°F) or cooler (38°F). Four replicates were placed into one small insulated container and 4 into another. This was repeated making a total of 4 containers, 2 were placed into the 28°F larger freezer and 2 into the 38°F cooler. Two other treatments were imposed on the initial seed lots of 50 seeds. Some seed lots were dried at room air temperature (72°F) for 4 days to a seed moisture of about 20%. Some seed lots were dried to 20% moisture over a salt solution (75% relative humidity) which took 40 days at a temperature of 85°F. After the appropriate drying days, seed lots of these 2 drying treatments were also placed into field moisture capacity peat and at the two storage temperatures as described for the other earlier 4 treatments.

Rehydration of the dry seeds was in water at 50°F for 30 days followed by 90 days in water at 38°F. The seeds initially stored in water or flooded peat were placed at 38°F for 90 days to release dormancy. Gemination percentage of all seeds in all the treatments were ascertained after the 120 days in water at 38° F. Germinations were obtained on May 14, 1997.

Results and Discussion

The germination and shoot length of Franklin wild rice seed treated differently in the fall of 1996 and stored for 120 days using different storage conditions are given in Table 9. After germinating the seeds in water at room temperatures for 6 days, the highest germination was obtained when seeds at harvest moisture were stored in flooded peat soil and stored above freezing (38° F). Germination was also good when seeds at harvest moisture were stored in field moisture capacity peat or peat with some water added but not flooded, and at temperatures below freezing (28° F). Germination was also good when harvest moisture seed was stored in water kept above freezing. The lowest germination was when seeds at harvest moisture or slow dried seeds were stored in ice. Germination after 21 days followed a similar pattern as after 6 days of germination.

Shoot lengths after 6 days of germination were longest when harvest moisture seeds were stored in flooded peat and kept at 38° F. The shoot length was shorter in the other peat soil storage methods than the flooded peat and were comparable to the harvest moisture seeds stored in water. Shoot length after 14 days again was the longest when harvest moisture seeds were stored in flooded peat at 38° F. The next best storage conditions were keeping harvest moisture seeds in water at 28° F or 38° F.

The one year results indicate that storing small quantities of seed at harvest moisture in flooded peat at 38° F may be a good way to store seeds during the winter for planting the following spring. Water storage at 38° F also appears to be adequate, but generally germination is lower than in flooded peat storage at 38° F.

Table 9. Germination percentage and shoot length after storage of wild rice seed dried differently in the fall and stored for 120 days using different storage conditions, St. Paul, 1997.

Treatments	Germination		Shoot length	
	6 days (%)	21 days (%)	6 days (mm)	14 days (mm)
Seed at harvest moisture				
Flooded Peat				
28 F	26	78	36	74
38 F	93	94	64	86
Field Moisture Peat				
28 F	62	66	46	66
38 F	38	40	48	61
Moistened Peat				
28 F	70	72	55	70
38 F	35	37	55	62
Water				
28 F	19	48	34	70
38 F	75	77	54	81
Seed dried before storage.				
Air Dried - Water Storage				
28 F	38	68	34	68
38 F	34	52	32	74
Fast Dried - Water Storage				
28 F	34	76	34	68
38 F	38	68	38	66
Slow Dried - Water Storage				
28 F	15	46	31	50
38 F	18	46	30	55
Averages	42	62	42	68

Wild Rice Fertility-Density Study

Introduction

The introduction and widespread use of the variety Franklin coupled with a general increase in the amount of nitrogen applied as topdresses by growers has lead to a need for reexamining the agronomics of Minnesota wild rice. In particular, there is considerable interest in whether higher plant densities are advisable under a higher nitrogen regime. Past research has demonstrated that 4 plants/ft^2 are necessary for optimum yields. This study was conducted at two separate locations in 1997: the North Central Experiment Station near Grand Rapids, MN and the Clearwater Rice Farm near Clearbrook, MN. These studies were done in conjunction with Dr. Paul Bloom who contributed his knowledge about nitrogen response in peat soils.

Materials and Methods, North Central Experiment Station

The experiment consisted of 6 plant densities and 3 fertilization levels for a total of 18 treatments. The experiment was replicated 6 times. The treatments were as follows:

Target Plant Density (plants/ft^2)	Nitrogen Fertilization Levels
1) 0.5	1) 75 lb/A basal
2) 1.0	2) 75 lb/A basal + 60 lb/A topdress
3) 2.0	3) 75 lb/A basal + 60 lb/A topdress + 40 lb/A topdress
4) 4.0	
5) 8.0	
6) 16.0	

The plots were planted and flooded on May 28, 1997. Prior to planting the paddy was fertilized with 75 lb/A of nitrogen. Soil samples were taken on June 17, 1997. The plots averaged 21.3 lb/A of inorganic nitrogen. Plots consisted of 8 rows, 6 inches apart and 10 ft. long. The center 4 rows were reserved for harvest, the outer rows for borders, and those between the harvest and border rows for plant sampling. To reach the desired plant densities, the plots were thinned by hand at the aerial leaf stage. Topdresses were applied at boot and flowering. The boot stage topdress, 60 lb/A of nitrogen (urea), was applied on July 23, 1997. The flowering stage topdress, 40 lb/A of nitrogen (urea), was applied on August 1, 1997. Plant samples were taken at 4 times during the season: boot, 7-23; flowering, 8-1; flowering + 10 days, 8-11; and harvest, 9-9. Each sample consisted of whole plants taken from a 4 ft. section of the sampling rows. Plants were bagged, dried, and stored for future nitrogen analysis. SPAD meter readings were taken on all plots at the boot stage. Stem diameters were measured on all plots 12 days before harvest. Stems were chosen from the center rows and measured at the first internode below the flag leaf. All plots were harvested on September 9, 1997. An 8 ft. section of the center 4 rows was taken for grain and straw data. After harvest, plant counts were made on all plots to determine the actual plant densities.

Results and Discussion

Consistent with past results, the best yields were obtained with a plant density of 2-4 plants/ft^2 (Figures 1 and 2). Yields for all but the lowest plant density increased with nitrogen topdresses (Figures 3 and 4). It was apparent during the season that the lowest density plots were severely set back by thinning and this may explain their aberrant response. The recovery percentage increased as the plant density increased (Figure 5); however, this increase could not compensate for the lower yields at high plant densities. The yield per panicle (Figure 6) mirrors the trends of the overall yield with a maximum occurring at 3 plants/ft^2. In examining the components of the yield (panicles per plant and yield per panicle) it is difficult to see where and how the nitrogen topdress is having an effect. Figure 7 shows little if any increase in the number of panicles per plant as nitrogen levels are increased. Figure 8 shows a similar response for the yield per panicle. It is, perhaps, small changes in both components which produce a noticeable change in yield. Stem diameters were not affected by nitrogen levels (Figure 9) but showed a definite inverse relationship to plant density (Figure 10). SPAD meter readings were also unaffected by nitrogen levels (Figure 11) but were inversely related to plant densities (Figure 12).

Plant samples taken during the season have yet to be analyzed for nitrogen content. The objective of this analysis is to determine the efficiency of Franklin's nitrogen usage and under what conditions Franklin is most efficient. Near infared reflectroscopy (NIR) is a technology commonly used with forages and other crops to determine nitrogen levels. It is fairly quick and inexpensive. For these reasons our study is directed toward establishing a relationship between NIR results and nitrogen levels in wild rice plants. Such a relationship would be useful for growers and researchers in quickly determining plant nitrogen levels.

