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Vegetable Info (October 2024)

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2024 Transplanter Trial I: Field Results

I. Experimental overview

Automated planters are able to plant more quickly with less labor than traditional planters. However, there is uncertainty whether there may be associated penalties in stand, yields, and fruit quality. This report gives preliminary results from a replicated field study. Our goal was to determine whether we could detect any consistent differences among planter types (a finger planter, a Ferrari FMAX carousel-type planter, and the Ferrari Futura and Agriplanter automated planters) for planting depth, skips, and fruit yields and quality.

We found that as expected, the automated planters tended to have more planting skips, especially the Agriplanter. However, skips were generally small and infrequent. There wasn't any evidence that planter type affected yields or quality in any of the three field trials.

Our next step will be to develop a cost-benefit analysis for the different planter types.

II. Study design

Large replicated side-by-side trials were planted in three fields, each with different growers, locations, varieties, and planting dates and conditions. All planters were tested in the three-row configuration. Transplants for each planter were randomly chosen from the lot supplied to the grower for planting the whole field. Plants came from a different transplant house for each field but were generally a good size, healthy, and fairly uniform within the trays. Trial planting in all fields started around 7:00 am. Agriplanter rows were planted by each grower, using their own machine and crew. The other planters were operated by custom transplant businesses accustomed to their use, using their own machines and crew.

Table 1. Experimental conditions for the three trial sites

Field site	Winters	Dixon	Clarksburg
Variety	SVTM 9034	H 2016	SVTM 9016
Planting date	March 27, 2024	May 8, 2024	May 17, 2024
Temp at planting (Low/High °F)	47° / 60°	58° / 82°	52° / 80°
Avg transplant height & variability*	6" (CV=9.8%)	4.6" (CV=10.2%)	5" (CV=16.2%)
Harvest date	July 24-25	Sept 11-12	Sept 29-30
Trial size	19.8 acres	13.8 acres	18.1 acres
Main soil type	Silt loam, silty clay loam	Silty clay loam	Clay
Site-specific challenges	Heavy bindweed and vine decline in one replicate	Strong north wind whole of planting day	Weed pressure, early-season irrigation challenges

** "Height"= plant height in the tray from the soil line to the growing tip. Variability measured as coefficient of variation (CV=standard deviation/average*100)*

Three replicates were planted per field, using a layout that allowed for harvest in a carousel pattern (Figure 1). Each replicate consisted of two passes of each three-row planter (6 rows * 3 replicates = 18 rows per planter field). Planter order was randomized within each replicate separately, so that no planter would always be at the center or outside position. Replicates were located at least 12 rows from a field edge and at least 12 rows apart from each other.

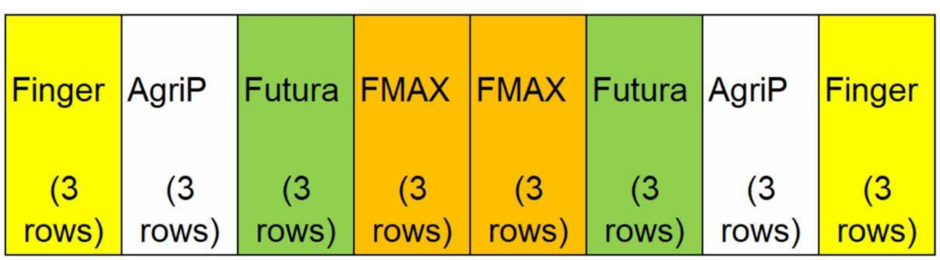

Figure 1. Example design of one replicate in one field. There were three replicates in each field.

Data collected:

- Planting depth--calculated by subtracting an average plant height (obtained by measuring the distance between soil line and growing tip of five random plants in three random trays from each transplant box that was used to supply each planter) from the height of each of ten random plants measured along one row of each pass
- Planting skips (counted just after planting on one row per pass)
- Stand establishment (measured by drone 3 weeks after planting)
- Yields and quality (weights and PTAB grades from processor for each unmixed load

III. Results

Planting depth

In each of the three 2024 field trials, all planters had a similar planting depth (p>0.05). They also all had similar variability at all sites (p>0.05 for Levene's test of homogeneity of variance). Figure 2 shows the combined data for all three sites in 2024.

