

Progress Report on UC Riverside Asparagus Breeding Program

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The overall objective of the breeding program at UC Riverside is to develop new asparagus cultivars for California that have higher yields of green, fresh market asparagus than existing cultivars. An emphasis is placed on high yields of export quality spears. The program involves development and identification of new parent clones; hybridization to produce new dioecious (mixed-sex) and all-male cultivars; and evaluation of these hybrids first in unreplicated trials, and later in replicated trials at several locations. The field research is supported by laboratory research which is aimed toward producing and identifying supermale clones to be used as parents of all-male cultivars, and toward developing genetic markers useful in cultivar identification, trait selection, and pathogen screening.

Field Research

Replicated Field Trials. These trials were established to evaluate the most promising advanced hybrids from the UCR breeding program compared with other cultivars currently available. In 2008 two replicated trials in Riverside were harvested three times per week, with collection of yield and grade records once per week. This year, for the third year, we collected daily harvest data from half of the replicates of five selected varieties from the trial planted in 2002. Except for those plots that were harvested daily, the data shown below are adjusted to a full harvest basis by multiplying observed yields by $7/2$ (for Friday harvests which reflects spears that reached harvestable size between Wednesday and Friday) or $7/3$ (for Monday harvests which reflects spears that reached harvestable size between Friday and Monday). This year, as opposed to last year, we collected the entire harvest (marketable and unmarketable) of both the 2002 and 2003 trials for the entire length of the season. However, data was collected in 2008 on only six of the top replicated lines and UC157 in the 2003 trial due to limited funding near the beginning of the harvest season. Also, in the 2002 trial data was not collected on any of the male lines or the hybrids from New Zealand due to continued poor performance of these varieties.

To identify promising new parent clones, an additional year of single plant spear production data was collected on 63 individual plants selected last year out of 1565 plants, based on three years of data for marketable spear production, cane diameter, branching height and vigor.

Grading Criteria. In all trials, spears were graded as marketable if they had reasonably tight heads, were relatively straight and unblemished. Export grade spears were defined as follows: Size - between 7/16" and 10/16" at the base of the spear; Head Tightness - very tight heads with smooth, closely appressed bracts; Color - all green, no white butt or excessive purpling of the base, bracts, or tip; Shape - spear tip should be uniformly tapered, not bulbous or extremely bent. Shaft should be straight and without blemishes. Spears which were marketable, but lacked a quality attribute essential for export grade were graded either as small domestic (3/16-10/16") or large domestic (>10/16"). The remainder of the small domestic spears which have somewhat looser heads, yet are still marketable, are classed as "Small Domestic. It is important to recognize that trial data will underestimate the proportion of marketable yield that will be

obtained in commercial planting because the trial data come from spears harvested 2 or 3 days after the previous harvest. This will increase the proportion of unmarketable spears in comparison with typical commercial harvests. As our comparative harvest regime (MWF vs daily) data on several lines has shown, hybrids having a high proportion of marketable or export spears in trials should also have a high proportion of marketable or export spears in commercial production.