In summary, our study shows that even at high nitrogen levels Franklin produces best at a plant density of 2-4 plants/ft^2. Topdressing is effective in increasing yields; however, the components of that increase remain obscure.

Materials and Methods, Clearwater Rice Farm

This experiment was conducted in a grower's paddy. A section of the paddy was thinned to three different plant densities:

Plant Density
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1) Not thinned
2) Thinned once by airboat
3) Thinned twice by airboat

Each thinning block was approximately 5 acres. The field was managed in accordance with the grower's usual practices. Soil samples were taken on June 16, 1997. The blocks averaged 30.9 lb/A of inorganic nitrogen. Three topdresses were applied for a total of 107 lb/A of nitrogen. A boot stage topdress, 40lb/A of nitrogen, was applied on June 26, 1997. A flowering stage topdress, 40 lb/A of nitrogen, was applied on July 15, 1997. A late flowering stage topdress, 27 lb/A of nitrogen, was applied on July 25, 1997. Four strips (each approximately 0.5 acre) were harvested with a regular wild rice combine out of the center of each block and the yields averaged. The blocks were harvested on August 30, 1997. Prior to harvest each block was sampled to determine the number of tillers per plant. After harvest each block was sampled to determine plant densities. Don Barron and Rod Skoe did the thinning, topdressing, and harvesting with their equipment.

Results and Discussion

The results of the study are presented in Table 7. The highest yield was obtained with a plant density of 2.8 plants/ft^2 (1 thinning). Thinning to lower plant densities increases the percent moisture at harvest and decreases the percent recovery; however, the lower percent recovery is more than offset by the increase in yields at lower densities.

In comparing this study with the Grand Rapids study, there are several results which correlate well. Both show Franklin producing its highest yields at a plant density of 2-4 plants/ft^2. At this density both studies also indicate each plant producing approximately 3 panicles. Both studies show an increase in percent recovery as plant densities increase, and that this gain falls short of compensating for the lower yields at high plant densities. There is a difference in the yields between the studies with the Clearwater Rice study reaching 1850 lb/A and the Grand Rapids study only 1400 lb/A. It is expected that different locations within the state will yield with some variation; however, two points should be noted:

1. There was significant wild rice worm damage at the Grand Rapids location and very little at Clearwater Rice.
2. There is a difference in soils. Grand Rapids is a mineral soil. Clearwater Rice is a peat soil.

Having noted the differences, both studies are the more compelling for their similar description of Franklin's response and management.

Table 7 - Plant Thinning Study at Clearwater Rice Farm, 1997

Thinning	Plant Density (plants/ft^2)	Tillers/ plant	%Moisture	Yield at 40% Moisture (lb/A)	%Recovery	Finished Yield (lb/A)
0	5.7	1.6	36.0	1293	46.1	558.3
1	2.8	2.7	36.7	1853	43.9	770.8
2	1.1	5.5	38.5	1655	42.9	692.0

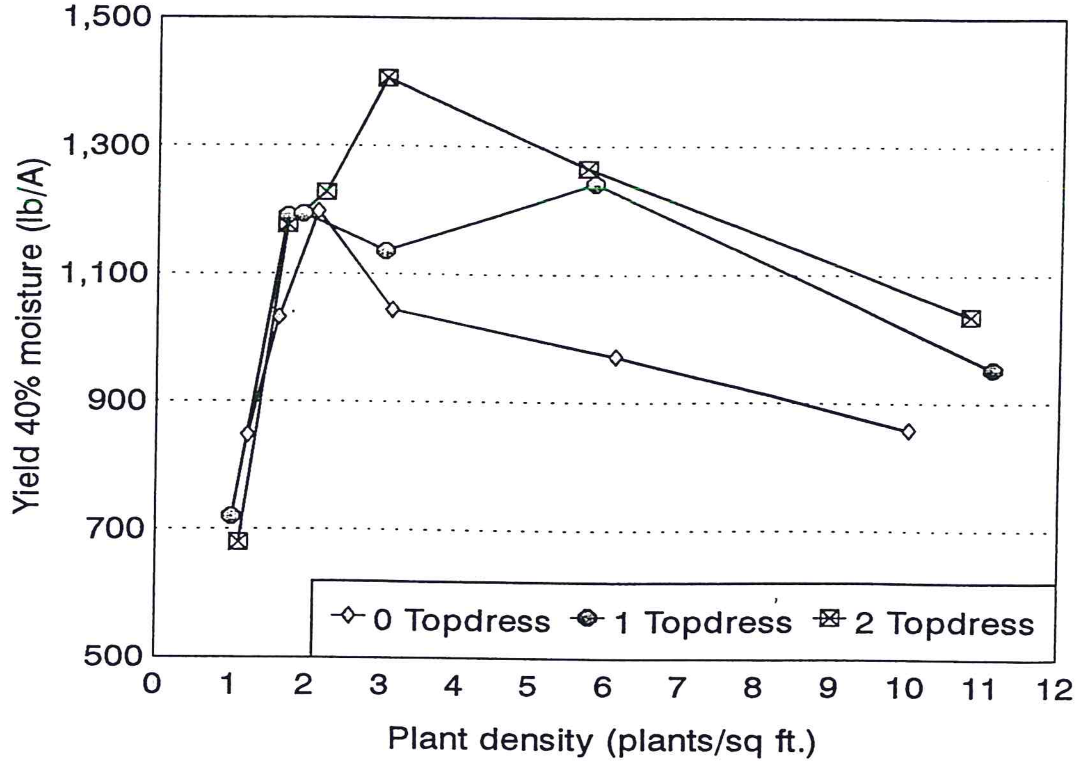

Figure 1 - Yield at 40% moisture as a function of plant density.
Fertility - Density Study Grand Rapids, 1997

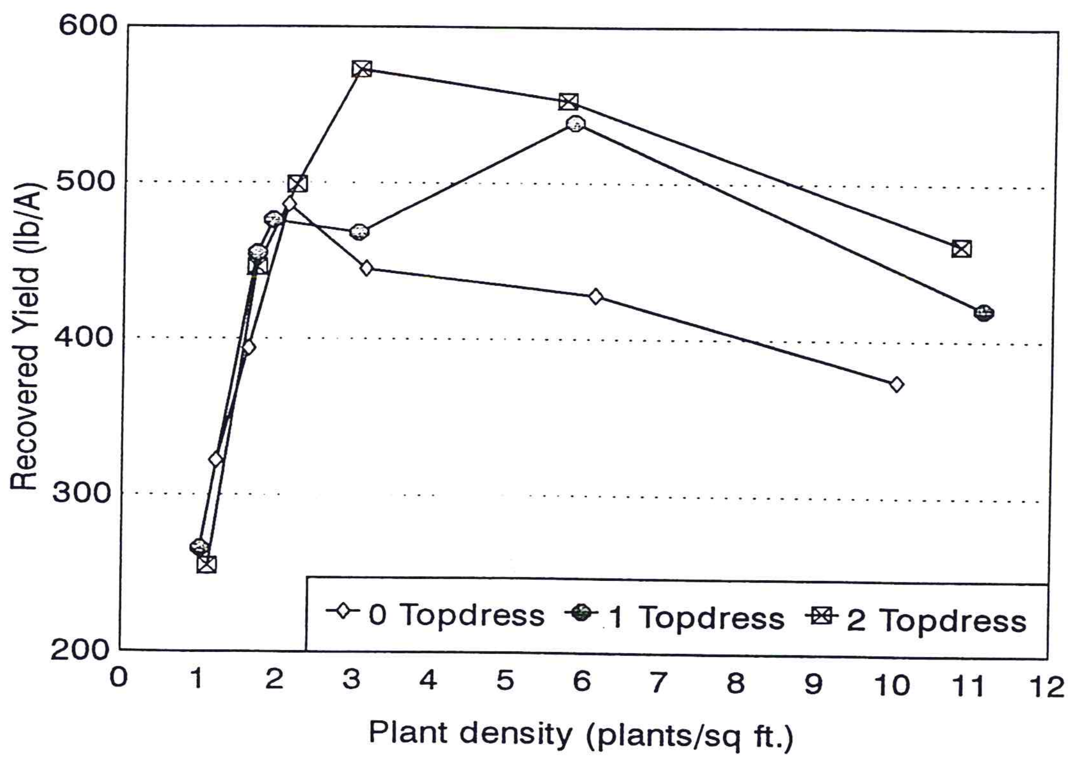

Figure 2 - Recovered yield as a function of plant density
Fertility - Density Study Grand Rapids, 1997