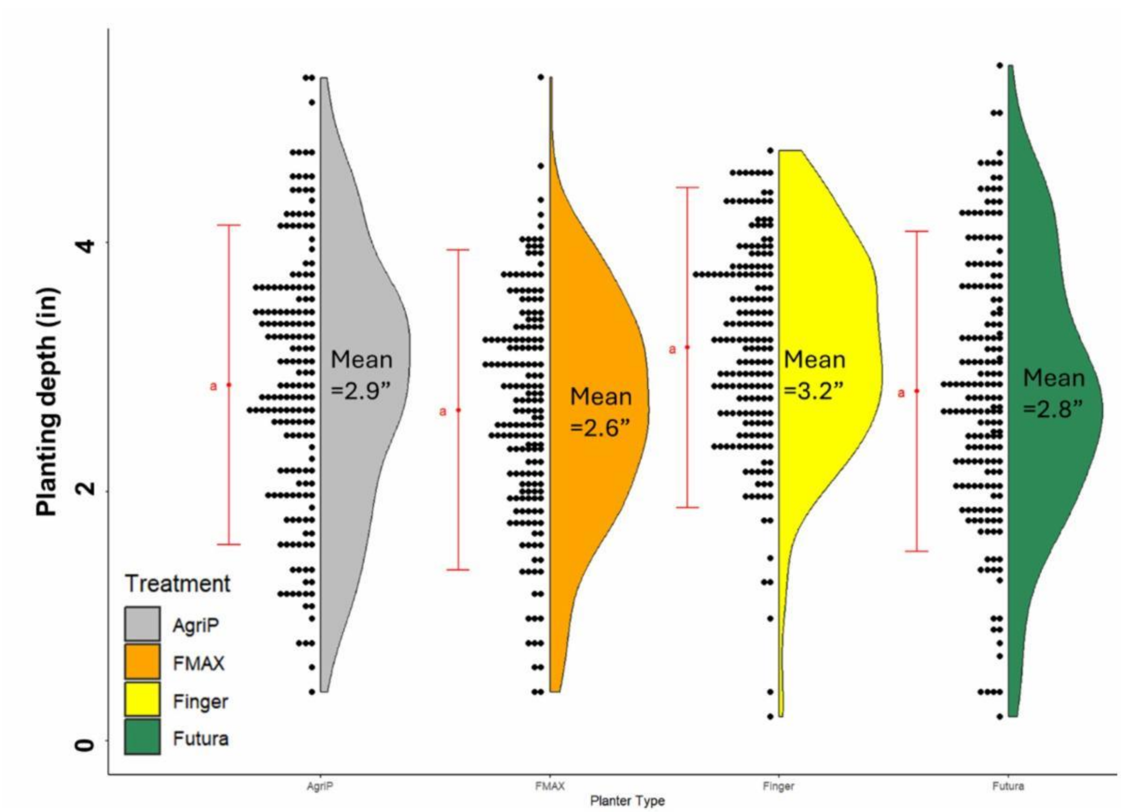

Figure 2. Range, mean, and variability of planting depth in the 2024 field trials. Each black dot represents one plant measurement.

This is in contrast to the results from the 2023 trial, in which the finger planter planted at a greater depth and with less variability than the Agriplanter or FMAX (the Futura was not included in the 2023 trial). These results show that while there can be differences depending on site-specific operating conditions, there very likely aren't any intrinsic issues with any of these machines that would make planting depth different or more variable than the others.

Planting skips

Normal / grower practice for replanting was followed for all planters-- for the finger and FMAX planters at all sites, workers followed behind filling in skips by hand. At the Winters site only, the grower filled in any long skips behind the Agriplanter using a single-row planter.

For the skips counted immediately after planting, the Agriplanter generally had more 2-plant or greater skips than the other planters. At the Clarksburg site, the Futura had the greatest number of single-plant skips (not shown). However, all skips greater than 2 plants were relatively infrequent, on average less than one per thousand feet (Figure 3). Only one skip greater than ten plants was measured; a 40-ft skip in one of the Agriplanter rows at the Winters site.

