1772 Varietal Response to Ultra Narrow Row Cotton in Spain

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Rationale A new cotton subsidy regime implemented in the European Union in 1996 provides incentives for growers to consider how to grow cotton in a more sustainable way. Ultra narrow row could be the way to increase the profitability through a cost reduction, but increasing yield at the same time.

Objectives The objective of this study was to compare the performance of different varieties growing under conventional row spacing and ultra narrow row.

Methods The trial in this experiment was conducted on a farm in South Spain testing the conventional row spacing for spindle pickers (1 meter) compared to 50 cm for ultra narrow row. The test also included a wide range of commercial varieties and experimental lines.

Results Significant differences were found in seed cotton yield, earliness and plant growth parameters such as plant height, total nodes, vegetative nodes, etc.

Key words: Earliness, Seed cotton yield, Ultra narrow row cotton

Introduction

Interest in production of Ultra Narrow Row Cotton in Europe is increasing. The new subsidy regime for the crop applied since 2006 season has made growers to think about cost reduction and yield increase. Farming practices in Greece and Spain, the two cotton production countries within European Union, generally include high planting rates (above 20 Kg of acid delinted certified seed per hectare), which usually results in high plant density, with more than 17 plants per meter for the common row space of 0.95 – 1.0 m. Farmers try to plant early in order to achieve the earliness needed in a short growing season. However, springtime often has unstable weather (rainy and cold) which can complicate plant stand establishment a critical period of the growing season. In order to avoid skippy stands and seedling diseases losses, high planting rates are very common.

Despite the different studies showing that an excessively high plant density can depress yield (Bridge et al., 1973; York, 1983), farmers both in Greece and Spain are satisfied with their plant population, and average seed cotton yields in the two countries are among the highest ones in the world. Very dense plant populations can also create competitive pressure, strong enough to force plants to grow more compact. These compact plants would have a lower number of fruiting branches and subsequent shorter flowering periods, resulting in the desired earliness (Galanopoulou et al., 1980). Therefore, there are strong based arguments to support the idea that Ultra narrow Row Cotton could be sustainable in Europe. Theoretical advantages of UNR cotton include: earlier crop cover, earlier season radiation interception, increased shading of germinating weeds, better sunlight interception under adverse conditions like poor soils, smaller compact plants with less second position bolls and increased earliness (Kerby et al. 1990). Both countries, Greece and Spain, have sunny and dry weather and with earlier canopy closure with UNR, it may be possible to increase the early season photosynthetic capacity. Furthermore, the compact plant pattern of UNR cotton with fewer nodes can improve earliness. This is very important in cotton short season countries like Spain and Greece. However, despite the potential benefits of cost production savings, yield increases and earliness, there are several potential limitations that should be appointed. These include crop management under UNR spacing, planting and harvesting equipment adaptations, and acceptance level of the seed cotton by gins.

Since 1994, Delta and Pine Land Co. and its partners in Europe are carrying out a testing program to learn about the adaptability of this technology to the growing conditions in the Mediterranean area.

The objectives of this study were to evaluate the yield potential and earliness of commercial varieties proprietary of Delta & Pine Land Co in Spain under conventional row spacing and ultra narrow row cotton, and the differences in plant growth habit between the two planting patterns.

Material and Methods

The experiment was planted in Las Yeguas farm, located in the municipality of Jerez de la Frontera, in the province of Cádiz (South Spain) in 2006. The soil type is a solonchak, improved with addition of calcium carbonate.

The field experimental design was a split plot with 4 replications, with row spacing as main factor, and variety as subplot. Two row spacings were tested, the conventional one for spindle machine picking of 1 meter, and the Ultra Narrow Row spacing of 0.5 meters. Twelve cultivars were evaluated, including the commercial varieties: DP 388, DP 396, DP 399, DP 401, DP 419, DP 466, Delta OPAL, DP 499 and Sicala 40, and 3 experimental lines from Delta and Pine Land Co.: 04W032, 04Q035 and 04T049.

Experimental plot dimensions were 3 rows width and 10 meters length.

Plots were seeded on May 18, 2006 at high rates. Plots were subsequently hand thinned after the emergence to a plant density of 15 plants per row meter. This resulted in a plant density of 150,000 plants/ha for the conventional row spacing, and of 300,000 plants/ha for the Ultra Narrow Row spacing.

The trial was managed according to standard cultural practices as applied to official cotton yield trials. Plots were sprinkler irrigated and all plots received 200 Kg of Nitrogen on June 25. The entire trial received 0.75 l/ha of Mepiquat Chloride on August 9 and another 0.3 l/ha on August 15.

