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#### Abstract

A multi-location trial was conducted for five years across a range of sites and soil types in the San JoaquinValley of California to evaluate the potential of a change in cotton planting configuration on cotton yields and potential cost savings. The basic study involves comparisons done on 30 inch and 40 inch cotton beds, comparing yields under systems of single planted rows in the center of beds versus two planted rows per bed, with rows planted about 7 to 8.5 inches apart down the bed center. Objectives were to provide field evaluations across a broad range of soil types and production conditions and to determine the degree to which yield improvements noted in northern San Joaquin Valley studies could be reproduced in other areas and soil types within the valley. Over multiple years of trials, positive yield responses were much more consistent in the northern valley test locations, with inconsistent yield responses to double row plantings at other sites, where yield differences between single and double row plantings ranged from slight decreases to no change to slight increases. There were some consistent indications that crop earliness was affected with double row plantings, with 2 to 5 day earlier crop maturity noted across study sites. Although small plot studies indicated double row plantings yielded best at populations ranging from about 50,000 to 70,000 plants per acre, larger field studies at three locations indicated little consistent yield response within the plant population range of 40,000 to 85,000 plants per acre in double row plantings.

#### **Introduction**

Cotton growers in California (CA) and many other regions of the U.S. are under pressure to find lower production cost systems and/or systems with potential to increase yields or at least improve bottom-line production economics and profits. Where possible, it would be a benefit for these changes in systems to allow maintenance of high fiber quality characteristics so as to maintain the quality reputation and marketing advantages developed by California cotton producers and marketers over many years. Evaluations of a double-row 30-inch bed cotton production system have been done by Dr. Bill Weir of the University of CA Cooperative Extension (Merced, CA) in cooperation with growers Daniel Burns (San Juan Ranch) and managers at Bowles Farms have been promising both in terms of moderate yield improvements (as little as 0 to as much as 15 percent higher yields at different locations and years) and lower production costs (\$25.00 to over \$50.00 per acre lower

production costs) with the double-row approach. Ithough the results from some of these evaluations are from non-replicated trials and are concentrated in the northern San Joaquin Valley, results to date look promising and point out several areas of research needs.

A part of these evaluations of alternative production systems are variety choices. There are now varieties available that are truly shorter season than previously available full-season Acalas, plus transgenic herbicide resistant varieties (Roundup Ready and Buctril-resistant) which allow significant changes in management practices. Some testing that can be done depends upon the types of cotton and quality desired. If one of the approaches to reducing costs of production is a shorter growing season, it may be desirable to use practices that result in an overall tightening up of the production period, with more aggressive irrigation and growth regulator management. This approach would not require use of CA Uplands with shorter season characteristics, but the production season could potentially be shortened even more through use of shorter season varieties coupled with shorter season production practices. A basic premise of double-row 30 inch systems, though is that crop canopy development and closure will occur more rapidly with closer row spacing and a higher plant population. This could result in better crop competition with weeds, lower weed control and cultivation costs, and higher production with fewer fruit required per plant during shorter production periods.

Part of the reason we assigned importance to broader evaluations in other parts of the San Joaquin Valley (SJV) was due to past experience with research done with 30 inch cotton. Studies done in the late 1980's through early 1990's were generally quite conclusive in showing significant yield improvements with 30 inch versus 40 inch cotton in the northern SJV (Merced and Madera County), while results in the Fresno, Kings, Tulare and Kern County locations either were inconsistent or sometimes showed no consistent yield improvements with the switch to single seed line 30 inch cotton. While there may be other benefits to double-row 30 inch cotton in terms of faster leaf cover for more effective weed competition, allowing savings with reduced cultivation, it is important to know if good potential exists for yield improvements. In looking at the potential for cost savings, it is worthwhile to consider what the crop and weed growth expectations and management principles are with the double-row 30 inch cotton planted at a fairly high population density. The management approach used assumes the hypothesis that with the double-row, high density planting: (a) Cotton should more effectively compete with weeds and achieve earlier row closure and shading of beds and furrows than with single-row plantings, resulting in less need for cultivation and perhaps herbicides; and (b) Higher plant densities mean that fewer bolls are required per plant to achieve the same yield, as long as average boll size is not significantly affected