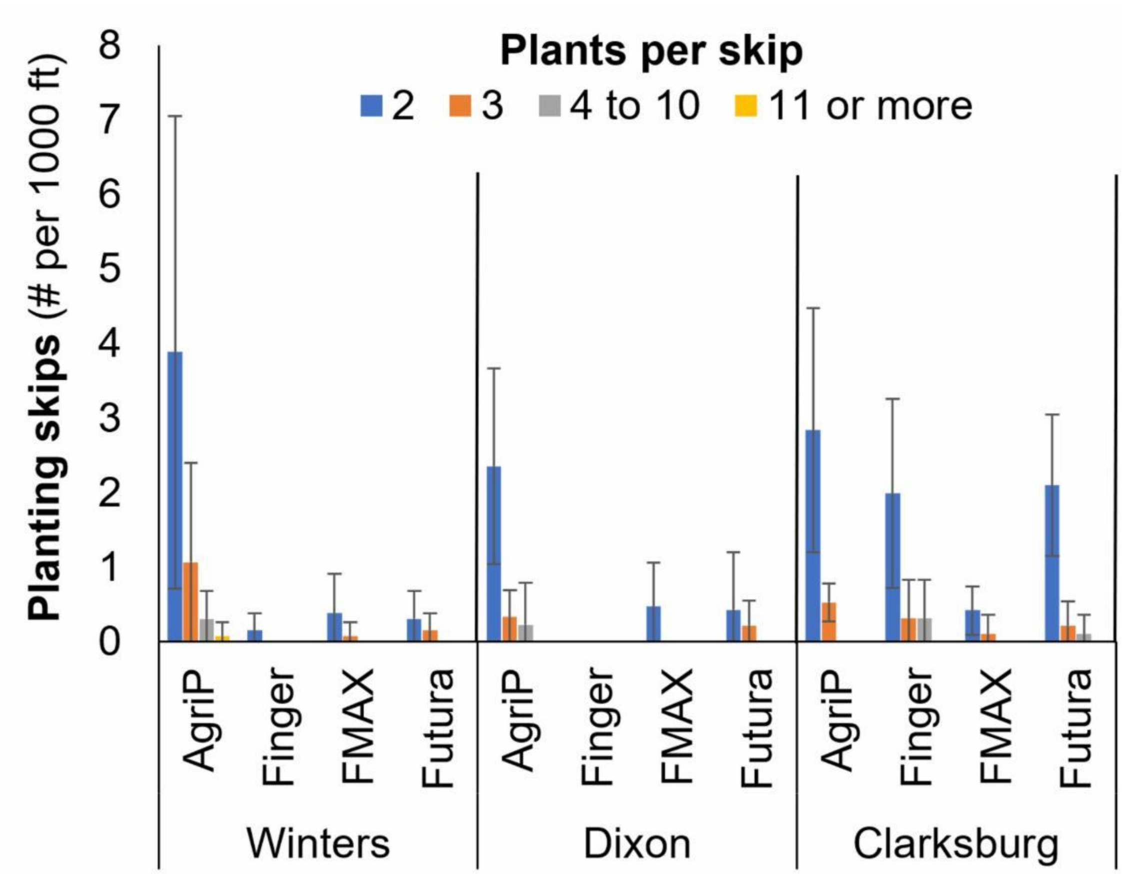

Figure 3. Skips approximately the length of 2 plant or greater, measured immediately after planting

Stand establishment data was taken three weeks after planting for whole replicates, via drone. We are still analyzing this imagery

Yield and quality

Neither total nor paid yield differed among the four planter types at any of the three sites (Figure 4). At the Winters site, there was a slight tendency for the Futura rows to have fewer greens (p=0.08); otherwise, there were no significant fruit quality differences among the planter types.