Plant height and total nodes measurements were taken in the middle of the growing season, on July 28. Final plant mapping was conducted on September 25, selecting 5 sequential undamaged plants from each plot plot. Plant map parameters taken at this measurement include: plant height, total nodes, node of the first fruiting branch, number of fruiting nodes, node of the uppermost cracked boll and node of the last harvestable boll. For all the plant growth parameters, just 3 replications were considered, since the first one had a certain lack of uniformity.

For yield and earliness measurements the plots were hand picked twice: October 9 and November 13. Only the middle row was picked and weighted. Seed cotton per ha was calculated and earliness is expressed as the percentage of the weight of the first picking compared to total yield. As an additional measurement of the earliness, the difference between the values of the Node of the Uppermost Harvestable Boll (NLHB) and the Node of the Uppermost Cracked Boll (NCB) was calculated The nodes difference can be transposed to Degree Days (36.6 degree days ºC per node) to compare the relative differences in maturity between the two planting patterns.

Analysis of variance (ANOVA) was use to determine variance effects and Student t-tests for mean separation by statistical software JMP (SAS Institute, 2002) and significance tests applied according to the procedures of the split plot experimental design (Petersen, 1994).

Results and discussion

1. Seed Cotton Yield

UNRC had seed cotton yield that was 298 kg/ha higher than conventional spaced cotton (Chart 1), this difference was not statistically significant (Table 1a). While differences seem significant, the 1 and 3 degrees of freedom for treatment and error limit statistical conclusions. Similar results have been found in the literature, UNRC yields higher but without significant differences (Roche and Bange, 2006). However, there are strong based arguments supporting to increase yields with ultra narrow row cotton in a wide variety of growing environments (Krieg, 1996; Weir, 1996; Husman et al. 2000).

There was significant interaction between Genotypes by Row Spacing (Table 1a), because some of the varieties yielded significantly more in UNRC than in conventional planting. Table 1b shows the seed cotton yield for all varieties and row spacing. Chart 2 is a summary of some of varieties yielding higher under UNRC. Among these varieties, there are different maturity types, so we can not conclude that a certain maturity type is performing better under UNRC management.

2. Earliness

Ultra Narrow Row Cotton resulted in a statistically significant earlier crop than conventional spacing (Table 2). The values for the earliness in both row spacings, expressed as the percentage of the first pick in the total seed cotton yield, are shown in Chart 3. These results are consistent with most of the references in the literature: Weir (1996); Kerby (1998) or Buehring and Dobbs (2000). UNRC creates an earlier crop cover and a higher sunlight interception under plant stress conditions, which could result in earlier yields. However, the data from some regions like Australia do not demonstrate this earliness (Roche and Bange, 2006). Roche et al. (2004) attribute the lack of earliness in UNR to an excessive cotton canopy that restricted light penetration into lower portions of the canopy.

Plant Mapping can provide additional information about the earliness of a certain field. The last effective flower at first position defines the Node of the Uppermost Harvestable Boll (NLHB). UNRC plants have the NLHB 2 nodes above the plants under conventional row spacing (Table 3). If it requires 3 days to develop an additional node, this would be 6 days of earliness. Earliness can also be estimated by the number of Degree Days needed for each treatment at the time of final plant mapping to reach the 100% open bolls. The difference between the Node of the Last Harvestable Boll (NLHB) and the Node of the Cracked Boll (NCB) gives the number of nodes that still require time to open and be ready for harvest (Speed et al. 2004). At the time of final plant mapping, UNRC plants were on average 61 DDªC more advanced in maturity than conventional spaced plants (Table 3). There was not interaction between Row Spacing and Variety.

3. Plant Growth

Row spacing configuration significantly affected all plant map parameters taken except for the number of vegetative nodes before the first fruiting branch (Table 4). In agreement with Kerby (1998) and Buehring and Dobbs (2000), plants growing under UNRC are shorter in Plant Height and have less Total Nodes. However, the number of Vegetative Nodes is roughly the same for both row spacings. Rossi and Braojos (2003) found that Plant Density had no effect over the number of vegetative nodes for the cotton growing conditions in Spain. It was also confirmed by the data taken by Kerby (1998) in Mississippi (USA). Since the number of vegetative nodes is the same and the number of total nodes is higher in plants growing with the conventional row spacing, the number of fruiting branches is also higher in this planting pattern. However, UNRC with higher plant density compensates for fewer fruiting branches per plant.

No interactions between row spacing configuration and variety were significant for any of the plant growth parameters tested in the trial.

Conclusions

For the cotton growing conditions of cotton in Spain, UNRC has the potential to increase seed cotton yield and earliness. Plant growth parameters indicate that the plants are shorter and with less total nodes. However, the higher plant density compensates for the lower number of fruiting positions per plant in UNRC. Further research must be conducted to evaluate the different UNRC harvesting equipments available for this system in Europe. Today, some entrepreneur farmers and consultants are taking the lead to adapt Ultra Narrow Row cotton to short season growing conditions. Several broadcast strippers are being imported to provide data about the quality of the seed cotton delivered to the gins. With appropriate crop management, including weed control, plant growth regulators, adequate irrigation and perfect defoliation, reasonable trash and moisture content could be achieved to supply the market with acceptable lint quality.

