SEEDING RATE FOR DRYLAND COTTON IN THE TEXAS ROLLING PLAINS

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Abstract

A 2x4 factorial experiment using a split-plot design was conducted in 2001 at Munday, TX on Miles fine sandy loam soil. The objective was to determine the effect of seeding rate on dryland cotton (*Gossypium hirsutum* L.) production parameters. Two varieties, PM 2326 BG/RR and PM 2280 BG/RR, were the main plots and seeding rates of 1, 2, 4, and 6 seeds/ft of row were subplot treatments. Seeds were planted on the center of raised beds listed 40 inches apart. Treatments were replicated 6 times. Seed cost ranged from $ 7/ac for 1 seed/ft to $ 43/ac for 6 seeds/ft. Increasing seeding rate resulted in decreased plant height, total nodes per plant, bolls/plant, and percent first position boll retention. In contrast, node height of the first fruiting branch and percent barren plants increased with increasing seeding rate. Height to node ratio and bolls/ft were not affected by seeding rate. Cotton bur yield was higher with lower seeding rates than with higher seeding rates. Variety PM 2326 BG/RR was taller, had greater height to node ratio, and higher bur cotton yield as compared to PM 2280 BG/RR. Year 2001 data shows that using a reduced seeding rate may lower production costs.

Introduction

Cotton is grown annually on 1 million acres in the counties of the Texas Rolling Plains, almost 95% grown dryland. Shortage of moisture is often a production problem for producers in this region. However, new technologies and opportunities exist for producers. The boll weevil eradication program has the boll weevil on the run in many zones in the state of Texas. Genetically engineered varieties are available and are in general use by most irrigated producers. Varieties which can tolerate the herbicide Roundup Ultra and/or contain the Bt gene to control the tobacco budworm and the bollworm are available. However, due to recent low lint prices coupled with high seed costs, producers are often reluctant to use this new technology. In some cases they have tried the technology and have been burned because dry weather overrode the potential benefits of this new technology. One way to reduce this high seed cost is to reduce the seeding rate. Thick stands often result in numerous barren plants which contribute nothing to yield while utilizing soil moisture and nutrients. Reducing plant stand will also make any stored soil moisture last longer. The objective of this study was to determine the effects of seeding rates of 1, 2, 4, and 6 seeds per foot of row on production parameters and lint quality of two BG/RR stripper type cotton varieties grown under dryland conditions in the Texas Rolling Plains.

Materials and Methods

The study was conducted at the Texas Agricultural Experiment Station farm near Munday, TX (30^{0}19' N, 99^{0}34'W). The soil type was Miles fine sandy loam (fine-loamy, mixed thermic, Typic Paleustalfs). Two varieties each containing the Roundup Ready (RR) and *Bacillus thurningienesis* gene, known as Bollgard (BG) were grown. Paymaster 2280 BG/RR and 2326 BG/RR were planted in mid May 2001 at seeding rates of 1, 2, 4, and 6 seeds per foot of row on beds spaced 40 inches on centers. Based on seed company literature, these seeding rates were approximately equivalent to 2.8, 5.5, 11.1, and 16.6 pounds per acre. Plots were approximately 75 feet in length by 4 rows wide. Treatments were arranged in a split plot design with variety as the main plot and seeding rates as sub plots. There were six replications. Plots had trifluralin applied prior to planting and one application of glyphosate during the growing season for weed control. Plots were planted using a vacuum planter set for the desired seeding rates and fertilized approximately 4 weeks after planting with granular 40-20-0. The insect infestation was very low this year. Due to heavy rainfall, cotton stripping was delayed until late November. The two center rows of each plot were machine harvested. Plant parameters were measured before harvest. Following harvest, samples were weighed and a sub sample was taken for ginning. After ginning, lint samples will be sub-sampled for fiber quality analysis. Lint fiber quality will be determined by the International Textile Research Center in Lubbock, TX. Statistical analyses were performed on data collected to date using SAS computer program (SAS Institute, 1989). Data were analyzed using the Proc GLM. Means were separated using the Fisher's Protected LSD Test at 5% probability level and data are presented in Table 3. Similar analyses will be performed on lint quality parameters.

Results

The 30-yr average rainfall during June and July ranges from 2 to 3 inches, but the total rainfall received during June and July 2001 was less than 0.5 inches (Table 1). During these months the crop water requirement was about 17 inches and evapotranspiration 21 inches. Peak blooming occured during the second week of July when the average maximum temperature was more than 100 degrees F, accumulated growing degree days were 1900, rainfall was zero, evapotranspiration was approximately 11 inches. This resulted in severe stress during the bloom and boll set period.