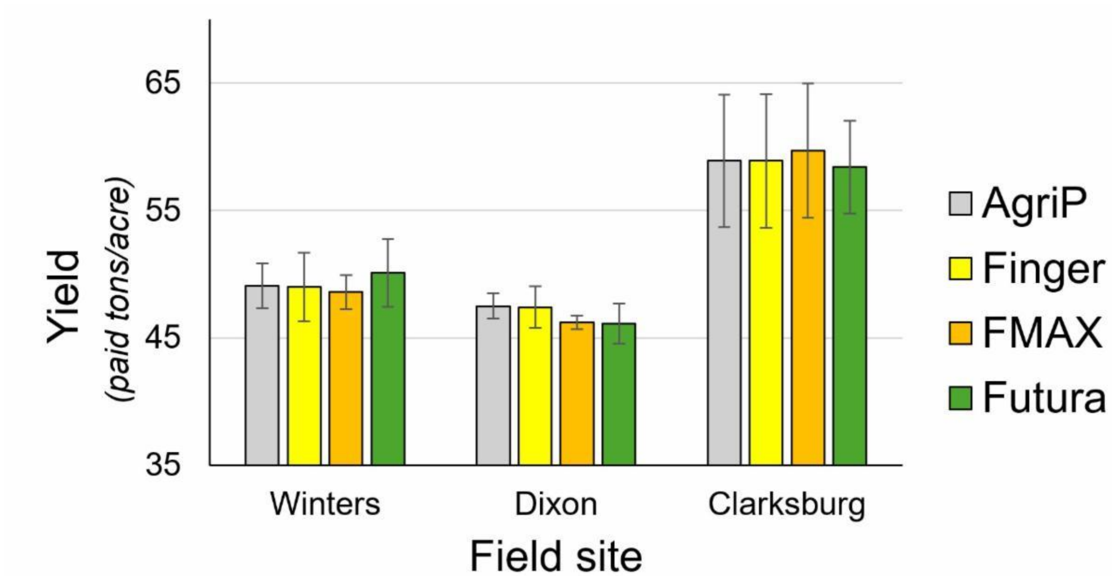

Figure 4. Average paid yields at the three field sites.

Overall, the variation between fields (combined effect of variety, planting date, and other management and site-specific factors) and the variation between the replicates within a field were much greater than the differences between planters. For example, in the Winters field, the first replicate (red dots) had much lower yields than the other two (likely due to bindweed issues), regardless of planter type (Fig. 5).

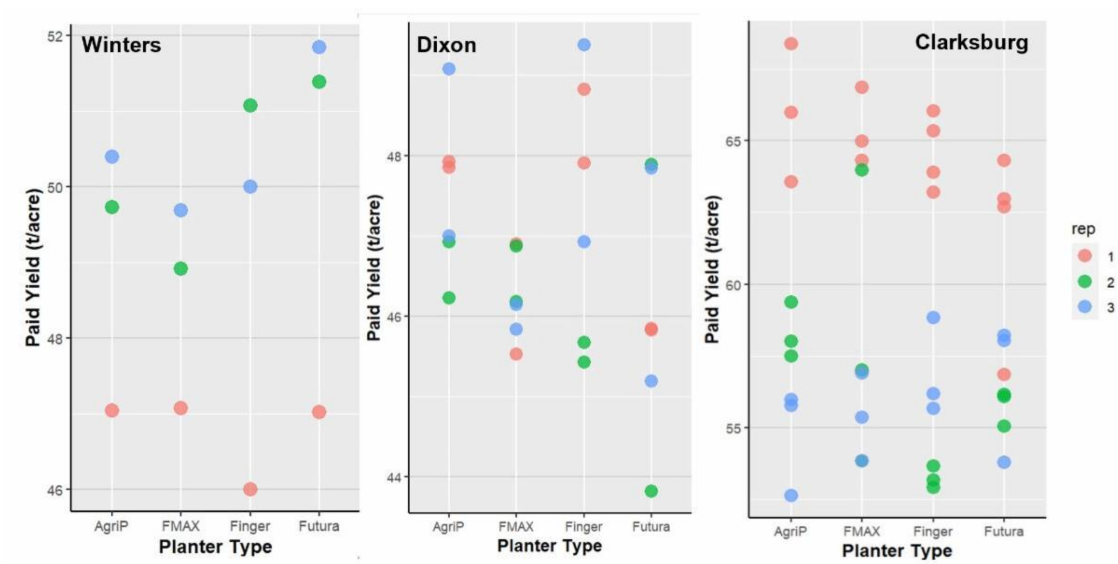

Figure 5. Yields for each planter, separated by replicate. Each dot represents a load (or the average of 2 or more loads, for the Winters site).