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Table 1a. Analysis of the Variance table for Seed Cotton Yield

Source	DF	Sum of squares	Mean Square	F ratio
Total	95			
Block	3	569581	189860	$0.70^{N.S.}$
Row Spacing	1	2102582	2102582	$7.72^{N.S.}$
Error	3	817066	272355	
Variety	11	4819182	438107	$0.91^{N.S.}$
Variety * Row Spacing	11	5239570	476325	2.69**
Error	66	11660980	176681.5	

**** indicates the significance at the 0.01 probability level**

Table 1b. Student t-tests for Seed Cotton Yield

Interaction Variety * Row spacing							Mean (kg/ha)
DP 388, UNRC	A						4010,0
Delta OPAL, UNRC	A	B					3805,0
04W032, UNRC	A	B	C				3715,0
DP 399, Conventional	A	B	C	D			3447,5
04Q035, UNRC	A	B	C	D			3420,0
DP 401, UNRC		B	C	D	E		3325,0
DP 401, Conventional		B	C	D	E		3320,0
Sicala 40, UNRC			C	D	E	F	3195,0
DP 396, UNRC			C	D	E	F	3175,0
DP 419, UNRC				D	E	F	3075,0
DP 466, Conventional				D	E	F	3067,5
DP 388, Conventional				D	E	F	3035,0
DP 419, Conventional				D	E	F	2947,5
DP 396, Conventional				D	E	F	2937,5
DP 499, UNRC				D	E	F	2905,0
04W032, Conventional				D	E	F	2902,5
DP 399, UNRC				D	E	F	2900,0
04T049, UNRC				D	E	F	2865,0
Delta OPAL, Conventional				D	E	F	2852,5
Sicala 40, Conventional					E	F	2810,0
04Q035, Conventional					E	F	2797,5
DP 499, Conventional					E	F	2743,9
DP 466, UNRC						F	2655,0
04T049, Conventional						F	2605,0

Table 2. Analysis of the Variance table for Earliness (Percentage of 1st pick)

Source	DF	Sum of squares	Mean Square	F ratio
Total	95			
Block	3	0.09437	0.03146	37.90361*
Row Spacing	1	0.04437	0.04437	53.45783**
Error	3	0.00249	0.00083	
Variety	11	0.46883	0.04262	2.115136$^{N.S.}$
Variety * Row Spacing	11	0.22168	0.02015	1.586989$^{N.S.}$
Error	66	0.837992	0.012697	

*** and ** indicate the significance at the 0.05 and 0.01 probability levels respectively**

Table 3. Earliness estimation parameters taken at Final Plant Mapping

Row Spacing	Node of the Uppermost Cracked Boll (NCB)	Node of the Uppermost Harvestable Boll (NLHB)	Difference NLHB - NCB	DDºC to reach 100% open boll stage
Conventional	8.18 *	10.9 ***	2.72	99.63
UNR	7.88	8.9	1.12	38.63
* and ** indicate the significance at the 0.05 and 0.01 probability levels respectively				

Table 4. Plant Mapping Parameters

Plant Growth Parameter	Conventional	UNR	Significance Level	Interaction Row Spacing * Variety
Plant Height (cm) July 28	52.43	40	***	N.S.
Total Nodes July 28	13.60	11.7	***	N.S.
Vegetative Nodes	4.59	4.99	N.S.	N.S.
Final Plant Height (cm)	68.46	44.27	**	N.S.
Total Nodes	16.8	13.7	***	N.S.
* and ** indicate the significance at the 0.05 and 0.01 probability levels respectively				

