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EFFECT OF ROW SPACING ON THE YIELD OF COTTON CULTIVARS

M.B. JAHEDI [1], F. VAZIN[2]*, M.R. RAMEZANI [3]

*E-mail: farshidvazin@gmail.com

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ABSTRACT. Modern cotton (*Gossypium hirsutum* L.) cultivars with herbicide resistance have rejuvenated an interest in narrow row cotton production, primarily because of the reduction of weed control problems encountered in the past with narrow row systems. While the primary goal of narrow row cotton is to reduce production costs, an agronomic and physiological evaluation of this cropping system is also needed. The objectives of this study were to determine the feasibility of using modern cotton cultivars in narrow rows (30 cm) for cotton production in the Gonabad and to assess the effect of these various systems on cotton growth, lint yield, and fiber quality. Plant height, sympodia and total bolls per plant were reduced in cotton grown in narrow row spacing. In most cases, cotton grown in narrow rows had lint yields equal to or higher than those attained in the 70 cm spacing. modern cultivars in narrow row cotton production did not improve lint yield. No conclusions could be made regarding the impact of plant stature on lint yield. Row spacing had little impact on fiber quality narrow row cotton appeared to be a viable agronomic cotton production practice for the Gonabad compared with conventionally - grown cotton based upon lint yield and fiber quality.

Key words: Cotton; Lint yield; Cultivars; Narrow row spacing.

INTRODUCTION

Cultivar selection, a key management component in any cropping system, is even more critical in ultra-narrow row cotton production. While high yield potential is a predominant consideration, maturity, plant size, the transgenes present, and fiber properties are also major factors to consider. Limited data are available regarding performance of cultivars grown in ultra-narrow rows.

In a study of eight transgenic cultivars, yields for cotton planted in ultra-narrow rows were higher than

[1] Agriculture Jahad Organization, Gonabad, Iran
[2] Islamic Azad University,Gonabad Branch, Gonabad, Iran
[3] Agricultural Research Centers, Mashhad, Iran

conventional row spacings (Witten and Cothren, 2000). In a 2-yr study in South Carolina, seed cotton yield, lint yield, and gin turnout were different among row spacings and cultivars (Jones, 2001). A significant row spacing by cultivar interaction was reported for seed cotton yield. In 1999, SureGrow 125 BR and Stoneville BXN47 grown in 19 cm rows had higher seed cotton yields compared with 38 and 97 cm rows. In 2000, Stoneville 474 and Fibermax 832 grown in 19 cm rows had higher seed cotton yields than with 38 and 97 cm rows. Conversely, Deltapine NuCotn 35B produced more seed cotton when grown in 97 cm rows compared with 19 and 38 cm rows in 2000. Gin turnout was approximately 37% and 41% for cotton planted in ultra-narrow rows and 97 cm rows, respectively.

Ultra-narrow rows was initially defined in terms of row spacing <25 cm (Atwell, 1996), but some contemporary ultra-narrow rows row spacings include 19, 25, and 38 cm (Parvin *et al.,* 2000). A common practice in ultra-narrow rows is the use of a finger-type stripper harvester instead of a spindle picker. The investment cost in a finger stripper is about one-half that of a spindle picker, and it has considerably lower operating (labor, fuel, maintenance, etc.) expenses (Larson *et al.,* 1997). Even though harvest costs might be lower, fingers tripping cotton may result in more leaf and bark content in the lint than spindle picking because more of these plant parts are harvested by the finger stripper, and they are not completely removed during lint cleaning (Valco *et al.,* 2001).

Common characteristic of ultra-narrow rows is the use of high plant population densities (plant population density) relative to wide-row cotton (Perkins, 1998; Jones, 2001; Delaney *et al.,* 2002). At one time, ultra-narrow rows was referred to as "narrow-row, high population cotton" (Hawkins and Peacock, 1973). Plant population densities in contemporary ultra-narrow rows often exceed 24.7 plants m^{-2} (Perkins, 1998; Jones, 2001). A major reason for relatively high plant population density revolves around limitations of available planting and harvesting equipment for ultra-narrow rows. Delaney *et al.* (2002) pointed out that ultra-narrow rows is grown at relatively high plant population density to decrease branching and facilitate machine harvesting with a finger stripper, and indicated that recommended plant population density range from 19.8 to 49.4 plants m^{-2}. The University of Georgia Cotton Production Guide (2002) recommends at least 24.7 plants m^{-2} in ultra-narrow rows. It suggests that spatial uniformity of the population is critical, because skips in the cotton stand may result in vegetative branching, which creates serious problems with harvest. Although large vegetative branches are known to interfere with finger-stripping, there are few published references on the relationship between plant population density and vegetative branch size. This information would be useful in defining a lower limit on the plant population density needed for efficient finger stripper harvest or a so called “agronomic minimum” plant population density in ultra-narrow rows.

