MANAGEMENT SYSTEMS FOR TRANSGENIC COTTON IN ULTRA-NARROW ROWS

Michael A. Jones, Charles E. Snipes and Gordon R. Tupper
Clemson University, Mississippi State University, and Mississippi State University
Florence, SC, Stoneville, MS, and Stoneville, MS, respectively

Abstract

Over the last decade, the cost of producing a pound of cotton lint has significantly increased while yields per acre and the price per pound of lint has remained virtually unchanged. A production system that would maintain or increase yields and fiber quality while increasing earliness and reducing production costs is needed. Ultra-narrow row systems have received increased attention by industry, research personnel, and producers in recent years. Ultra-narrow row systems consist of planting cotton in narrow rows (15 inches or less) at extremely high populations (approximately 100,000 plants/A) and harvesting with a stripper harvester. Ultra-narrow row systems are attractive to producers because they have the potential to increase yields, reduce production costs and labor, and increase earliness. However, changing to ultra-narrow row systems will require the adjustment of many management components. The purpose of this research was to determine the feasibility of using transgenic cottons in ultra-narrow rows (15-in. rows or less) for cotton production, to evaluate the effectiveness of various row spacings, plant populations, varieties, and mepiquat chloride management strategies for transgenic cottons in ultra-narrow row systems, and to assess the effect of these various systems on cotton growth, maturity and lint quantity/quality. Three replicated field studies were conducted at the Delta Research and Extension Center in Stoneville, MS, in 1998 and 1999 and at the Pee Dee Research and Education Center in Florence, SC in 1999. In the first study, three row spacings (7.5-in., 15-in., and 40-in. rows) and six varieties (NuCotn 35, ST 474, ST BXN47, PM 1220RR, MD51ne Normal-leaf, and MD51ne Okra-leaf) were evaluated. A second study evaluated two row spacings (7.5-in. and 15-in. rows) and six plant populations (75 000 plants/A, 100 000 plants/A, 125 000 plants/A, 150 000 plants/A, 175 000 plants/A, and 200 000 plants/A). All plots were planted at the highest plant population, and lower population treatments were formed by hand removal of individual plants at the two to three true-leaf stage. A third study consisted of three row spacings (7.5-in., 15-in., and 30-in. rows) and five mepiquat chloride applications (untreated check, four applications of 4 oz/A, two applications of 8 oz/A, four applications of 8 oz/A, and four applications of 12 oz/A). Mepiquat chloride applications began at matchhead square and were applied every 10 to 14 days depending on growth conditions.

The following results were observed:

1) **Variety x Row Spacing Study**. First year results indicated significant differences in seedcotton, lint yield, and percent lint existed among row spacings and varieties. Seedcotton yields averaged 2383, 2023, and 2243 lbs/A for 7.5, 15.0, and 40 inch row spacings, respectively. NuCotn 35B, ST 474, and ST BXN47 produced significantly more seedcotton (2597, 2512, and 2376 lbs/A, respectively) than PM 1220RR (2056 lb/A), MD 51ne Normal-leaf (1972 lbs/A), and MD 51ne Okra-leaf (1786 lbs/A) in all three row spacings. However, a significant row spacing x variety interaction was found for lint yield and percent lint. Highest lint yields were attained for NuCotn 35B (913 lbs/A), ST BXN47 (893 lbs/A), and MD 51ne Okra-leaf (574 lbs/A) in 7.5 inch row spacings. Stoneville 474 produced more lint yield (1021 lbs/A) when grown in 40 inch rows, with a 190 lb/A increase over 7.5 inch rows and a 261 lb/A increase over 15 inch rows. Paymaster 1220RR and MD 51ne Normal-leaf varieties also produced more lint yield (845 and 673 lbs/A, respectively) when grown in 40 inch rows, while yields were extremely low (549 lbs/A) for Paymaster 1220RR when grown in 15 inch rows. Percent lint was significantly reduced by narrow row spacings, with 15 inch rows averaging only 31% lint and 7.5 inch rows averaging only 32% lint. Lint percentage for 40 inch rows averaged 36%.
2) **Plant Population x Row Spacing Study**. No significant differences in seedcotton, lint yield or percent lint were found between row spacings or among plant populations in this study. Lint yield averaged 948 and 960 lbs/A for the 7.5 and 15 inch row spacings, respectively. Lint yields ranged from a low of 921 lbs/A for the 75,000 plants/A treatment to a high of 994 lbs/A for the 175,000 plants/A treatment. Percent lint was extremely low for all treatments, averaging only 29.3%.
3) **Mepiquat Chloride x Row Spacing Study**. Cotton grown in 7.5 inch rows (3414 lbs/A) and 15 inch rows (3149 lbs/A) produced more seedcotton than cotton grown in 30 inch rows (2840 lbs/A). However, percent lint was significantly lower (31.1 and 29.7% lint, respectively) for 7.5 and 15 inch rows compared to 30 inch rows (37.1% lint). These differences in percent lint among row spacings negated the

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potential yield advantage for the ultra-narrow row spacings, resulting in similar lint yields for the 7.5 inch rows (1063 lbs/A) and the 30 inch rows (1055 lbs/A). Lint yield in 15 inch rows averaged only 938 lbs/A. No yield advantage was found in applying mepiquat chloride to plants grown in any row spacing in this study.