2002 Replicated Trial. In 2002 a replicated trial was planted in Riverside. The trial consists of six replicate plots of 19 new experimental hybrids from UCR (six all-male hybrids and 13 dioecious hybrids), six replicate plots of each of three commercial varieties (UC157, Atlas, and Depaoli), three replicate plots of one experimental hybrid from UCR and five experimental hybrids which are part of an exchange agreement covering *Phytophthora* tolerant material from New Zealand. This trial also includes single plots of 26 new observation hybrids (five all-male hybrids and 21 dioecious hybrids). Most of the new experimental material in this trial has one parent that has a California/European (75%/25%) pedigree and has been selected over several years of observations based on individual plant yield, rust tolerance, and spear quality. This trial continues to have excellent stand and vigor. Data was not collected on any of the male lines or the hybrids from New Zealand due to continued poor performance of these varieties. Yields were collected from each plot for about 80 days, with the harvest being terminated up to ten days earlier for those lines that produced the earliest spears. This year, for the third time, we collected daily data on half of the replicates of five selected lines: Depaoli, UC157, F132 x MCE4, FCE1 x M256, and FCE2 x M256. The other three replicates of these lines were harvested as before: MWF harvest with data collected on Mondays only. The same regime as last year was continued: plots of the selected five lines in blocks 1, 3, and 5 were harvested according to a MWF schedule while plots in blocks 2, 4, and 6 were harvested according to a daily schedule. In the next section we looked at differences between the two methods of harvesting, but this year for the cumulative multi-year analysis we treated each line-harvest regime combination as a separate entry, with two entries for each of the five selected lines: MWF and daily (Table 1). It is important to keep in mind that these entries represent 3 plots worth of data rather than 6 plots as with the previous year's reports. However we felt it was important to present the data this way since it is evident that the harvest regime has a relatively large effect on the data. This is especially evident considering that there are large differences in ranking for the same line under different harvest regimes even though the first two years of cumulative data for all plots was collected under a MWF regime. All experimental lines with the exception of F609 x MCE4, F608 x MCE2, and F137 x MCE3 (and Atlas) had higher cumulative marketable yield than daily harvested UC157. Perhaps if these lines had been harvested daily as well their marketable yield would have exceeded that of daily UC157. All three of the daily harvested experimental lines and Depaoli had the highest marketable yield, with daily harvested F132 x MCE4 having significantly higher marketable yield than all other entries. Export yield for this line is also significantly higher than the rest of the entries. When harvested daily this line has almost twice the export yield of daily harvested DePaoli, comprising 62.4 percent of its marketable yield. 89% of its total yield is marketable. Marketable spear weight for this line is 14.1 g/spear – significantly smaller than UC157 (17.7 g/spear). Daily harvested FCE2 x M256 was ranked second, although total marketable yield was not significantly higher than third-ranked daily harvested DePaoli. Daily and MWF-harvested FCE1 x M256 follow DePaoli in ranking for marketable yield. Average marketable spear weight for daily harvested FCE1 x M256 is the largest of all the experimental lines tested, at 20.4 g/spear. One unreplicated line (F189 x MCE4 - MWF harvest) had an export

yield close to F132 x MCE4 under a MWF harvest regime (9921 lbs/acre). The percent of marketable yield for this line that was export quality (62.6) was higher than that of F132 x MCE4, daily harvest regime.

Comparison of daily harvest and MWF harvest, 2002 Replicated Trial. In order to determine how some of our promising experimental lines have responded to the increased cutting pressure of a daily harvest schedule we performed a daily harvest, collecting data daily as well, on half of the replicates (3/6) of five selected lines: Depaoli, UC157, F132 x MCE4, FCE1 x M256, and FCE2 x M256. The other three replicates of these lines were harvested as before: MWF harvest with data collected on Fridays only. The data for these latter replicates was corrected to simulate a daily harvest, multiplying by a factor of 7/2. To determine the effect of a MWF harvest versus a daily harvest in 2007 we compared line means for blocks 1, 3, and 5 (MWF harvest) with line means for blocks 2, 4, and 6 (daily harvest) (Table 2). Plots of most lines harvested daily had more than twice the marketable yield than those of the same lines harvested MWF, with the largest difference in yield of export-grade spears. As expected, percent marketable spears was higher for daily harvests. Spear weights were similar between harvest treatments of the same line with no significant difference between marketable spear weights. Because there were only three replicate plots of each line in each harvest treatment and the MWF harvest data extrapolate from M-only data collection, individual line responses are not measured very precisely and apparent differences should be interpreted cautiously. In 2005, when all plots were harvested on the MWF schedule, mean yields for the plots assigned to each harvest treatment were similar, so it seems likely that the higher yield of the plots harvested daily are caused by the harvest regime rather than condition of the plots before the daily harvest regime was initiated. Possibly the total weight of harvested spears was similar between treatments, but the MWF harvests had a much larger weight of discarded butt material (which we do not weigh). In 2006 the total number of spears harvested using the daily harvest schedule was about 1.22 times larger than that harvested using the MWF schedule.

We plan to continue this harvesting schedule for the same plots next year. It may also help us to better understand how our data from those plots harvested MWF correlates to a commercial harvest schedule. Please note that there were errors in the MWF Data for 2007 in the report for last year. In general, the total marketable yield as reported last year for all varieties was larger than the correct values. This was due to a correction that was applied in error to last year's data to make up for the limited data (first 60 days only) on unmarketable spears. The correct data is presented in Table 4. Since data for unmarketable yield was only collected during the first 60 days of harvest in 2007 the total yield and percent marketable yield reported for 2007 are based on only a portion of the harvest, therefore it is difficult to make comparisons between 2007 and other years for this data. In comparing years 2006 and 2007 for the MWF harvest regime (Tables 3 and 4) marketable yield increased for F132 x MCE4 and UC157 while it decreased for the other three lines. However in the daily regime over the same time period, marketable yield increased for all five lines. In comparing years 2007 and 2008 (Tables 4 and 5) marketable yield increased for all lines over both harvest regimes except UC157 where it decreased over the same time period. When comparing lines each year from 2006 to 2008 (Tables 3, 4, and 5) daily marketable yield has increased over MWF marketable yield for each line; In 2007 and 2008 all size categories for each line reflect this trend with the exception that during 2007 the MWF large domestic yield portion of marketable yield was greater than the daily large domestic yield for all five lines, with DePaoli showing the largest difference. If we compare average marketable spear weight over the years, there is not much difference between years or harvest regimes for any of the five lines from 2006 and 2007. In 2008 daily harvested