Chart 1: Seed Cotton Yield (kg/ha) for both row spacings

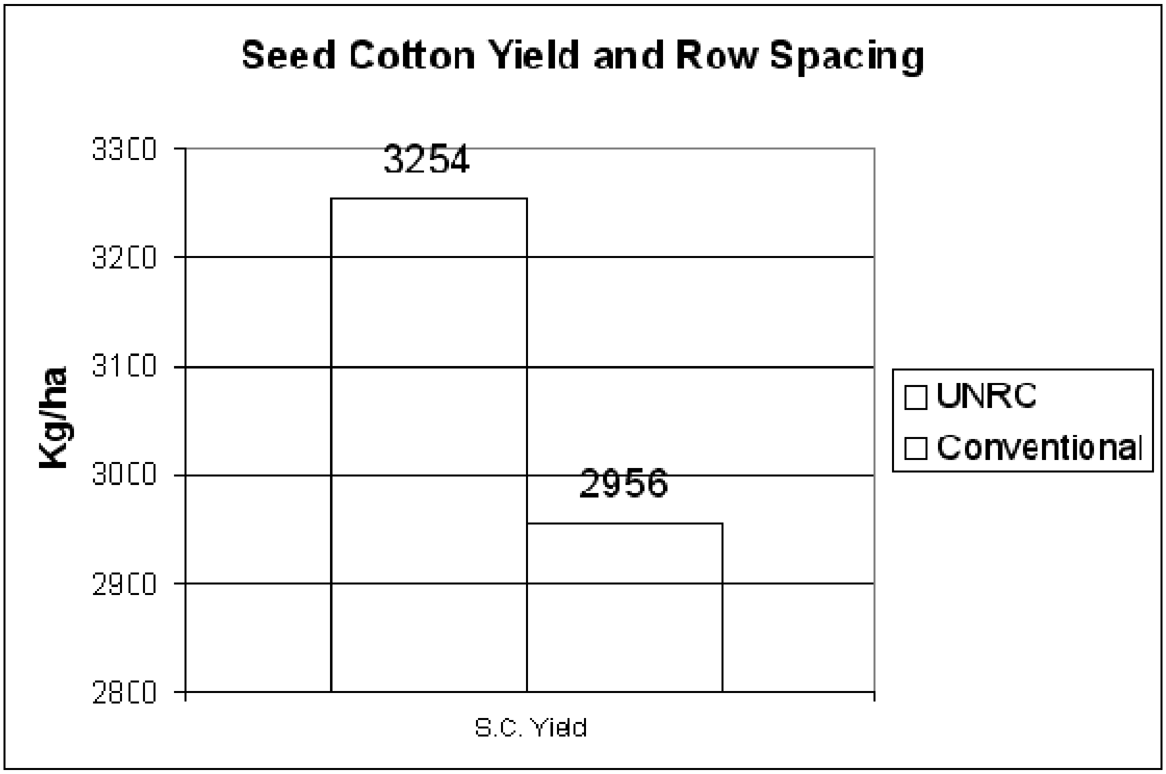

Chart 2: Varieties yielding higher under UNR

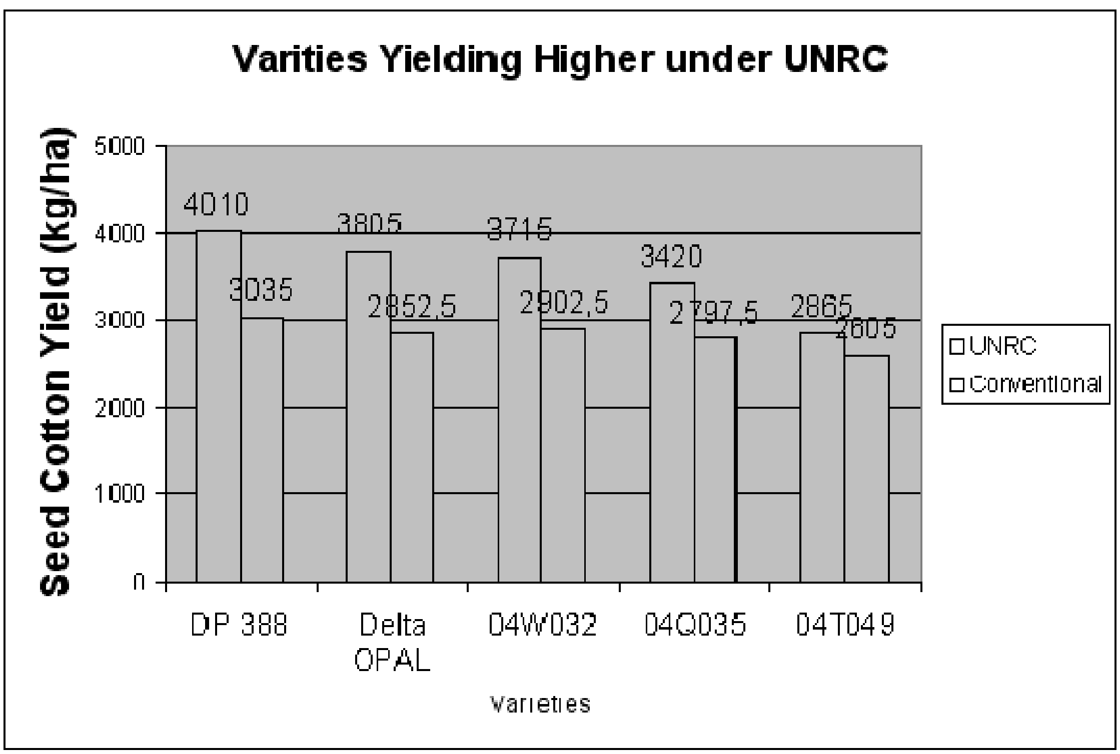

Chart 3: Earliness (%1st pick) and Row Spacing