

California Tomato Research Institute – Final Report 2006

Project Title: Transplant Density in the Control of Curly Top Virus

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Objectives:

- 1) Evaluate transplant density in relation to incidence and severity of curly top virus in grower production fields.
- 2) Evaluate the effect of plant density (in-row spacing and number of plants in a transplant plug) on yield performance of two varieties.

Summary:

Two field trials were established in Fresno County in 2006 to investigate in-row spacing and number of plants per transplant plug with two varieties in efforts to minimize effect of curly top virus. One trial was located in a grower field and the other was conducted at the UC WSREC. Disease incidence in these trials was too low to impact yield, which basically turned these trials into plant density (in-row spacing x number of plants per transplant plug) studies for two varieties: AB2 and Halley 3155. Similar studies have been conducted in previous years:

- 2004 trial - closer in-row plant spacing and 2 plants per plug resulted in higher yields for both varieties.
- 2005 trial - there was no response to in-row plant spacing and varieties responded differently to plug density. AB2 showed no difference between 2 and 3 plants/plug but yields were significantly higher than one plant/plug. Halley 3155 exhibited the opposite response: higher yields with one plant/plug. It is possible that higher percentages of green fruit in the denser plantings of Halley could account for the different yield response to density between the two varieties. Unfortunately green fruit % was not measured.

Results from 2006 are similar to the results of 2004. Closer in-row plant spacing definitely resulted in higher yields over wider in-row spacing. Two plants/plug resulted in higher yields for both varieties at the wider in-row plant spacing. Three plants/plug were rarely more advantageous than two plants/plug. As the number of plants per plug increased, the amount of green fruit increased. This was more apparent in Halley 3155. The yield gain with 2 plants/plug covered the expense of the additional seed and transplant growing costs.

Background:

Curly Top Virus continues to plague tomato growers on the west side of the San Joaquin Valley, however the unpredictability of its occurrence and severity each year complicates the development of control strategies. There is no genetic resistance in tomatoes to beet curly top virus. A statewide program designed to control the beet leafhopper, *Circulifer tenellus*, (the vector of the virus) is practiced annually by spraying foothill areas where leafhoppers are congregated. When curly top occurs the amount of damage to tomatoes appears to be more

extensive in transplant fields compared to direct seeded fields. Growers have been steadily switching to transplants for a number of reasons, and in the process the total number of plants per acre has been reduced. Fewer plants per area create conditions favorable for the beet leafhopper, since it is believed that dense stands of tomatoes discourages visitation by leafhoppers.

Procedures:

Two transplant density field experiments were established in the Five Points area of Fresno County in the San Joaquin Valley in 2006, one was in a commercial field and the other was in a research field at the UC West Side Research and Extension Center.

The first trial was established at Five Star Ranch (Frank Coelho, grower) on April 26 and machine harvested on August 24, 2006 (120 days after transplanting). The second trial was planted May 4 and harvested on August 23, 2006 (113 DAT). Two varieties, Halley 3155 (medium vine size) and AB2 (large vine size), were sown at 1, 2, and 3 seeds per transplant plug in a 336 plug tray and grown by a commercial greenhouse. Plugs were transplanted in the field at 14” and 28” in-row plant spacing.

Individual plot size was one 66-inch bed wide by either 50 or 100 feet of row length. Trials were evaluated at the end of May to be sure that plots were establishing properly without a significant number of skips. Both fields were grown under furrow irrigation after the plants were established with sprinklers. Both experiments were harvested my machine. Fruit samples from the mechanical harvester were delivered to PTAB for analysis. The following table details the trial procedures at the two field locations.

2006 Plant Density Trials	Five Star Ranch	UC WSREC
Transplant date	April 26, 2006	May 4, 2006
Transplant method	machine	hand
Machine harvest date	August 24, 2006 (120 DAT)	August 23, 2006 (113 DAT)
Plot size	one 66” bed x 100’ row	one 66” bed x 50’ row
Varieties	AB2 and Halley 3155	AB2 and Halley 3155
Spacing	14” and 28”	14” and 28”
# plants/plug	1, 2, or 3	1 or 2
Irrigation method	sprinkle, then furrow	sprinkle, then furrow

2006 Results:

Since the incidence of curly top virus was too low at each location to have any effect, the yield results reflect plant density and variety differences. **Tables 1a & 1b** are results from **Trial #1** at the Five Star Ranch. **Tables 2a & 2b** are results from **Trial #2** at the WSREC.

Trial #1 - Five Star Ranch:

Variety yield response to the different treatments (spacing and plant #/plug) was similar and not significantly different from each other. AB2 averaged 49.6 tons/acre and Halley 3155 averaged 50.3 tons/acre across all treatments. In-row spacing had the greatest effect on yield. Yields were highest at the 14" spacing regardless of number of plants per plug for either variety. When both varieties are averaged together across 1, 2 or 3 plants in a plug then the 14" spacing yielded 52.6 tons while the 28" spacing averaged 47.3 tons per acre. This trend was consistent within each variety.