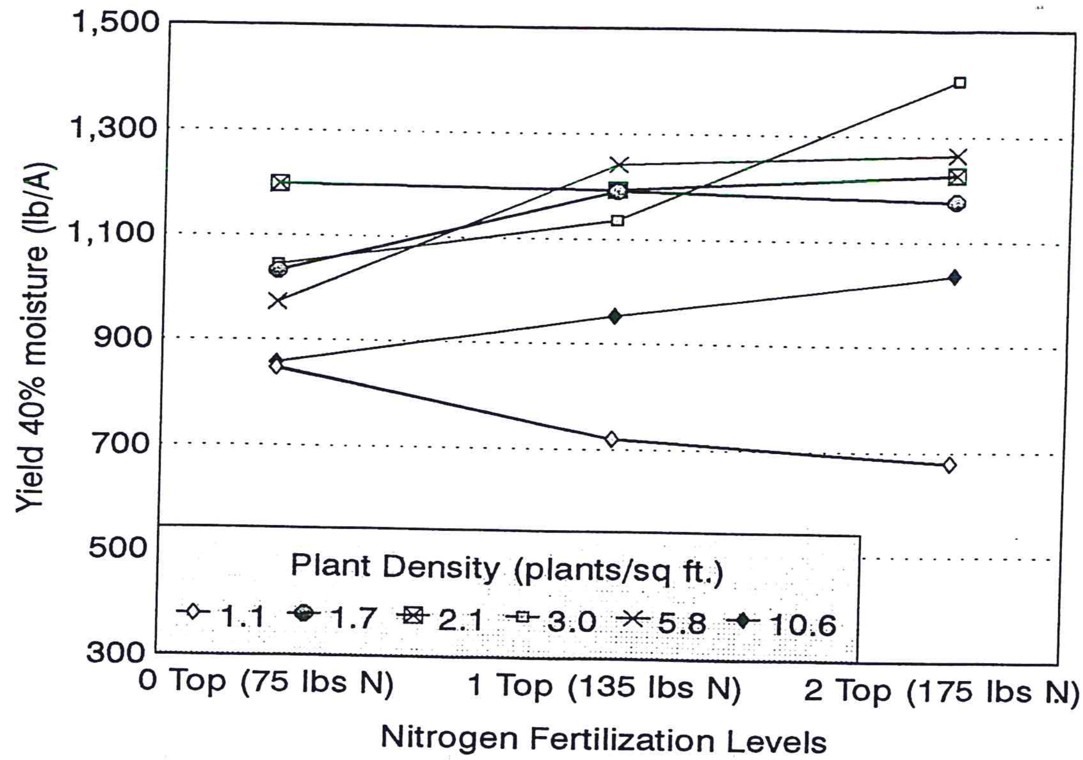

Figure 3 - Yield at 40% moisture as a function of nitrogen fertiliization
Fertility - Density Study Grand Rapids, 1997

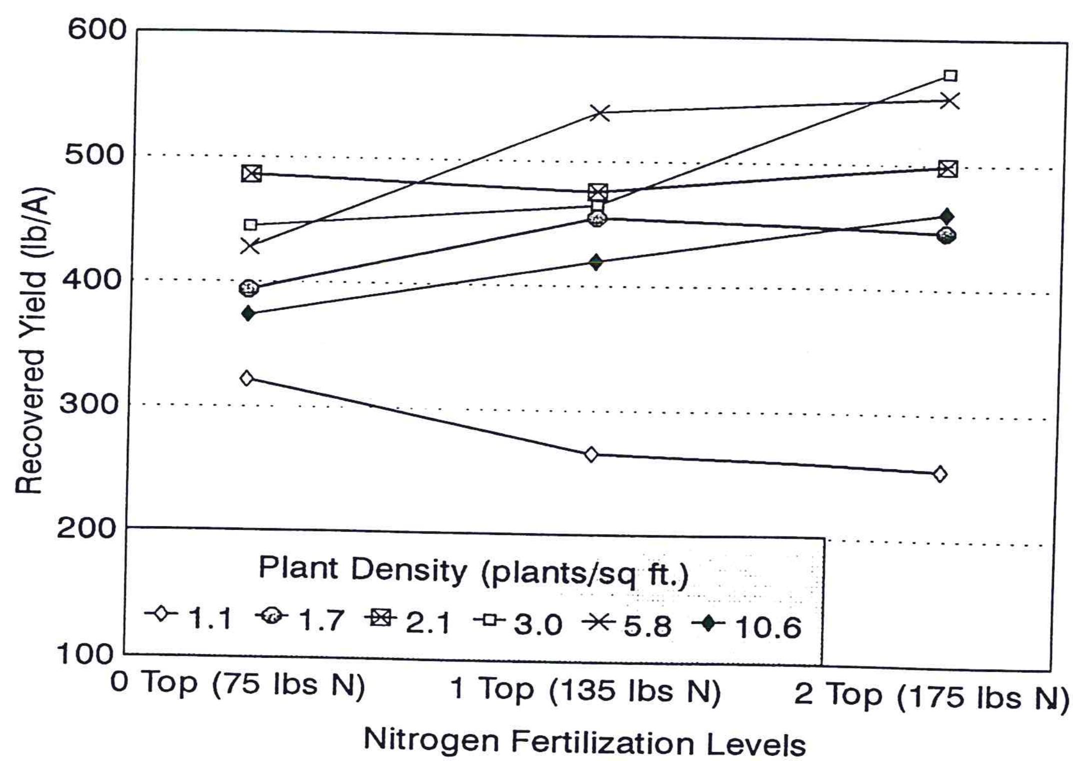

Figure 4 - Recovered yield as a function of nitrogen fertilization
Fertility - Density Study Grand Rapids, 1997