FCE1 x M256 was markedly higher than MWF-harvested FCE1 x M256 or the same line harvested in previous years under either harvest regime. We can see a similar jump in average marketable spear weight for FCE2 x M256 in 2008, although for this line spear size increased in both the MWF and daily harvest regimes in 2008 over the 2007 spear size. In 2008 large domestic yield increased for all five lines with FCE1 x M256 having the largest increase in this size category, although this increase was not enough to offset this line's low increase in total marketable yield as compared with the other lines. Both UC157 and FCE1 x M256 had a relatively smaller difference in yield between the daily and MWF harvest regime than that seen in the other three lines for years 2007 and 2008 (Tables 4 and 5). These two varieties also had the lowest increase in small domestic yield and export yield for 2007 and 2008 among the five lines tested. It may be that the MWF harvest schedule does not accurately measure the production potential of these other three lines. In order to get a more complete picture of production potential it may also be necessary to measure differences not only in the ability of the plant to produce under more frequent harvest pressure, but also its ability to produce over an extended harvest. A combination of these traits is what may make the difference between varieties that perform well and those that do not. We have attempted to answer some of these questions, but further research along these lines, in particular, determining how the length of the cutting season affects the performance of a variety may help to elucidate more yield differences among varieties.

2003 Trial. A trial was planted in 2003 to evaluate new hybrids including six replicate plots of 10 new experimental hybrids from UCR (one all-male hybrid and 9 dioecious hybrids) and six replicate plots of UC157 and DePaoli. This trial also includes single plots of six new all-male hybrids and 19 dioecious hybrids, each involving at least one parent that has a California/European (75%/25%) pedigree, and has been selected for high individual plant yield, rust tolerance, and spear quality. Stand and vigor remained excellent in 2007. Due to limited funding near the beginning of the harvest season data was collected in 2008 on only six of the top replicated lines and UC157. F582 x MCE4 produced the highest marketable yield as well as the highest export yield, followed by Depaoli, which had the highest small domestic yield. (Table 6). All of the top five experimental lines have California/European (75%/25%) selections as one of their parents and have significantly higher total marketable yield than UC157. Also, MCE1 and MCE4 (full siblings) seem to act as good male parents when crossed with F132 (see F132 x MCE4, Table 1). F600 x MCE1 and F132 x MCE1 are both higher than Depaoli for percent marketable yield. Two unreplicated lines, F189 x MCE2 and FCE8 x MCE4, had total marketable yield higher than the top two lines in the replicated portion of the trial. Three male lines with A1 as the male parent had higher marketable yield than UC157.

2007 Trial. A trial was planted in 2007 to evaluate new hybrids including six replicate plots of 22 new experimental hybrids from UCR (six replicate plots of UC157, Atlas, and DePaoli), and 42 unreplicated lines. All of the replicated and 22 of the unreplicated experimental hybrids have one parent with a California/European (75%/25%) pedigree that has been selected for high individual plant yield, rust tolerance, and spear quality. One of each of the parents of eight replicated and 31 unreplicated experimental lines in this trial derives from a new method of obtaining supermales through andromonoecious-male crossing, described in more detail in the Breeding section below. Of the nine potential-supermale parents used in this trial and derived from this method, three have been determined to be supermale through testcrossing and one appears to have a skewed segregation for sex with predominantly male progeny. These four

parents have fathered a total of nine varieties and are included in the unreplicated section of this new trial. At the time we designed this trial, no information was available on the supermale status of any of these new parents. Otherwise we would have included a few all-male lines in the replicated section as well. Stand in this trial continues to be excellent at close to 100%. A short harvest of this trial will begin in the Spring of 2009.