Actual plant stand densities were close to the desired plant stand densities (Table 2). The actual plant spacing (within row) ranged from 13.3 inch for 1 seed/ft to 2.26 inches for 6 seeds/ft (Table 2). These plant spacings resulted in an area of 3.7 sq ft/plant for 1 seed/ft to 0.63 sq ft/plant to 6 seeds/ft. Equivalent plant populations ranged from 12 000 plants/ac for 1 seed/ft to 69 000 plants/ac for 6 seeds/ft. The seed cost was 7 $/ac for 1 seed/ft to 43 $/ac for 6 seeds/ft.

Plant height and total nodes/plant decreased with increasing seed rate (Table 3 and Table 4). PM 2326 BG/RR was significantly taller than PM 2280 BG/RR. However, total nodes per plant was not affected by variety. Height to node ratio ranged from 1.4 to 1.6 and was not affected by seeding rate, but PM 2326 BG/RR had a higher height to node ratio than PM 2280 BG/RR. It was observed that a higher seed rate resulted in plants with fewer branches and leaves than with lower seeding rate. Increasing seeding rate resulted in an increasing percentage of barren plants. The node at which the first fruit appeared was higher with an increasing seeding rate. With 1 seed/ft the first fruit appeared about 2 nodes lower than with 6 seeds/ft. First position boll retention capacity decreased significantly with increasing seed rate. The percent first position boll retention between nodes 6 to 10 dropped from 60 with 1 seed/ft to about 25 with 6 seeds/ft. Similarly, the percent first position boll retention between nodes 7 to 15 dropped from 50 with 1 seed/ft to 15 with 6 seeds/ft. Total bolls/plant decreased significantly with increasing seeding rate and ranged from 9 with 1 seed/ft to 2 with 6 seeds/ft. However, total bolls/ft were not affected by seeding rate. Since cotton samples have not been ginned only bur cotton yields are reported here. Bur cotton yield was also significantly higher with 1 and 2 seeds/ft than with 4 or 6 seeds/ft. Bur cotton yield was significantly higher with 4 seed/ft than with 6 seeds/ft. PM 2326 BG/RR yielded significantly more bur cotton than PM 2280 BG/RR. Even though the bolls/ft was not affected by seeding rate, bur cotton yield was higher with the lower seeding rate than with the higher seeding rate. This indicates that bolls grown using the lower seeding rate had a higher lint weight/boll than bolls from the higher seeding rate.

Discussion

Increasing plant population per unit area results in a reduced soil volume per plant. This causes water and nutrient stress (Daniel R. Krieg, Professor, Texas Tech University, Lubbock, TX, personal communication). Further increasing plant population creates shading to lower leaves. Water and heat stress have the most damaging effect on yield through loss of fruit and other means. If moisture stress occurs during the vegetative stage, then it results in the formation of smaller leaves, a reduced leaf area index (LAI), and interception of less light by the crop. Krieg (1997) reported that the growth rate of the crop was reduced by water stress through a reduction in size and number of leaves produced (primarily sympodial leaves) and in reductions of photosynthesis. He indicated that water supply from the first square stage until the first flower was the most critical for cotton in the Texas High Plains because fruiting sites produced during that time were capable of maturing under a short growing season. Grimes et al. (1970) suggested that the peak flowering period was the most sensitive to drought and water stress at this time led to the greatest decrease in yield. Similar to water stress, high temperatures have a devastating effect on dry weight allocation to bolls. Reddy et al. (1991) reported that when day/night temperature (F) increased from 68/50 F to 86/68 F cotton fruit dry wt increased from 1/4 ton to 1 ton/ac, but when the temperature was raised to 104/86 F fruit dry weight decreased to almost zero.

Summary and Conclusion

Recently, low lint prices coupled with the high seed cost of genetically altered varieties has made producers reluctant to use new technologies under dryland conditions. One way to reduce the high seed cost is to reduce the seeding rate. Thick stands often result in numerous barren plants which contribute nothing to yield while utilizing soil moisture and nutrients. Two genetically altered varieties, PM 2326 BG/RR and PM 2280 BG/RR, were grown dryland in 2001 on a Miles fine sandy loam in Knox county, TX, to determine the effect of seeding rate on production parameters. Seeding rates were 1, 2, 4, and 6 seeds/ft of 40 inch row. Treatments were replicated 6 times. Seed cost ranged from $ 7/ac for 1 seed/ft to $ 43/ac for 6 seeds/ft. Increasing seeding rate resulted in decreased plant height, total nodes per plant, bolls/plant, and percent first position boll retention. In contrast, node height of the first fruit and percent barren plants increased with increasing seed rate. Height to node ratio and bolls/ft were not affected by seeding rate. Bur cotton yield was higher with lower seeding rates than with higher seeding rates. PM 2326 BG/RR was taller, had a higher height to node ratio, and higher bur cotton yield as compared to PM 2280 BG/RR. Year 2001 data shows that reduced seeding rate may lower production costs.

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Table 1. 2001 seasonal weather data for Munday, TX.