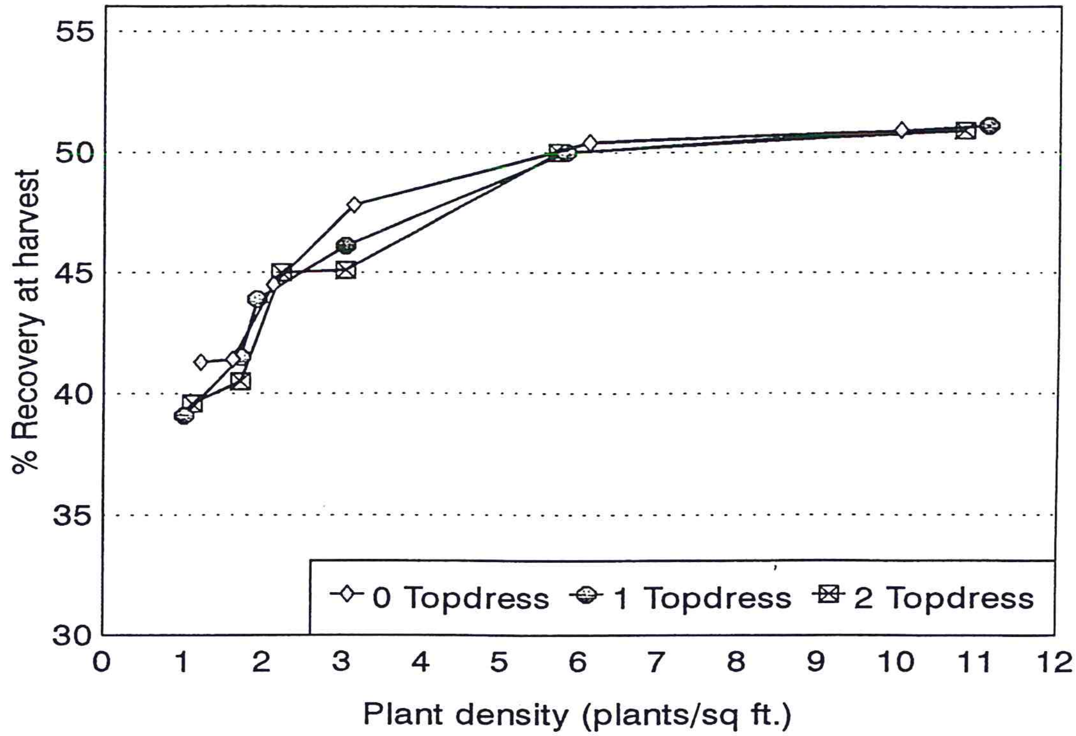

Figure 5 - Percent recovery as a function of plant density.
Fertility - Density Study Grand Rapids, 1997

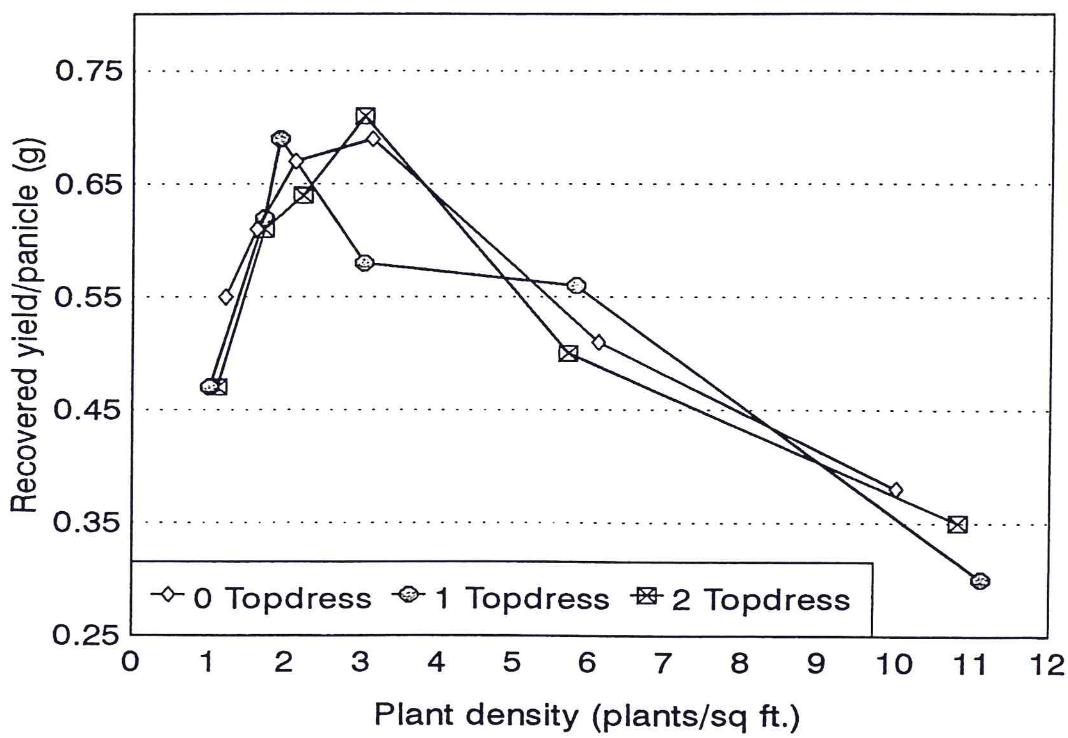

Figure 6 - Yield per panicle as a function of plant density
Fertility - Density Study Grand Rapids, 1997

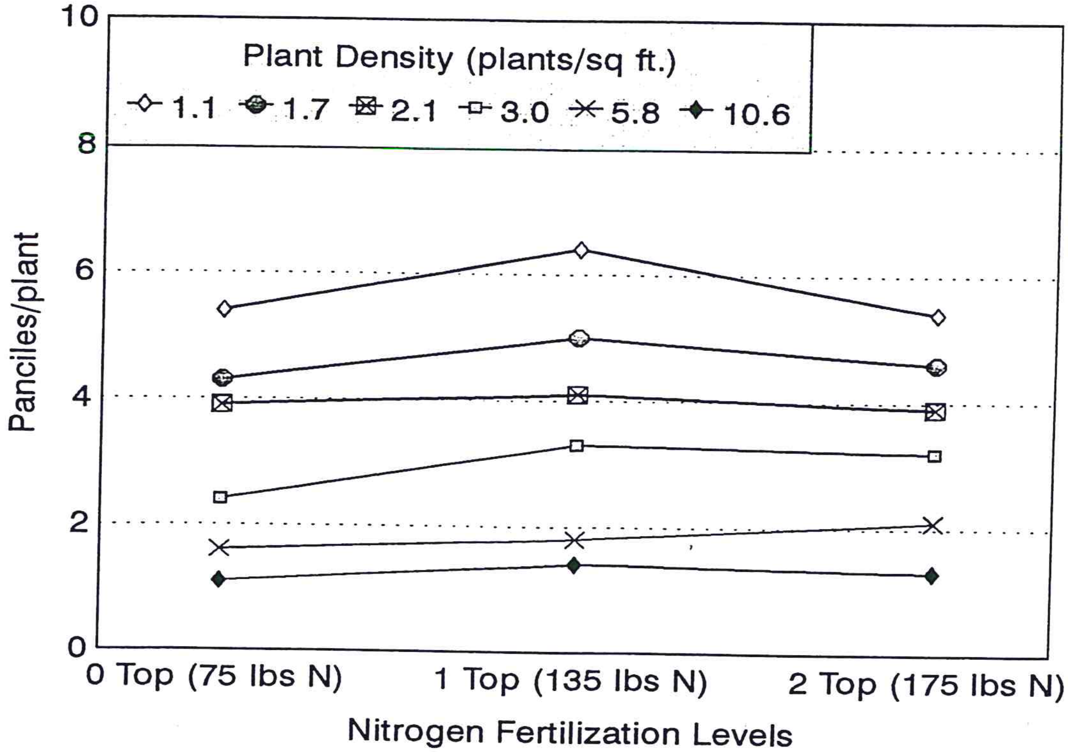

Figure 7 - Panicles per plant as a function of nitrogen fertilization
Fertility - Density Study Grand Rapids, 1997