# Materials and Methods

Field research and demonstration work has been underway with variations of the concept of two planted rows on 30-inch beds since an initial 15 acre study in 1998 in Merced County (near Dos Palos and Los Banos, CA). Additional small-scale research trials have been conducted also at the West Side and Shafter Research and Extension Centers since that time, plus grower large scale trials in several other counties. Primary reasons for interest in this type of system include:

- 1. the possibility of earlier row closure and better crop competition with and shading of developing weeds
- 2. opportunities to try a narrow-row system that could still be harvested with a spindle-type picker, avoiding some fo the concerns regarding quality and needs for stripper harvests
- 3. earlier crop closure (with conventional cotton varieties) or use of over-the-top or post-directed herbicides with transgenic herbicide-resistant varieties offered the chance for reduced number of tillage operations and reductions in ditch openings and closings for furrow irrigation at the farm locations tests = cost savings

Most of the projects were done on 30 inch beds. The exceptions are noted in the tables, the sites at the West Side REC location were on 40 inch beds in 1999 and 2000 due to problems with availability of planters and pickers suitable for 30 inch plots. All project sites were harvested using commercial type spindle pickers. Projects involving comparisons of double row with single row cotton plantings were initiated at the following locations:

- Merced County multiple sites on grower fields from 1998 through 2002
- Madera County one primary site on grower field in 2002 and 2003
- West Side Research and Extension Center site with variety comparisons, growth regulator management, canopy cover evaluations from 1999 through 2003
- Shafter Research and Extension Center site with variety comparisons, growth regulator management evaluations, plant population comparison, canopy cover evaluations from 1999 through 2003
- Tulare County one primary site on grower field with plant population comparisons in both row orientations, growth regulator management comparisons, weed control and population evaluations
- Fresno County one site on grower field in 2003

The 2002 Madera County site was deleted from this experiment due to poor plant populations and the need for extensive replanting. Data collection was varied across sites in how extensive a data set was collected, including details on economics of production. Yield data was collected at all sites, along with samples for HVI fiber quality analyses. Only a limited summary of the yield data will be summarized for this report. Other publications are planned using analyses of the multiple location data set.

### **Planter Considerations**

Field plots were planted with a wide range of planters during the course of these studies. The earliest studies in Merced County were all planted with grower modified versions of sled planters and the West Side and Shafter REC sites were planted with modified bean planters, with offset tool bars used to place double row planters as close as possible on the beds, anywhere from 7 to about 10 inches apart. For purposes of most troublefree picking as well as planter operation and size considerations, most planters set up were between 7.5 and 8.5 inches apart. The sled planters used generally were effective, but heavy planters and relatively good plant populations were achieved in the double row plantings (ranging from about 45,000 plants per acre to about 95,000 plants per acre). Conventional planters of a range of styles and manufacturer were used for the single row comparisons, usually depending upon equipment already in use on site. Based on grower interest in expansion of the trials for 2002 and 2003, we worked with Great Plains Equipment Company as well as Merced County growers in 2002 and with Monsanto and Monosem Planters Company for 2003 single versus double-row 30 inch cotton in multiple sites from Merced County down through Kern County.

These planters used in 2002 and 2003 tended to require packing beds down prior to use of the planter in order to flatten and firm up the beds. Soft beds tended to have a lot of soil moved by the planter as we tried to position seed firmly in contact with the soil and within adequate moisture. We experienced significant problems at multiple sites in trying to find and maintain adequate moisture for both seed lines when planting two lines closer to the bed edge rather than one line down the center. Across the sites: (a) in some situations, this problem resulted in the growers deciding not to plant with this configuration; (b) in some other locations this arrangement worked acceptably, achieving good plant populations; (c) in others plant stands achieved ranged from marginal to fair; and (d) at some sites, there was a strong tendency to get one good row established out of the two planted, with the other row more variable due to soil moisture problems. One grower used a culti-packer to effectively produce a "cap" for the double-row planting, an approach which improved success in germination and emergence, and one which we will try or recommend to others interested in double row plantings in the future.