The number of plants per plug only impacted yield at the wider in-row spacing. This was observed in each variety. Yields of AB2 jumped from 42.8 to 48.7 tons per acre with 2 plants in a plug. With three plants per plug yields increased another ½ ton but this was not statistically significant. Halley 3155 exhibited the same trend with yields approximately 49.5 tons/acre with 2 and 3 plants in a plug compared to 44.4 tons/acre with only one plant in a plug. The conclusion from this experiment is that at a close plant spacing plug density has no impact on yield, whereas at wide in-row spacing there is a yield advantage that would pay for the cost of extra seed in 2 plants per plug.

Varieties were different in °brix and pH, but not in color. AB2 averaged 0.2 higher in °brix and 0.04 lower in pH than Halley 3155. Plant spacing had no effect on solids, pH, or color. Variety and plant #/plug influenced the amount of green fruit at harvest, but in-row spacing did not. Halley 3155 averaged 7.6% green, while AB2 averaged 4.9% green. In-row spacing of 14 inches averaged 6.6 % compared to 5.8% green at 28-inch spacing. As the number of plants per plug increased the amount of green fruit increased. This was more apparent in Halley 3155.

Trial #2 - UC WSREC:

Results were very similar between the two field locations, although yields at the field station were approximately 15 tons less than the grower's field. Three plants per plug were not included in this trial. Varieties responded similarly to increasing density and in-row plant spacing. Closer in-row spacing yielded more than wider in-row spacing. Two plants /plug yielded more than 1 plant /plug. Once again AB2 had higher °brix and lower pH than Halley 3155. Color was similar between the two varieties. Soluble solids, pH, color, % green fruit, and % rotten and sunburn fruit were not impacted by in-row spacing or the number of plants/transplant plug.

Summary:

Three years of density trials in Fresno County have resulted in somewhat similar trends and findings. Closer in-row spacing (14 or 15 inches) produces higher yields than wider in-row spacing (28-30 inches). Two plants per plug usually yield higher than one plant per plug, especially at a wider plant spacing. Three plants per plug are rarely an advantage at either in-row spacing. Color, pH, and °brix do not appear to be severely affected by increasing density, while % green fruit are increased in denser plantings.

**Table 1a. Effect of variety, in-row spacing, and plant number in transplant plug on yield and quality of processing tomatoes, Five Star Ranch, Fresno County, 2006.
Sorted by YIELD**

TRT #	Variety	In-row Spacing	# Plants in Plug	YIELD Tons/A	PTAB			lbs per 50 fruit	% green	% rot + sunburn
					°Brix	Color	pH			
5	Halley 3155	14	3	54.2 a	5.2 d	24.3 ab	4.42 bc	10.1 ab	10.4 c	5.9 bc
3	Halley 3155	14	2	52.5 ab	5.2 d	25.3 b	4.41 abc	11.0 a	7.8 bc	11.5 ab
11	AB2	14	3	52.4 ab	5.4 bcd	24.3 ab	4.39 abc	9.9 b	5.6 ab	9.6 ab
9	AB2	14	2	52.3 ab	5.5 abc	23.5 a	4.37 a	10.6 ab	6.0 ab	11.9 ab
1	Halley 3155	14	1	52.2 ab	5.4 bcd	23.5 a	4.43 c	11.0 a	5.0 ab	7.9 abc
7	AB2	14	1	52.1 ab	5.5 abc	23.5 a	4.37 a	10.5 ab	4.8 ab	9.0 abc
4	Halley 3155	28	2	49.6 ab	5.3 bcd	24.3 ab	4.40 abc	10.7 ab	4.0 ab	6.2 bc
6	Halley 3155	28	3	49.3 ab	5.4 bcd	24.0 ab	4.42 c	10.7 ab	10.4 c	3.0 c
12	AB2	28	3	49.2 bc	5.6 ab	24.0 ab	4.38 abc	10.4 ab	4.1 ab	12.1 ab
10	AB2	28	2	48.7 bc	5.3 cd	24.3 ab	4.41 abc	10.5 ab	5.2 ab	9.6 ab
2	Halley 3155	28	1	44.4 cd	5.5 abc	23.8 a	4.40 abc	11.1 a	7.2 abc	7.5 bc
8	AB2	28	1	42.8 d	5.7 a	23.0 a	4.37 a	11.0 a	3.8 a	14.1 a
Overall average				50.0	5.4	24.0	4.40	10.6	6.2	9.0
LSD 0.05				5.0	0.2	1.3	0.05	1.0	3.9	6.6
CV %				6.9	3.2	3.9	0.79	6.5	43.6	50.8
AB2 average				49.6 a	5.5 a	23.8 a	4.38 a	10.5 a	4.9 a	11.0 b
Halley average				50.3 a	5.3 b	24.2 a	4.42 b	10.7 a	7.5 b	7.0 a
LSD 0.05 (var)				NS	0.1	NS	0.02	NS	1.6	2.7
** LSD .05 (spacing)				2.0 T/A	NS	NS	NS	NS	1.6	NS
*** LSD .05 (#plant/plug)				2.5 T/A	0.1	0.7	NS	0.5	1.94	NS
**** LSD .05 (spacing x #plant/plug)				3.5 T/A	NS	NS	NS	NS	2.75	NS

NS = no significant difference Results followed by same letter are not significantly different from each other.