Introduction

Over the last decade, the cost of producing a pound of cotton lint has significantly increased while yields per acre and the price received per pound of cotton lint has remained virtually unchanged. If this trend continues, many Mid-South cotton producers will be forced to reduce the total number of cotton acres on their farms and begin producing other crops with lower production inputs and higher economic returns. Since a large percentage of the cotton production costs is associated with pest control, a production system that would maintain or increase yields and fiber quality while increasing earliness and reducing production costs is desperately needed by Mississippi cotton producers.

One production system that has received increased attention by industry, research personnel, and producers in recent years is ultra-narrow row cotton production. Ultra-narrow row systems consist of planting cotton in narrow rows (15 inches or less) at extremely high populations (approximately 100,000 plants/A) and harvesting with a stripper harvester. Ultra-narrow row systems have the potential to increase earliness and reduce production costs due to the decreased plant size and shortened fruiting period that is associated with this system. Plants grown in ultra-narrow row systems reach full canopy closure earlier in the growing season and develop more of their bolls at first position sympodial fruiting sites located at lower nodal positions on the main stem compared to plants grown in conventional systems. Therefore, less time is required to set and mature a cotton crop with the ultra-narrow row system, while yields should exceed or equal that of the conventional system. It is this earliness benefit and resulting reduction in input costs that is one of the main motivations for producer interest in ultra-narrow row systems in the Mississippi Delta.

Cotton performance in ultra-narrow row systems was evaluated in the 1960's (Hughes and Tupper, 1965; Kirk et al., 1969; Parish et al., 1973; Tupper, 1966; Tupper and Hughes, 1964), and these studies showed ultra-narrow row systems to be an acceptable alternative to conventional, wide-row cotton production. However, ultra-narrow row systems failed to work consistently on commercial operations because of inconsistent yields, low cotton grades, weed control problems, and difficulty in controlling stalk growth. Since the late 1960's, new developments in production technology such as earlier-maturing cotton varieties with shorter stature, new plant growth regulators, improved over-the-top herbicide systems, the development of genetically engineered cotton varieties, and improvements in equipment technology have opened new possibilities for ultra-narrow row cotton systems. These new developments in production technology coupled with the continual economic pressure to lower production costs per pound of lint warrants re-evaluation of ultra-narrow row production systems in the Mississippi Delta.

Since cotton production is a highly complex system, changing to ultra-narrow row systems will require the fine-tuning or adjustment of many management components. Management components that need evaluating include: plant populations, weed control systems, varieties, and plant growth regulators as well as the development of new harvesting equipment for better harvest efficiency. Since the ideal plant density is one that provides maximum utilization of the environmental resources with a minimum of plant-to-plant competition for those resources, choosing the ideal plant population has a great potential to increase cotton yields. Equidistant plant spacing has always been more productive than plants in rows because it allows greater light interception per plant and more of the total leaf area to be effective leaf area. Kreig (1996) observed greater light interception per unit ground area at equivalent leaf area indices from ultra-narrow row to narrow row to traditional 40-inch row spacing. This resulted in faster growth rates as measured by both crop growth rate (g dry matter m^{-2} ground area day^{-1}) and net assimilation rate (g dry matter m^{-2} leaf area day^{-1}). Due to this faster growth rate with ultra-narrow row plants, more fruiting sites were produced especially during the early part of the fruiting period and greater fruit retention resulted in higher yields.

Recent developments in herbicide technology and biotechnology for cotton have led to a dramatic increase in options for cotton producers. These developments include the use of Staple, Buctril/BXN cotton, and Roundup Ready cotton. Each can contribute to successful weed control programs in a system that removes the possibility of cultivation and/or band application of herbicides. These products have strong attributes that can be helpful in ultra-narrow row production depending on the weed spectrum present and desired level of weed control. A well-planned weed control program can reduce weed control costs significantly in an ultra-narrow row system, but will depend on canopy closure and the weed-free maintenance period for the ultra narrow row system relative to conventional systems.

Planting short-statured, early-maturing varieties and using plant growth regulators appear to be important components of ultra-narrow row systems in order to control plant size and reduce trash and grade discounts. Mepiquat chloride is a plant growth regulator that can help cotton growers manage the development and maturity of their crop when used effectively. Plants treated with mepiquat chloride are normally more compact (Walter et al., 1980), have fewer nodes (Reddy et al., 1992), have shortened internodes (Heilman, 1981), and produce fewer reproductive branches. Moreover, mepiquat chloride has also been reported to decrease plant height (Heilman, 1981; Walter et al., 1980), increase earliness (Briggs, 1981), decrease boll rot (Snow et al., 1981), and facilitate insect management.