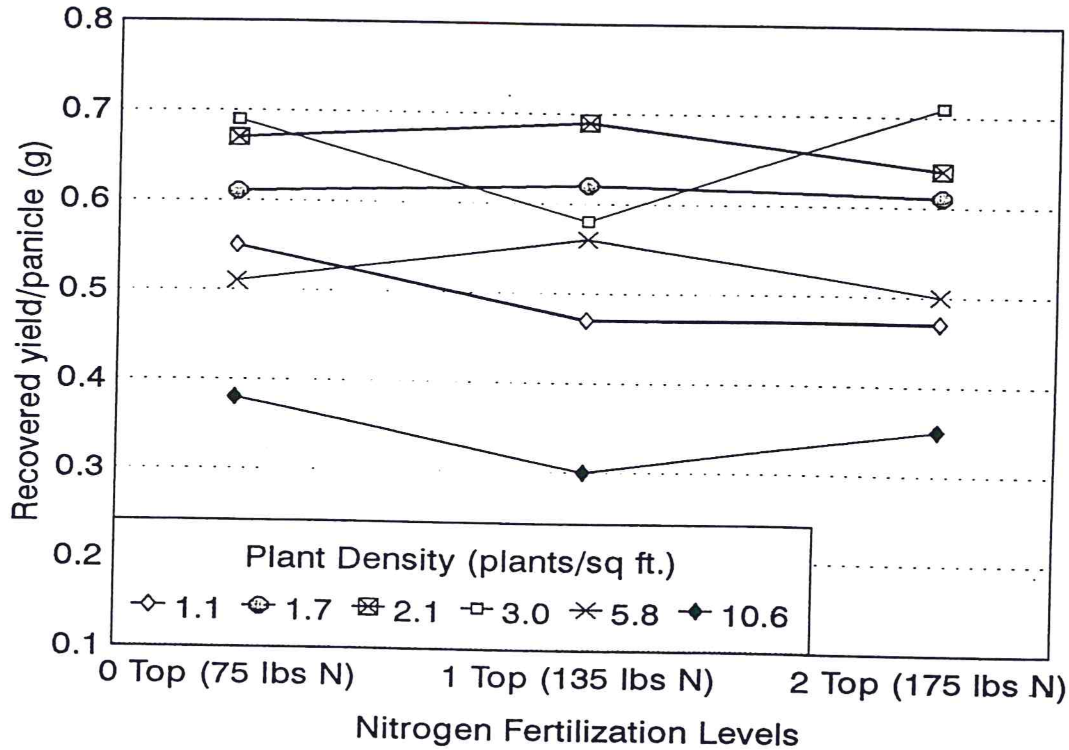

Figure 8 - Yield per panicle as a function of nitrogen fertilization
Fertility - Density Study Grand Rapids, 1997

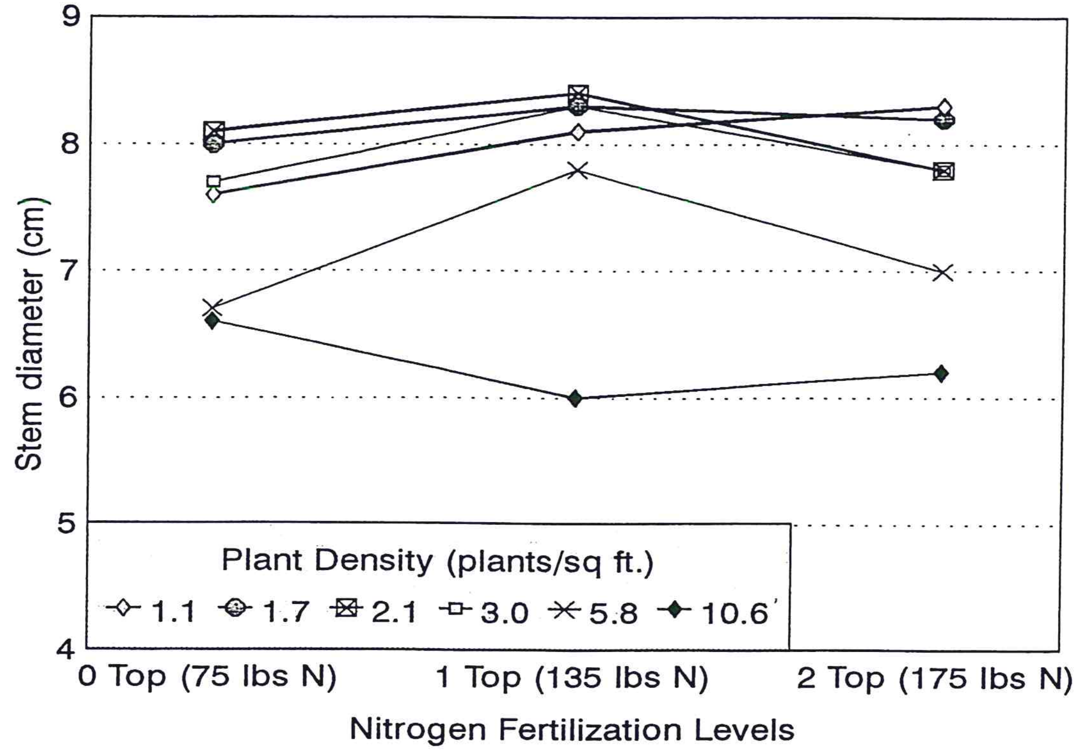

Figure 9 - Stem diameter as a function of nitrogen fertilization
Fertility - Density Study Grand Rapids, 1997

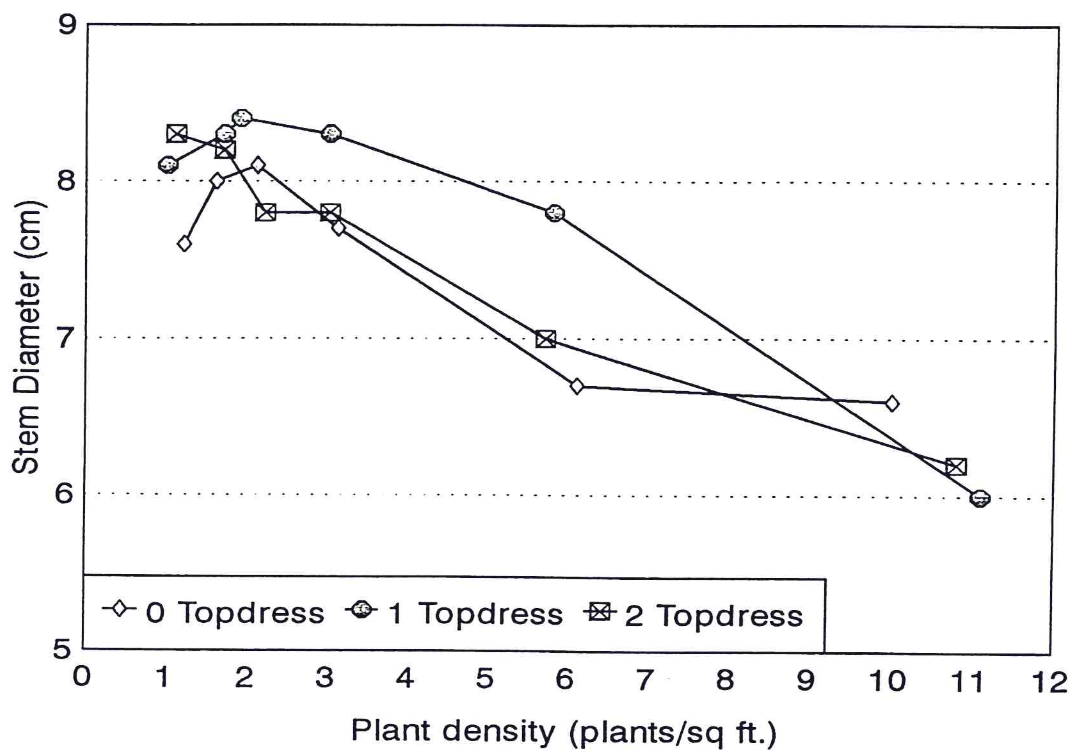

Figure 10 - Stem diameter as a function of plant density
Fertility - Density Study Grand Rapids, 1997