**Table 1b: Effect of in-row plant spacing and #plants/plug on yield of AB2 and Halley 3155
Five Star Ranch, Fresno County, 2006**

	AB2 Tons/A			Halley 3155 Tons/A			Both Varieties Tons/A				
	14"	28"	Avg.	14"	28"	Avg.	14"	*****	28"	*****	Avg. ****
1	52.1	42.8	47.5	52.2	44.4	48.3	52.1	ab	43.6	c	47.9 p
2	52.3	48.7	50.5	52.5	49.6	51.1	52.4	ab	49.2	b	50.8 q
3	52.4	49.2	50.8	54.2	49.3	51.8	53.3	a	49.3	b	51.3 q
Avg. (var)	49.6 x*			50.3 x*			50.0				
Avg. (spacing)	52.3 u	47.0 v		53.0 u	47.8 v		52.6 s		47.3 t		
* LSD .05 (variety)							NS (x,y)				
** LSD .05 (spacing)							2.0 T/A (s,t)				
***LSD .05 (var x spacing)							3.53 (u,v)				
**** LSD .05 (#plant/plug)							2.5 T/A (p,q)				
***** LSD .05 (spacing x #plant/plug)							3.5 T/A (a,b,c)				

NS no significant difference Results followed by same letter are not significantly different from each other.

Table 2a. Effect of variety, in-row spacing, and plant number in transplant plug on yield and quality of processing tomatoes, UC WSREC, Fresno County 2006. Sorted by YIELD

TRT #	Variety	In-row Spacing	# Plants in Plug	YIELD Tons/A	PTAB			lbs per 50 fruit	% green	% rot + sunburn
					°Brix	Color	pH			
7	AB2	14	2	39.9 a	6.1 abc	22.5 a	4.29 abc	8.9 ab	10.0 a	17.7 a
3	Halley 3155	14	2	39.8 a	5.7 bc	23.0 a	4.31 abc	9.4 ab	7.2 a	19.4 a
1	Halley 3155	14	1	36.7 ab	5.6 c	23.5 a	4.32 ab	10.0 a	12.1 a	21.0 a
5	AB2	14	1	36.3 ab	6.4 a	23.0 a	4.29 abc	7.9 b	15.3 a	22.9 a
8	AB2	28	2	33.4 bc	6.1 abc	22.8 a	4.29 bc	9.8 a	9.2 a	23.2 a
4	Halley 3155	28	2	31.2 cd	5.8 abc	23.8 a	4.30 abc	9.6 a	17.9 a	17.3 a
6	AB2	28	1	28.9 cd	6.3 ab	22.8 a	4.26 c	10.3 a	11.8 a	20.6 a
2	Halley 3155	28	1	28.0 d	5.6 c	23.5 a	4.33 a	10.0 a	10.2 a	21.8 a
Overall average				34.3	5.9	23.1	4.30	9.5	11.7	20.8
LSD 0.05				4.6	0.6	NS	0.04	1.6	NS	NS
CV %				9.3	7.0	5.4	0.50	11.8	79.0	32.1
AB2 average				34.6 a	6.2 a	22.8 a	4.28 a	9.9 a	11.6 a	21.8 a
Halley average				33.9 a	5.7 b	23.4 a	4.32 b	9.1 a	11.8 a	19.9 a
* LSD 0.05 (var)				NS	0.3	NS	0.01	NS	NS	NS
** LSD .05 (spacing)				2.33	NS	NS	NS	0.2	NS	NS
*** LSD .05 (#plant/plug)				2.33	NS	NS	NS	NS	NS	NS
**** LSD .05 (spacing x #plant/plug)				NS	NS	NS	NS	NS	NS	NS

NS = no significant difference Results followed by same letter are not significantly different from each other.

Table 2b: Effect of in-row plant spacing and #plants/plug on yield of AB2 and Halley 3155, UC WSREC, Fresno County, 2006

# plants/plug	AB2 Tons/A			Halley 3155 Tons/A			Both Varieties Tons/A			
	14"	28"	Avg.	14"	28"	Avg.	14" *****	28" *****	Avg. ****	
1	36.3	28.9	32.6	36.7	28.0	32.3	36.5 ab	28.4 c	32.5 p	
2	39.9	33.4	36.7	39.8	31.2	35.5	39.9 ab	32.3 b	36.1 q	
Avg. (var)	34.6 x*			33.9 x*			34.3			
Avg. (spacing)	38.1 u	31.2 v		38.3 u	29.6 v		38.2 s	30.4 t		
* LSD .05 (variety)							NS (x,y)			
** LSD .05 (spacing)							2.33 T/A (s,t)			
*** LSD .05 (var x spacing)							3.30 (u,v)			
**** LSD .05 (#plant/plug)							2.33 T/A (p,q)			
***** LSD .05 (spacing x #plant/plug)							3.30 T/A (a,b,c)			

Results followed by same letter are not significantly different from each other. NS = no significant difference

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