### **Results and Discussions**

### Results of Prior Year Studies - Perspective on Why Continuing Studies are Needed

The bulk of the field evaluations have been done by Dr. Bill Weir of UCCE - Merced County in cooperation with San Juan Ranch and Bowles Farms in western Merced County, but we have also conducted trials for multiple years at Shafter and West Side REC locations. In addition, in 2002 we started some additional trials in other grower fields in different parts of the SJV, so hopefully information will be available in future years across a broader range of soil types and production conditions. Some of this information was presented previously in the December, 2001 issue of the CA Cotton Review newsletter available on the web at http://cottoninfo.ucdavis.edu. Conventional cotton production in California typically employs 38 inch or 40 inch beds, planted to a single line of seeds, typically at seeding rates that result in 30,000 to 60,000 plants per acre. University of CA studies in Merced County in the 1980's and 1990's compared growth and yields in narrower beds (30 inch) with those in 38 or 40 inch cotton. Results from these studies over multiple years in Merced County demonstrated an average 9% increase in lint yields with 30 inch beds. Results of those earlier 30 inch versus 40 inch comparisons were not as conclusive in the central and southern parts of the San Joaquin Valley, where the 30 inch cotton often did not significantly produce higher yields than at 40 inch row spacing.

### 2000 and 2001 Results—Merced County

Approximately 100 acres of Roundup-Ready CPCSD variety "Riata" were planted in double versus single-row 30 inch comparisons in various fields near Dos Palos in 2000. Yield improvements over single row 30 inch plantings with double-row 30 inch plantings at these different sites were quite consistent, with a significant lint yield increase averaging 7.3 percent. Table 1 shows average lint yield responses of single-row versus double-row 30 inch comparisons in replicated trials in grower fields in the Dos Palos area (Merced County) in 1998 through 2001.

### 2002 Trial Locations (Merced County Data)

<u>Economic Comparison Trial.</u> At a grower field site in central Merced County, Acala Maxxa and Riata RR varieties were used in a field trial, with plantings in ten 30 inch beds 1000 feet in length, replicated four times. Plantings were in two lines 7 inches apart on 30 inch beds. The field was planted on April 13, 2002 and yield data is summarized in Table 2. Although the yield differences were relatively small in this trial, the other focus of the study was to collect detailed information on production costs under the two systems. Some comments on the economic analysis will be presented later in this report.

<u>Grower Site Double versus Single Row 30 Inch Bed Comparison – Merced County.</u> At another grower field site in Merced County, Acala Riata RR variety was used in the trial, with plantings in ten 30 inch beds 1000 feet in length, replicated four times. Plantings were in two lines 7 inches apart on 30 inch beds. The field was planted on April 13, 2002 and yield data is

shown in Table 3. As with the other trial site shown in Table 2 for 2002, yield differences were not significant between double and single row plantings.

## <u>Yields in Other Test Locations – 1999 through 2003</u>

More than 1000 acres of double row 30 inch cotton were planted in 2001 and 2002 in the northern SJV using either a "Monosem" brand planter designed to precisely place seeds in two lines as close as 7 inches apart, or variations on the sled planter used in earlier years of field trials. Sites have been initiated at several other locations since 1999 at the University of CA West Side and Shafter Research and Extension Centers. The Shafter trials have been single versus double-row 30 inch studies, while those at the West Side site were on 40 inch beds in 1999 and 2000 and 30 inch beds in 2001 through 2003. Yield results from these trials are shown in Table 4.

Yield improvements at some other test sites shown in Table 4 have not been as consistent as those achieved in the western and central Merced County in the northern SJV. At the West Side REC site (central SJV), it should be noted that these were 40 inch single versus double row comparisons, and plant populations in the double row plantings averaged 52,000 (1999), 61,000 (2000) and 53,000 plants per acre (2001), while the Merced County studies averaged over 75,000 plants per acre in double-row plantings. A range of plant populations were investigated in many of the trial sites from 2001 through 2003, but will not be discussed here. Another article in the Beltwide proceedings in 2004 (by Steven Wright, et al) covers some aspects of plant population responses at one of the test sites over a two year period, so will not be discussed here other than to say that plant populations within the range of about 45,000 to 85,000 plants per acre were not found to have significant effects on lint yields in several years of trials at the West Side of Shafter REC sites and at a Tulare County grower site.