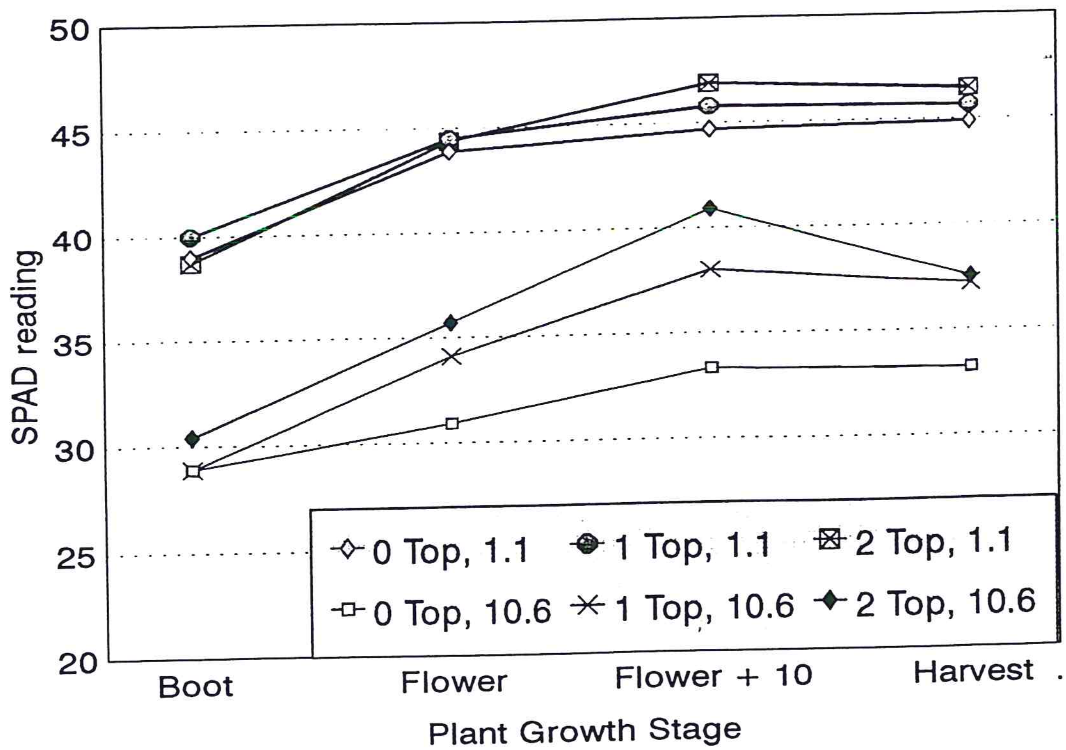

Figure 11 - SPAD readings as a function of plant growth stage and nitrogen levels for two plant densities
Fertility - Density Study Grand Rapids, 1997

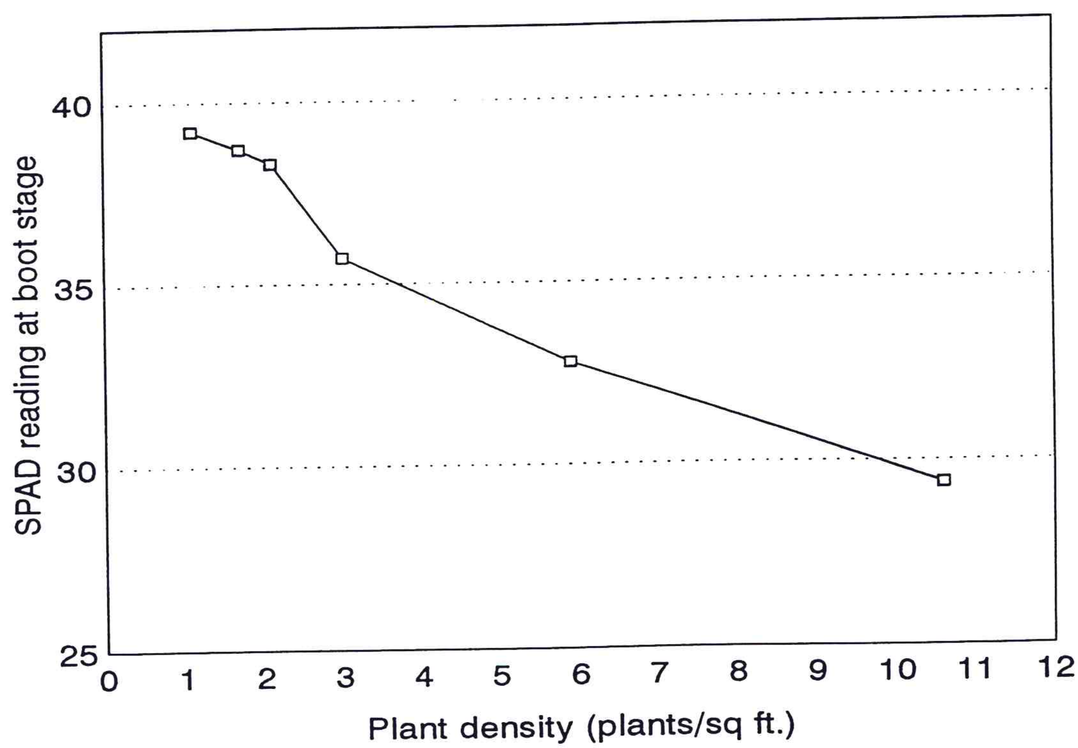

Figure 12 - SPAD readings at boot stage as a function of plant density
Fertility - Density Study Grand Rapids, 1997