Therefore, these studies were conducted to determine the feasibility of using transgenic cottons in ultra-narrow rows (15-in. rows or less) for cotton production in the Mississippi Delta; to evaluate the effectiveness of various row spacings, plant populations, varieties, weed control programs, and mepiquat chloride management strategies for transgenic cottons in ultra-narrow row systems; and to assess the effect of these various systems on cotton growth, maturity, and lint quantity/quality.

Methods

Several replicated field studies were conducted at the Delta Research and Extension Center in Stoneville, MS, (Bosket fine sandy loam soil) in 1998 and 1999, and at the Pee Dee Research and Education Center in Florence, SC in 1999. In the first study, three row spacings (7.5-in., 15-in., and 40-in. rows) and six varieties (MD 51ne Normal-leaf, MD 51ne Okra-leaf, ST 474, ST BXN 47, PM H1220RR, and NuCotn 35) were evaluated. Treatments were arranged as split plots in a randomized complete block design with main plots consisting of row spacings and subplots consisting of varieties. Four replications were used, and plots were 50 feet long. Subplot size was 13 feet with the number of rows in each plot varying depending on row spacing treatments. Plant populations were approximately 100,000 plants/A in 7.5 and 15 in. rows. All other cultural practices were performed in an attempt to optimize yields for that particular system.

A second study consisted of two row spacings (7.5-in. and 15-in. rows) and six plant populations (75 000 plants/A, 100 000 plants/A, 125 000 plants/A, 150 000 plants/A, 175 000 plants/A, and 200 000 plants/A). Treatments were arranged as split plots in a randomized complete block design with four replications. Main plots consisted of row spacings, and subplots consisted of plant populations. All plots were planted at the highest plant population, and lower population treatments were formed by hand removal of individual plants at the two to three true-leaf stage. Subplots were 13 feet wide by 50 feet long. All other cultural practices were performed in an attempt to optimize yields for that particular system.

A third study consisted of three row spacings (7.5-in., 15-in., and 30-in. rows) and five mepiquat chloride applications (untreated check, four applications of 4 oz/A, two applications of 8 oz/A, four applications of 8 oz/A, and four applications of 12 oz/A). Treatments were arranged as split plots in a randomized complete block design with four replications. Main plots consisted of row spacings, and subplots consisted of mepiquat chloride applications. Subplots were 50 feet long and 13 feet wide, and treatments were replicated four times. Mepiquat chloride applications began at matchhead square and were applied every 10 to 14 days depending on growth conditions. Plant populations were approximately 100,000 plants/A. All other cultural practices were performed in an attempt to optimize yields for that particular system.

Weekly white bloom counts from one middle row were measured. Cotton will be mapped at season's end to assess changes in fruiting patterns and earliness. At season's end, cotton from 1-m of one middle row was plant mapped determine total boll numbers and the pattern of fruit maturation. Seedcotton was machine-harvested (stripper for ultra-narrow rows and spindle-picker for wider rows) to assess total yield, changes in picker efficiency, gin turnout and trash content. A 50-boll subsample was used to assess changes in yield components (% lint, seed index) and lint quality will be determined.

Results

1) **Variety x Row Spacing Study**. First year results indicated significant differences in seedcotton, lint yield, and percent lint existed among row spacings and varieties. Seedcotton yields averaged 2383, 2023, and 2243 lbs/A for 7.5, 15.0, and 40 inch row spacings, respectively. NuCotn 35B, ST 474, and ST BXN47 produced significantly more seedcotton (2597, 2512, and 2376 lbs/A, respectively) than PM 1220RR (2056 lb/A), MD 51ne Normal-leaf (1972 lbs/A), and MD 51ne Okra-leaf (1786 lbs/A) in all three row spacings. However, a significant row spacing x variety interaction was found for lint yield and percent lint. Highest lint yields were attained for NuCotn 35B (913 lbs/A), ST BXN47 (893 lbs/A), and MD 51ne Okra-leaf (574 lbs/A) in 7.5 inch row spacings. Stoneville 474 produced more lint yield (1021 lbs/A) when grown in 40 inch rows, with a 190 lb/A increase over 7.5 inch rows and a 261 lb/A increase over 15 inch rows. Paymaster 1220RR and MD 51ne Normal-leaf varieties also produced more lint yield (845 and 673 lbs/A, respectively) when grown in 40 inch rows, while yields were extremely low (549 lbs/A) for Paymaster 1220RR when grown in 15 inch rows. Percent lint was significantly reduced by narrow row spacings, with 15 inch rows averaging only 31% lint and 7.5 inch rows averaging only 32% lint. Lint percentage for 40 inch rows averaged 36%.
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