The objectives of this study were to determine the feasibility of using modern transgenic cotton cultivars in ultra-narrow rows (<38 cm) for cotton production in the Gonabad and to assess the effect of these various systems on cotton growth, lint yield, and fiber quality.

MATERIAL AND METHODS

Field experiments were conducted in 2010 through 2011 at the Gonabad Agricultural Research Station, located in Gonabad (latitude: 34°21’ N; longitude: 58°41’ E; rainfall average: 142 mm). The soil in the experimental plot is sandy loam with pH 7.8, containing total N (703 ppm), total P (2 ppm), and total K (0.23 ppm), with an EC of 1.4 ds m^{-1}. The experiment was carried out in a split plot design based on randomized complete block with three replications. Experiment treatments including row spacing were carried out at three levels of 30, 50 and 70 cm at main plot. Subplots were considered with three cultivars Varamin, Khordad and Sepid. Recomended dose of fertilizer was applied at the rate of 50 kg ha^{-1} nitrogen, 100 kg ha^{-1} K_2O and 150 kg ha^{-1} superphosphate triple.

Cotton was planted in a flat-row profile into adequate soil moisture. Planting dates was May 6, 2012. Plant populations were approximately 167 000 plants ha^{-1} in the 30 cm, 100 000 plants ha^{-1} in the 50 cm and approximately 71500 plants ha^{-1} in the 70 cm row spacing. Cultural inputs were performed to optimize yields for each row spacing and were consistent with local agronomic practices. Plant height was determined from 10 plants $plot^{-1}$.

Yield variables evaluated included seed cotton yield, gin turnout, and lint yield. A laboratory gin was used to separate seed cotton samples into lint and seed. In 2012, gin turnout, which takes into account trash and seed in harvested cotton, was calculated by dividing the weight of lint by the weight of a given sample and was expressed as a percentage. Fiber samples were subjected to high volume instrument (HVI) testing at Starlab (Starlab, Inc., Knoxville, TN). Fiber quality characteristics reported include micronaire, length, length uniformity, and strength.

All data were subjected to an analysis of variance (SAS Institute, Inc. Cary, NC). Means were separated using Fisher’s Protected Least Significant Difference (LSD) test. All statistical determinations were made at $P \leq 0.05$. LSD values presented in the tables are for main effect means, unless otherwise noted.

RESULTS AND DISCUSSION

Plant height and sympodia

Cotton height prior to harvest was approximately 13 and 17 cm less in the 30 and 50 cm row spacings, respectively, than the 70 cm row spacing (*Table 1*). These results are similar to those reported by Fowler and Ray (1977), who observed a decrease in plant height on cotton grown on 12.7 cm rows compared with 50.8 cm rows.

Table 1 - Main effects of row spacing on quality and quantity characteristics of cotton cultivars

Treat	LY ($g\ m^{-2}$)	NB	BW (g)	FL (mm)	FS (g/tex)	FF ($\mu g/inch^2$)	PH (cm)	SPAD	SY
Row spacing									
D_{30}	1130.79a	17.10c	4.65b	30.10b	31.40b	4.32	67.40c	48.60	9.50
D_{50}	686.94b	20.00b	5.02b	31.00ab	31.50ab	4.33	71.10b	48.10	9.60
D_{70}	358.69c	24.50a	5.79a	31.30a	32.50a	4.38	84.20a	47.40	10.90
Cultivar									
Varamin	648.20	20.20ab	4.97b	30.90	31.70	4.35	71.00c	45.90b	9.90
Khordad	818.13	22.00a	4.74c	30.50	31.50	4.34	72.40b	45.50b	10.10
Sepid	710.18	19.50b	5.75a	31.00	32.10	4.33	75.40a	52.70a	10.00
Significant[1]									
R. spacing	**	**	**	**	**	ns	**	ns	ns
Cultivar	ns	*	**	ns	ns	ns	**	**	ns
R×C	ns	ns	ns	ns	ns	ns	ns	ns	ns

[1]Significant effects are denoted as: ns, *, **, non significant or significant at $P \leq 0.05$, 0.01, respectively; LY: Lint yield, NB: Number of boll in plant, BW: Boll weight, FL: Fiber length, FS: Fiber strength, FF: Fiber fineness, PH: Plant height, SPAD: Chlorophyll index, SY: Number of sympodia.