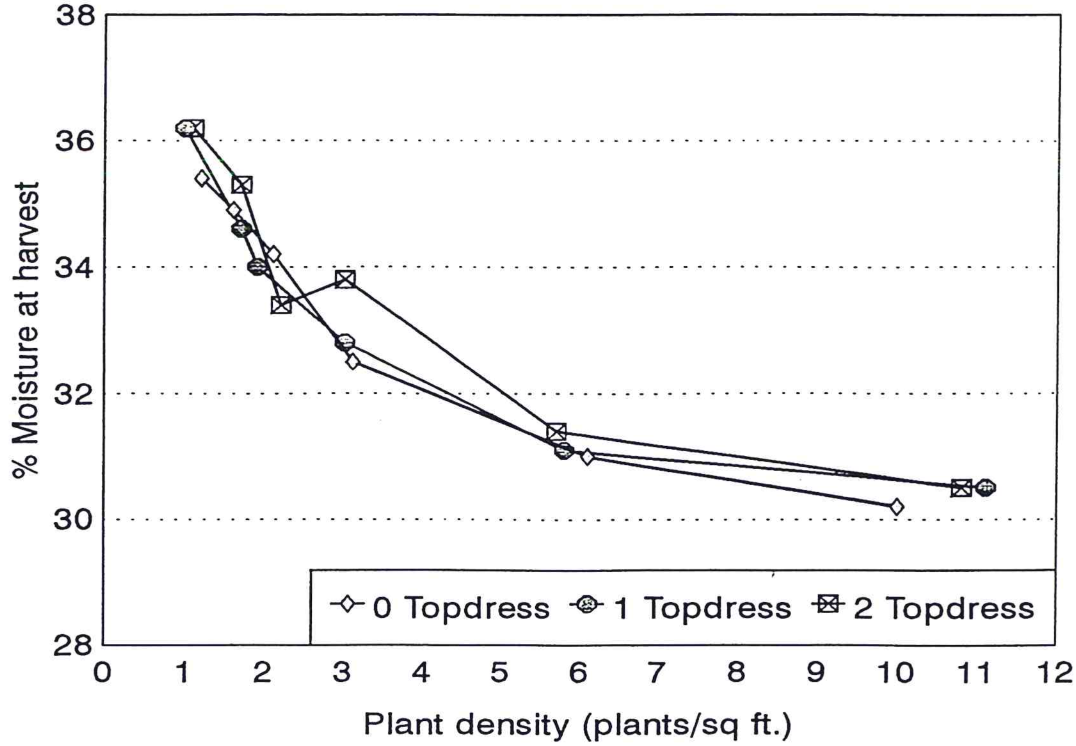

Figure 13 - Percent moisture as a function of plant density
Fertility - Density Study Grand Rapids, 1997

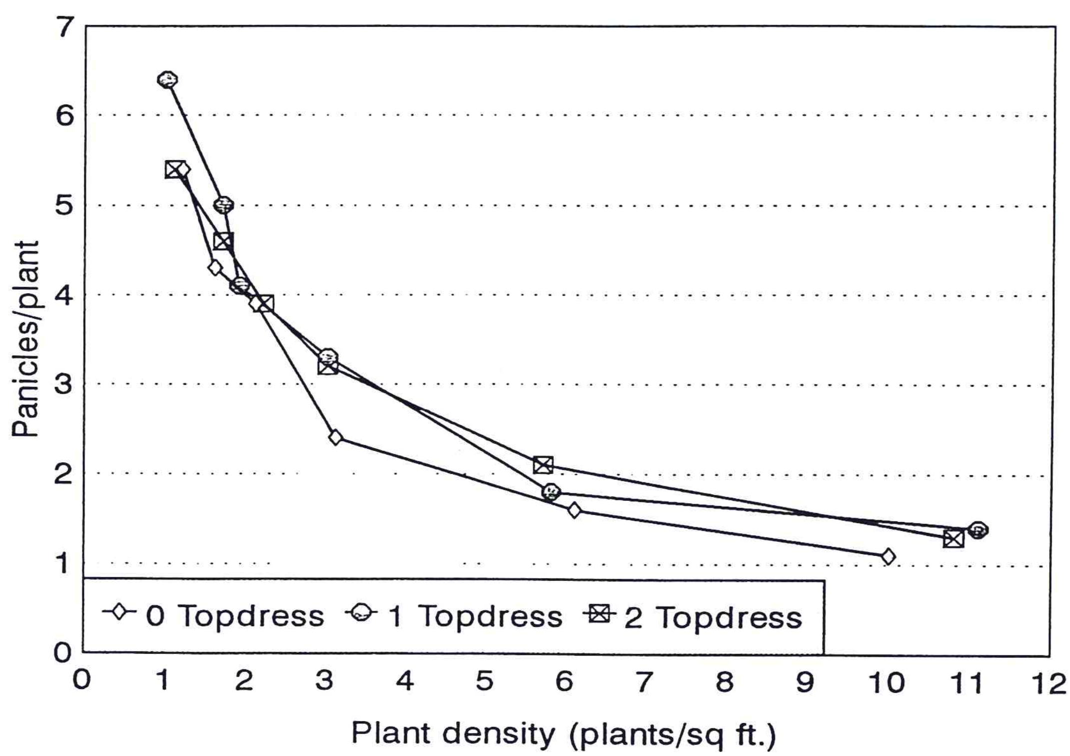

Figure 14 - Panicles per plant as a function of plant density-
Fertility - Density Study Grand Rapids, 1997

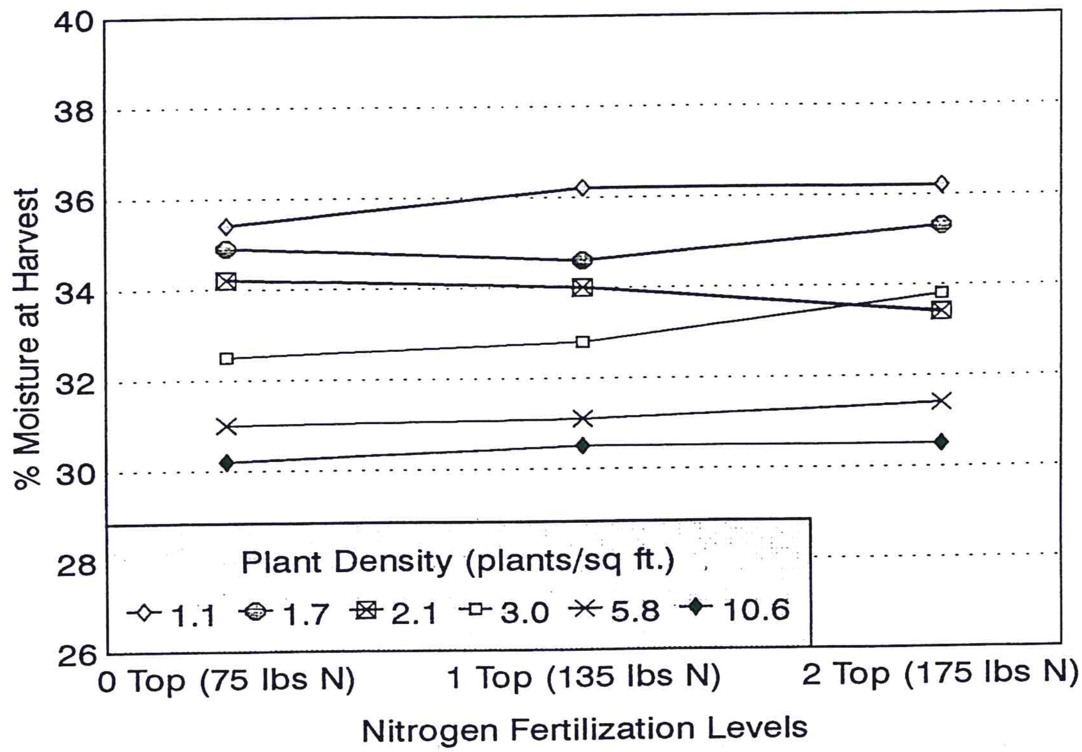

Figure 15 - Percent moisture as a function of nitrogen fertilization
Fertility - Density Study Grand Rapids, 1997

