PLANT GROWTH ANALYSIS OF TRANSGENIC Bt COTTON

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Abstract

The objective of this research was to determine the variation in growth patterns among transgenic cotton varieties compared with conventional varieties. Nine cultivars, five from Deltapine and four from Paymaster lineage, were planted on 23 April. Growth was monitored at various times during the season via Crop Growth Rate, Relative Growth Rate and Net growth Rate.

In general, transgenic varieties showed a significant increase in biomass (crop growth rate) during 84-105 days after planting period. All the cultivars evaluated in this study had the same efficiency as a producer of new material (relative growth rate). The Paymaster genotypes had the highest values of net growth rate.

Introduction

Since the use of techniques to estimate Net Assimilation Rate and Relative Growth Rate, plant phisiologists have applied them and have found them useful tools in the quantitative analysis of plant growth (Radford, 1967). They possibly want to know that one particular environment or management practice is or is not more suitable for a particular plant than another (Hunt, 1978). Or they may wish to compare the performance of different species or varieties grown under the same conditions. Or they may just wish to explore and quantify the growth of a new experimental subject.

Palomo and Godoy in 1996 suggested that plant growth analysis can be used to characterize new cotton varieties compared with obsolete varieties. Wells and Meredith (1984) indicated that modern cultivars appears to produce larger lint yield by a grater partitioning of dry matter to reproductive organs and an increased amount of reproductive development occurring when maximal leaf mass and area are present.

Gerik and Rosenthal in 1990 concluded that total accumulated above-ground biomass of cotton varieties Acala SJ-2, Deltapine 50 and Tamcot CD3H, did not differ between years, but Tamcot CD3H produced significantly less total biomass on average than the other varieties. Same researchers indicated that harvest index of Deltapine 50 was significantly lower than Acala SJ-2 and Tamcot CD3H.

Carter *et al.*, in 1997 concluded that fruiting patterns of transgenic varieties were erratic and irregular with respect to conventional varieties. NuCOTN 33^B required also higher amounts of growth regulators to limit plant height.

The present study was initiated to determine the variation in growth patterns among transgenic cotton varieties compared with conventional varieties.

Materials and Methods

Nine cotton cultivars, five from Delta & Pine Land Company and four from Paymaster Seed Company were grown during 1997 at Matamoros, Coahuila, Mexico. The cultivars were planted in 10 row plots with rows 0.80 m wide and 20 m long on 23 April. The plants were thinned to seven plants/m at 30 days after planting. Before planting, 120 kg/ha N and 60 kg/ha P were applied and incorporated into the seedbed. During growing season irrigation were applied at 60, 80 and 100 days after planting.

The transgenic varieties were sprayed twice to control Siver whitefly, while conventional varieties were sprayed twice to control pink bollworm and twice to control Silver whitefly.

Variables Measured

The variables measured in this experiment were: Crop Growth Rate (CGR), Relative Growth Rate (RGR) and Net Assimilation Rate (NAR). Estimation of these indices of growth was done using the techniques described by Radford in 1967 and by Hunt in 1978.

1. The Crop Growth Rate measures the increase of plant material per unit of time

$$CGR = W_2\text{-}W_1/A(t_1\text{-}t_2),\ g/m^2/day$$

Where:

A = Area where dry weight was determined.
W_1 = Dry weight of sample 1.
W_2 = Dry weight of sample 2.
t_1 = Sampling date 1 expressed in days after planting (DAP).
t_2 = Sampling date 2 DAP.

2. The relative growth rate (RGR) of a plant at an instant of time (t) is defined as "the increase of plant material per unit of material present per unit of time".

$$RGR = \text{Loge } W_2 - \text{Log}_e\ W_1/t_2 - t_1,\ g/g/day$$

Where:

Log_e = natural logarithm.

3. The Net Assimilation Rate (NAR) of a plant at an instant of time (t) is defined as "the increase of plant material per unit of time".