#### Savings Potential versus Increased Costs

At the sites near Dos Palos represented by the lint yields summarized in Table 1, grower records of expenses and changes in production costs with the single versus double-row 30 inch production methods were carefully recorded. The records indicated that an average of \$43.00 per acre was saved using the double-row 30 inch bed configuration in place of the single-row 30 inch configuration. Cost savings in the field studies ranged from about \$25.00 to over \$70.00 per acre. <u>Savings</u> were generally found in reduced number of field tractor operations, including fewer cultivations with higher density double-row beds, and fewer openings and closings of irrigation ditches under furrow irrigation at the study sites. With the management approaches used with the double-row 30 inch cotton to date, there does not appear to be any increased costs or additional savings in fertilizer requirements, defoliation or harvesting costs. <u>Additional costs</u> incurred with switching to the double-row system as described here can include costs of additional seed needed for high density planting, initial costs and operating costs for a planter suitable for this configuration, and technology fees (if the grower decides to use a transgenic herbicide tolerant variety). Although data is not conclusive at this point, more applications and higher rates of Mepiquat chloride growth regulator may be useful to help manage growth and earliness of double-row 30 inch cotton and keep defoliation and harvesting problems to a minimum.

	Average Lint Y across all sites for the y		
	Single Row	<b>Double Row</b>	<b>Average Percent Yield</b>
Year	<b>30-Inch Beds</b>	<b>30-inch beds</b>	Increase in Double-Row
1998	1123	1256	8.4
1999	1300	1475	8.8
2000	1976	2114	7.3
2001	1548	1837	15.7

Table 1. Average lint yields and percent yield increase with double-row 30 inch planting configuration in replicated grower field studies near Dos Palos, CA from 1998 through 2001.

Table 2. Average lint yields across two varieties (CPCSD "Maxxa" and CPCSD "Riata RR") in double-row 30 inch planting versus single row per bed planting in replicated grower field study near Dos Palos, CA in 2002.

	Lint Yi	_			
Treatment	Rep 1	Rep 2	Rep 3	Rep 4	Average
Double-Row	3.25	3.36	3.37	3.11	3.28
Single Row	3.05	3.13	3.10	3.19	3.14

Table 3. Average lint yields of variety CPCSD "Riata RR" in
double-row 30 inch planting configuration versus single row per
bed planting in replicated grower field study in central Merced
County, CA in 2002.

Treatment	Lint Yield (bales of lint per acre)				
	Rep 1	Rep 2	Rep 3	Rep 4	Average
Double-Row	3.62	3.51	3.76	3.63	3.63
Single Row	3.56	3.51	3.73	3.65	3.61

Table 4. Average lint yields and percent yield increase with double-row 30 inch planting configuration in other field studies (various locations and years).

	Average Lint Yie	eld (lbs/acre)	Yield increase (+) or	
	Single Row	<b>Double Row</b>	Yield decrease (-) with	
Location	30" average	30" average	double row plantings	
Merced Co.				
Fld #2 2001	1329	1504	12	
Fld #3 2001	1056	1132	7	
Madera Co.				
Fld #1 2001	(4280) *	(4320)	1	
Fld #2 2001	(4423) *	(4540)	3	
West Side REC				
1999 (40")	1104	1083	- 2	
2000 (40")	1654	1709	3	
2001 (40")	1553	1485	- 4	
2002 (Riata RR)	1733	1801	4.0	
2002 (DP 6100RR)	1633	1668	2.1	
2002 (Phy-78)	2085	1951	-6.4	
2003 (estimated – not ginned yet)	3500 *	3700 *	5	
Shafter REC				
1999	1520	1652	9	
2000	1428	1355	- 5	
2001	test incomplete of	lue to poor stand		
2002 (Riata RR)	1527	1712	12.1	
2002 (DP6100 RR)	997	1073	7.6	
2002 (Phy-78)	1913	1991	4.1	
2003 (estimated – not ginned yet)	3350	3200 *	- 5	
Tulare County				
2002 (one grower site)	1730 (estimate)	1825 (estimate)	5	
2003 (one grower site)	1560 (estimate)	1540 (estimate)	- 1.5	

\* yields shown in parentheses are seedcotton yields