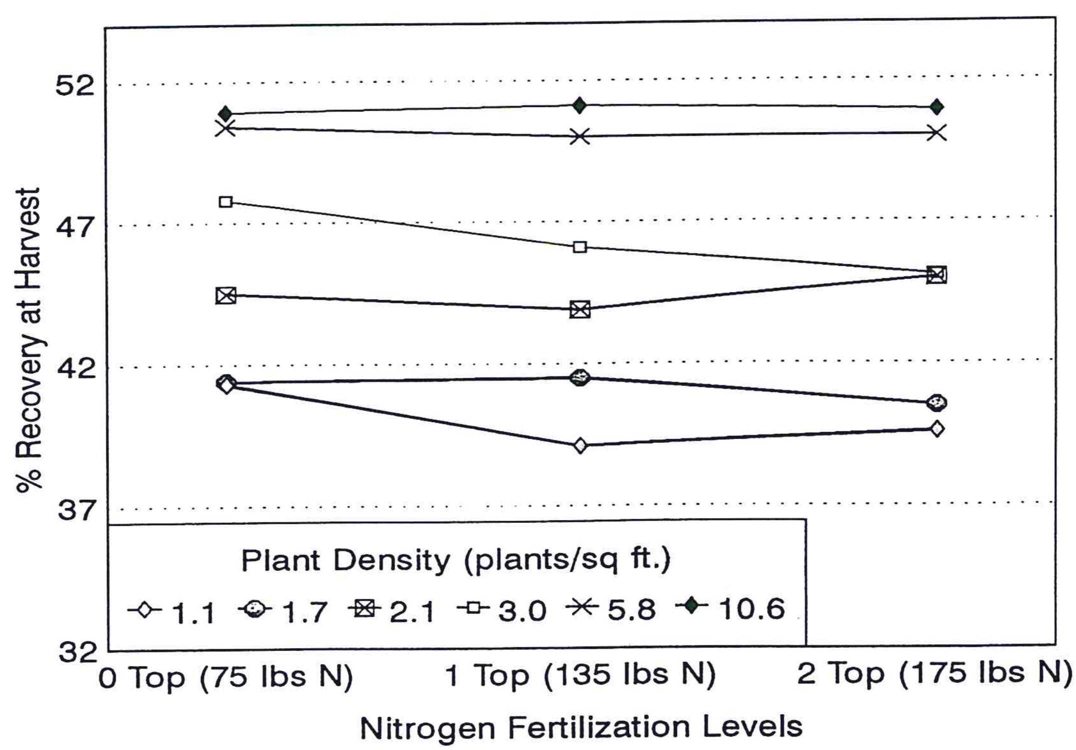

Figure 16 - Percent recovery as a function of nitrogen fertilization
Fertility - Density Study Grand Rapids, 1997

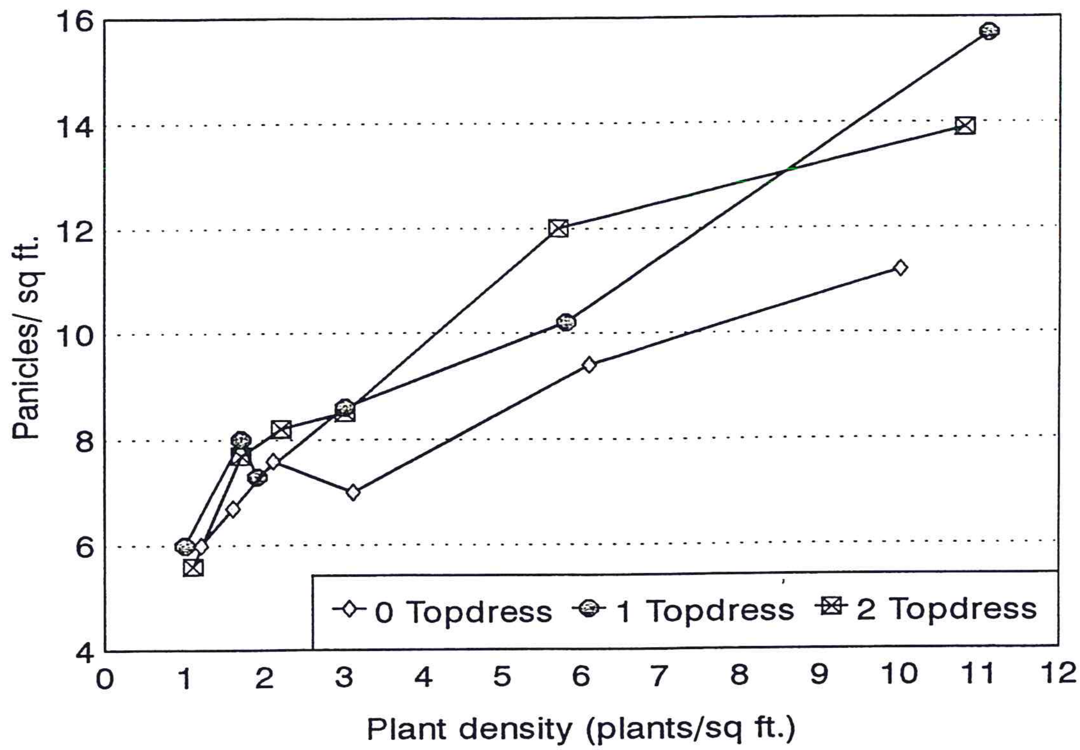

Figure 17 - Panicles/sq ft. as a function of plant density
Fertility - Density Study Grand Rapids, 1997

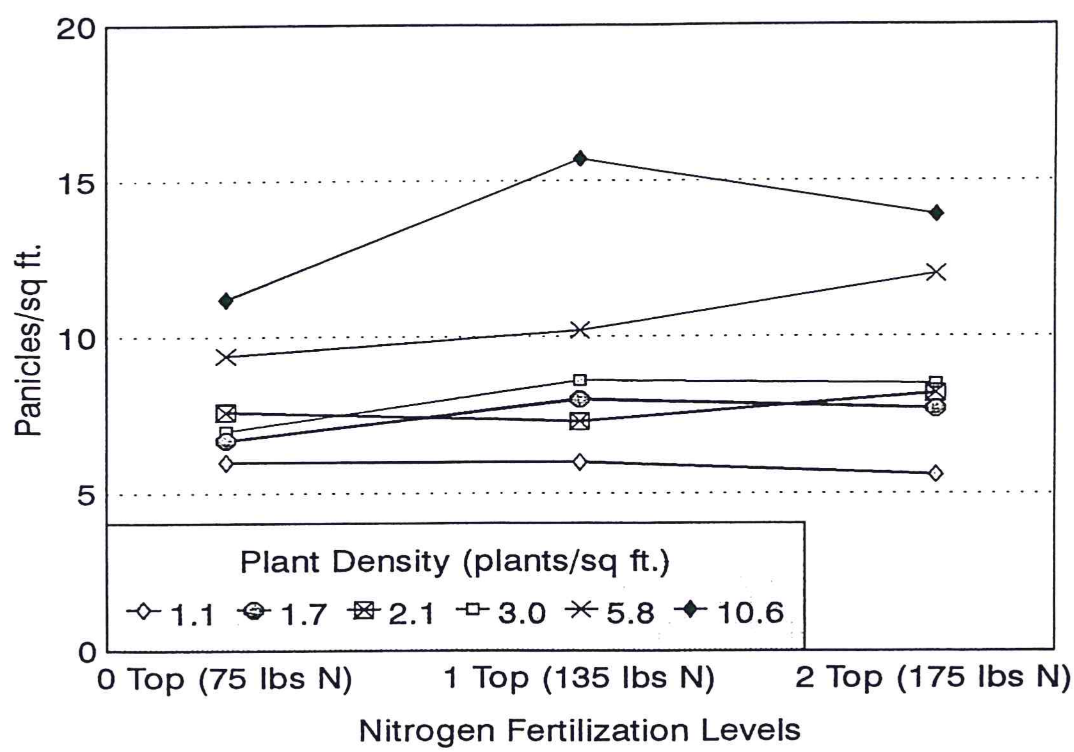

Figure 18 - Panicles/sq ft. as a function of nitrogen fertilization
Fertility - Density Study Grand Rapids, 1997

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