Narrow row spacing (30 and 50 cm) had no effect on crop height prior to harvest (*Table 1*) these findings in agreement with other studies that reported no effect of ultra-narrow row spacing on plant height (Atwell, 1996; Gerik *et al.,* 1998; Gwathmey, 1996). Cultivars also no affected height, but Sepid was taller than Khordad and Varamin (*Table 1*). Neither row spacing nor cultivar had a significant effect on sympodia (*Table 1*). Because of the good weather in the fall and spring, failure to deal with the cold winter and Cloudy days (Reduced light), all planting densities even 30 cm row spacing with greater competition was favorable vegetative and reproductive growth.

Yield components

The numbers of bolls per plant and percentage boll retention among treatments were different at the end of season. All cultivars grown in 70 cm rows produced more bolls per plant (data not shown), which is attributed primarily to plant densities of the various row spacing. The number of bolls per plant was significantly different among cultivars (*Table 1*). Khordad had more the number of bolls per plant (10%) compared with the other cultivars.

Cotton planted in wide rows had a higher percentage (23%) of bolls weight than cotton grown in narrow rows (*Table 1*). Sepid had more the bolls weight (18.5%) compared with the other cultivars.

Yield data

Row spacing had no effect on seed cotton yields. Comparison of seed cotton yields between narrow and wide row spicing should take into account differences in method of harvest. The initial foreign matter of seed cotton is typically higher for ultra-narrow row cotton in comparison to cotton in wide rows, averaging 20 and 8%, respectively, for stripper and spindle harvested cotton (Valco *et al.,* 2001). Lint yield were higher in the narrow row spacing compared with the 70 cm row spacing (*Table 1*). Cultivars had no significantly effect on lint yield, but there was a significant different in harvest first and second of lint cotton between cultivars (*Table 1*). Highest lint yields were observed for Khordad, Sepid and Varamin, respectively (*Table 1*).

Lint quality

Row spacing significantly effect on fiber length (*Table 1*). Other studies (Baker, 1976; Howard *et al.,* 2001; Vories *et al.,* 1999) have reported diferent results; however, Jost (2000) found ultra-narrow rows reduced length compared with conventional row spacing in 2 of 3 yr. Fiber lengths ranged from 30.0 to 31.3 cm. Row spacing had no effect on fiber fineness (*Table 1*). Fiber fineness was higher in 70 cm rows compared with 30 and 50 cm rows. These findings are similar to those reported by Jost (2000) and Valco *et* *al.* (2001) who found no differences in fineness due to row spacing. Row spacing had a significant effect on fiber strength (*Table 1*). Cotton planted in wide rows had a higher percentage (3%) of fiber strength than cotton grown in narrow rows (*Table 1*). Heitholt *et al.* (1993) reported no differences in fiber strength due to row spacing. Fiber strength is largely determined by genotype such that cultivars with the highest strength tend to produce longer cellulose molecules providing fewer break points in the lint and greater cross linkages between fibers (Jordan, 2001).

Chlorophyll index

The effect of row spacing on chlorophyll index wasn't significant, the highest chlorophyll index was obtained in 30 cm treatment (48.6%) and the lowest chlorophyll index was obtained in 70 cm (47.4%). The effect of cultivar on chlorophyll index was significant. The highest amount of chlorophyll index was obtained in Sepid with 52.7% (*Table 1*). Chlorophyll maintenance and consequently photosynthesis durability in stressful conditions are among physiological indicators of stress resistance (Zhang *et al.,* 2006).

CONCLUSIONS

Cultivars, and to a lesser extent, row spacing were associated with differences in plant growth characteristics. Based on plant mapping data, earliness was not enhanced by ultra-narrow row cotton. Cotton grown in narrow rows had fewer bolls per plant and boll weight compared with cotton grown in 70 cm rows, but lint yield comparisons were similar due to the higher plant populations of the narrow row systems. Row spacing had no effect on seed cotton yield. No advantage was observed for the short stature cultivars grown in narrow rows. Cultivar performance in narrow row systems appears to fluctuate with environmental conditions of a growing season with the advantage for narrow row systems during drier seasons for the cultivars evaluated. Cultivar selection for narrow row cotton should be based on recent cultivar trials similar to selection for conventionally grown cotton. HVI analysis data suggests row spacing had little effect on fiber quality. narrow row cotton appears to be a viable agronomic cotton production practice for the Gonabad based upon lint yield and fiber quality. Economic comparison between these two crop cultures might be warranted if accurate estimates of seed, weed control, and other production costs can be attained.

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