Table 2 Mean and standard deviation for yield and quality parameters from commercial harvest at each of the three fields. Each number is the average of at least three commercial cannery trailers

Field	Planter	Means								Standard deviation							
		Net yield t/a	*Paid yield* t/a	*Unpaid* %	*Greens* %	*Lim. use* %	*Solids*	*pH*	*Hue*	*Net yield*	*Paid yield*	*Unpaid*	*Greens*	*Lim. use*	*Solids*	*pH*	*Hue*
Winters	AgriP	49	49	0.7	0.50	0.83	5.42	4.43	21.67	1.72	1.77	0.38	0.25	0.52	0.03	0.06	0.38
	FMAX	49	49	1.9	1.11	0.61	5.46	4.44	22.22	1.53	1.34	1.28	0.67	0.35	0.13	0.05	0.25
	Finger	50	49	2.0	0.58	2.17	5.35	4.44	21.67	2.43	2.67	1.15	0.14	2.02	0.09	0.06	0.14
	Futura	50	50	0.6	0.17	1.58	5.52	4.45	20.83	2.49	2.66	0.52	0.14	1.66	0.13	0.08	1.04
Dixon	AgriP	50	48	5.0	3.25	0.58	5.63	4.29	19.08	1.16	1.00	1.12	0.82	0.38	0.05	0.06	0.38
	FMAX	49	46	5.5	3.50	1.00	5.73	4.29	19.58	0.71	0.55	0.51	0.63	1.14	0.29	0.06	0.38
	Finger	50	47	4.5	3.08	0.75	5.65	4.31	19.58	1.66	1.63	0.67	0.38	0.82	0.14	0.06	0.38
	Futura	48	46	5.0	3.58	0.25	5.75	4.29	19.58	1.17	1.57	0.98	1.16	0.61	0.08	0.02	0.38
Clarksburg	AgriP	63	60	5.3	3.28	0.06	4.59	4.28	22.28	4.49	5.20	2.16	2.00	0.17	0.14	0.04	0.87
	FMAX	65	60	7.9	5.17	0.20	4.53	4.28	21.87	4.64	5.26	2.73	1.35	0.35	0.15	0.05	0.47
	Finger	63	59	6.8	4.60	0.05	4.54	4.27	22.05	4.92	5.26	2.45	1.79	0.16	0.08	0.05	1.07
	Futura	63	58	7.8	5.00	0.10	4.62	4.25	22.05	3.55	3.64	1.63	0.88	0.32	0.10	0.03	0.50

IV. Conclusions and next steps

Trial results suggest that under a range of representative growing conditions for high-yielding processing tomato production in the southern Sacramento Valley, planter type is unlikely to influence fruit yield or quality. While the automated planters (especially the Agriplanter) have more frequent skips, they were small and rare enough that they didn't influence yields. However, while planting conditions were different in all three fields, it's important to note that:

1. Each machine was operated by a grower and planting crew experienced in its use
2. Apart from the high wind at the Dixon site, planting conditions were generally good (e.g. moderate temperatures, excellent bed prep, mostly good quality transplants and trays.)
3. All three fields were flat, did not have major differences in soil type or drainage, and did not have any complicating surface conditions such as stones or undecomposed biomass.

It's possible that some of the planters would be more affected than others by having less experienced operators or more challenging planting conditions. For example, growers who have worked with the Agriplanter for a couple years report that cracked trays or uneven plant heights pose special challenges for the planter's automation. As a next step, I'll be compiling a list of factors especially likely to affect the performance of each planter type, as well as a rough cost-benefit analysis. Stay tuned!

Want more info? Feel free to contact me (Patricia Lazicki; 530-219-5198; palazicki@ucanr.edu).

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