Reprinted from the *Proceedings of the Beltwide Cotton Conference*
Volume 2:1485-1487 (1998)
National Cotton Council, Memphis TN

$$NAR = [(W_2 - W_1)/(LA_2 - LA_1)] [(Log_e\ LA_2 - Log_e\ LA_1)/(t_2 - t_1)],\ g/m_2/day.$$

Where:

LA = Leaf area over a period from t_1 to t_2.

The experimental design was a randomized complete block with four replications. Sampling throughout the season was considered a split of the whole plot. Each plot consisted of 8 rows with two completely bordered rows for destructive plant sampling during the season; growth was determined at 45, 65, 84 and 105 mean DAP. Plants from each section of row were separated into leaves, stems, and reproductive organs. The stem sample included petioles and branches. Twenty leaves representative of the ages and positions on a plant were removed for determination with a area meter. All samples were dried at 70° C and the dry weights were recorded.

Results and Discussion

Crop Growth Rate

The results of crop growth rate averaged over cultivars are presented in Table 1. The analysis of variance indicated significant differences among sampling periods. There were significant differences among varieties for sampling at 65-84 and 84-105 DAP.

In general, transgenic varieties showed a bigger increase in biomass than conventional varieties at 84-105 DAP period. NuCOTN 35[B] and its parental variety Deltapine 5690 showed similar values of CGR.

Relative Crop Growth

Crop growth values averaged over cultivars are presented in Table 2. The analysis of variance detected significant differences only among sampling periods. These results indicated that the plants of all the cultivars evaluated in the present experiment have the same efficiency as a producer of new material.

Net Assimilation Rate

The results of net assimilation rate study of the transgenic and conventional cultivars are presented in Table 3. The values of NAR at first and third periods were significantly higher than the values of NAR at second sampling period.

The data in Table 3 demonstrate, only for the period from square and flower initiation (45-65 DAP), clear differences in the photosynthetic capacities (NAR) of cotton genotypes in this study. It can observed that all the Paymaster varieties had the highest values of NAR, significantly superiors to the observed values in Deltapine varieties. The analysis of variance did not detected significant differences among genotypes in periods of 65-84 and 84-105 DAP.

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Table 1. Crop growth rate values of transgenic and conventional cotton varieties. 1997.

	Days after planting		
Varuety	45-65	65-84	84-105
DP 5415	2.73	6.04	12.41
NuCOTN 33B	2.33	3.92	12.06
NuCOTN 32B	2.44	2.06	11.00
DP 5690	2.18	3.93	11.79
NuCOTN 35B	2.79	3.64	13.87
H 1220	2.43	4.94	22.23
PM 1215 BG	1.65	2.81	11.54
H 1244	2.07	4.56	16.99
PM 1244 BG	2.47	3.68	13.94
LSD 0.05	0.82	2.15	5.85

Table 2. Relative growth rate values of transgenic and conventional cotton cultivars. 1997.

	Days after planting		
Variety	45-65	65-84	84-105
DP 5415	0.085	0.047	0.033
NuCOTN 33B	0.073	0.044	0.040
NuCOTN 32B	0.074	0.022	0.053
DP 5690	0.062	0.042	0.038
NuCOTN 35B	0.083	0.057	0.031
H 1220	0.077	0.057	0.049
PM 1215 BG	0.071	0.043	0.054
H 1244	0.066	0.049	0.049
PM 1244 BG	0.089	0.032	0.054
LSD 0.05	0.024	0.024	0.019

Table 3. Net assimilation rate values of transgenic and conventional cotton varieties. 1997.

	Days after planting		
Variety	45-65	65-84	84-105
DP 5415	6.22	7.99	14.22
NuCOTN 33B	14.70	7.42	15.35
NuCOTN 32B	14.09	3.14	17.46
DP 5690	10.48	7.19	15.08
NuCOTN 35B	7.08	12.05	14.53
H 1220	25.99	12.78	29.13
PM 1215 BG	19.01	5.39	16.68
H 1244	14.02	8.59	23.33
PM 1244 BG	29.01	5.49	20.55
LSD	5.91	6.42	9.69