Month	Rainfall 2001	Rainfall 30-yr avg	Evapotran-spiration[z]	Crop water Use[y]	Avg. monthly Temp Max	Avg. monthly Temp Min	Avg. monthly Temp Mean	Accumulated GDD
	----------------Inches	--------------------			------------F-----------			
May	3.98	3.80	7.6	0.9	85.8	61.5	73.7	302
June	0.43	2.98	10.01	5.5	92	67	79.5	976
July	0.00	2.34	10.87	11.6	102	75.4	88.6	1871
August	1.69	2.06	7.83	2.3	95.5	70.6	83.1	2591
September	2.68	2.88	5.7	0	83.8	59.2	71.5	2974
October	0.57	2.52	5.3	0	78.4	49.6	64	3107
November	5.71	1.38	2.8	0	66.8	46.7	56.7	-

[z]Source: North Plains ET Network, Weather Station, Munday, TX.
Website: http-amarillo2.tamu.edu-nppet-station.htm.
[y]Source: Crop Watch. 2000. Delta and Pine Land Company, Scott, MS. Vol. 4, No. 5.

Table 2. Desired and actual stand density, actual within row spacing, actual area/plant, actual plant population, and seed cost/ac in 2001 at Munday, TX.

Plant stand density Desired	Plant stand density Actual	Actual within row spacing Inches	Actual area Sq ft/plant	Actual Plant Population Plants/ac	Seed cost $/ac
--------Plants/ft--------					
1	0.9	13.33	3.7	11 761	7.11
2	2.0	6	1.67	26 136	14.2
4	3.7	3.24	0.9	48 351	28.39
6	5.3	2.26	0.63	69 260	42.59

Table 3: Analysis of variance of plant parameters.

Source of variation	df	Plant height	Total nodes/ plant	Height/ Node	Percent barren plants	Node at 1st fruit	% fruit retention node 6 to 10	% fruit retention node 7 to 15	Bolls/ plant	Bolls/ foot	% open boll	Bur yield lbs/ac
		-----Pr > F-----										
Rep	5	-	-	-	-	-	-	-	-	-	-	-
Variety (V)	1	0.003	0.611	0.032	0.630	0.128	0.531	0.168	0.306	0.331	0.964	0.015
Error (a)	5	-	-	-	-	-	-	-	-	-	-	-
Seed rate (SR)	3	0.001	0.001	0.161	0.001	0.001	0.001	0.001	0.001	0.610	0.075	0.001
V x SR	3	0.690	0.741	0.165	0.990	0.004	0.905	0.386	0.699	0.734	0.479	0.044
Error (b)	30	-	-	-	-	-	-	-	-	-	-	-
Total	47	-	-	-	-	-	-	-	-	-	-	-

Table 4. Plant parameters as affected by variety and seeding rates in 2001 at Munday, TX.

Variety/Seed rate desired	Plants / ft obtained	Plant ht (inches)	Total nodes/ plant	Ht/ Node	% barren plants	Node # at 1st fruit	% first boll retention node 6 to 10	% first boll retention node 7 to 15	Total bolls per plant	% open bolls	Bolls per foot	Bur cotton yield lbs/ac
PM 2280 BG/RR												
1 seed / ft	0.9	23.7	16.7	1.4	0.8	4.7	66	49	9.9	74	10	1110
2 seeds / ft	1.9	22.2	15.8	1.4	3.7	6.0	48	38	5.3	82	10	1071
4 seeds / ft	3.6	20.5	14.5	1.4	4.4	6.6	34	25	3.0	83	10	1048
6 seeds / ft	5.5	19.0	13.2	1.4	6.6	7.4	24	17	1.9	68	9	938
PM 2326 BG/RR												
1 seed / ft	0.9	24.0	17.0	1.4	0.0	5.2	58	50	8.6	61	8	1265
2 seeds / ft	2.1	23.2	15.8	1.5	3.0	5.6	46	31	5.1	78	10	1296
4 seeds / ft	3.9	21.2	14.0	1.5	3.9	6.6	33	18	2.7	90	10	1107
6 seeds / ft	5.2	20.5	13.0	1.6	6.5	6.0	23	13	1.8	76	8	995
PM 2280 BG/RR		21.3b	15.0a	1.4b	3.9a	6.2a	43a	32a	5.0a	77a	10a	1042b
PM 2326 BG/RR		22.2a	15.0a	1.5a	3.4a	5.8a	40a	28a	4.5a	76a	9a	1167a
1 seed / ft	0.9	23.8a	16.8a	1.4a	0.4c	4.9c	62a	49a	9.3a	67b	9a	1188a
2 seeds / ft	2.0	22.7b	15.8b	1.4a	3.3b	5.8b	47b	34b	5.2b	80ab	10a	1183a
4 seeds / ft	3.7	20.8c	14.3c	1.5a	4.2ab	6.6a	34c	22c	2.9c	86a	10a	1078b
6 seeds / ft	5.3	19.8d	13.1d	1.5a	6.5a	6.7a	24c	15d	1.8c	72ab	9a	967c