Breeding

This year's efforts in breeding have resulted in a large increase in potential new material for testing, particularly in material that can be used to develop all-male varieties. Most of the crosses we make are in a relatively insect-free greenhouse but not entirely insect-free. Therefore in most of our crosses it is generally understood that there is a small chance that the resulting plant is not from the intended cross. In 1994 we identified several male plants from European germplasm that produce almost exclusively bisexual flowers (andromonoecious) and we are studying the inheritance of this trait. This trait could be used to develop alternative breeding methods depending on how it is transmitted to progeny. In 2002 we were apparently successful at producing seed from a cross in which the andromonoecious plant served as the female in the cross. Some limited work using molecular markers appears to confirm the parentage of one resulting hybrid. In 2003, a set of similar crosses was performed using as the female parent an andromonoecious plant that shares half of its genes with a California-adapted female. The pollen parent in a new set of crosses with this hermaphrodite was M256 (the male parent of DePaoli). A total of 48 plants have been produced to date using M256 as the pollen parent in an andromonoecious-male cross; seven out of sixteen males from this type of cross have been determined to be supermale through testcrossing and one plant appears to have skewed segregation in one cross, with a predominance of male progeny. 80 plants have been produced in the same type of cross using MCE4 as the pollen parent. One hybrid individual from this cross has been determined to be highly andromonoecious as well as having a high branching height, which may indicate this plant carries genes for superior head tightness. The emasculated flowers from this plant have been pollinated with M256, resulting in 100 plants and with MCE4, resulting in 66 plants. Overall, we now have a total of 278 untested plants derived from an andromonoecious-male cross. On average, 1/4, or approximately 69, of these are expected to be supermale, producing only male progeny when crossed with any female. We also have 45 plants derived from selfing, whose parents derived from an andromonoecious-male cross. Two out of six selfing-derived plants were found to be supermale after testcrossing. Initial results indicate that this system is likely to make it easier produce large numbers of supermales that share the desirable traits of some of our most promising male parents. It is also evident from initial observations that this system can also result in undesirable levels of andromonoecy in certain crosses. If it proves successful, this new approach may also lead to new methods of analyzing individual traits. The 63 individual plants selected last year out of 1565 plants identified through single plant selection in the field over the past three years have all been initiated in tissue culture. 50 of these clones have rooted and 8 clones have been successfully transferred to the greenhouse for use as parents in further crosses. The mother plants of these clones continue to grow in the field. This year we continued data collection on these clones in the field. Next year we also plan to collect data from these clones to further characterize them for their use as potential parents.

Laboratory Research New information on asparagus DNA sequence is being examined to develop a marker that is more reliable and useful in a wide variety of crosses for distinguishing

males from supermales in asparagus plants. Significant progress has recently been made toward this goal by a new graduate student in our lab, and we hope to produce some candidate markers within the next month. This marker will help us to efficiently screen the many potential plants we have in the greenhouse to see if they are supermale.

Table 1. 2002 Riverside Trial. Cumulative production (2004-2008) for the replicated portion of the 2002-planted Riverside asparagus trial in Field 9A, ranked by total marketable yield. There are two entries, MWF and daily, for each of five selected lines, each consisting of three replicated plots. Entries labeled daily were harvested daily for the 2006, 2007, and 2008 harvest only. All other entries have six replicates and were harvested under a Monday-Wednesday-Friday harvest schedule.

Line	Marketable Yield		Sm Domestic Yield lbs/ac	Lg Domestic Yield lbs/ac	Export Yield		Marketable Spear Wt. g/spear
	lbs/ac	%**			lbs/ac	% of mkt	
F132 x MCE4 DAILY*	31995	87.9	11396	2830	20132	62.4	14.1
FCE2 x M256 DAILY*	25456	78.0	9253	4606	13222	51.8	17.8
DePaoli DAILY*	23515	70.2	11145	3323	10614	44.6	15.7
FCE1 x M256 DAILY*	22965	76.9	5576	7933	10787	46.8	20.4
FCE1 x M256 MWF*	17009	68.1	5702	4103	8747	51.5	18.7
F132 x MCE4 MWF *	16472	67.7	7057	905	10052	61.0	13.1
FCE4 x M256	16322	64.8	6106	2839	9012	55.3	17.4
DePaoli MWF *	16141	65.5	6947	2280	8191	51.0	16.9
FCE2 x M256 MWF *	15200	63.5	5623	3974	6874	44.9	19.4
F600 x MCE4	15121	64.0	7184	1095	8024	52.8	14.2
FCE7 x M256	14617	61.1	6121	3596	6089	41.8	17.3
FCE6 x M256	14602	65.0	6478	2343	7573	51.8	15.4
UC157 DAILY*	11702	55.6	6687	1948	3727	31.5	17.7
F609 x MCE4	11309	64.2	5159	1088	5891	51.4	15.0
F608 x MCE2	10484	56.7	5242	2598	3737	35.1	18.6
F137 x MCE3	9344	47.8	4542	2547	2858	30.4	19.9
Atlas	8813	39.3	4116	4002	1732	18.1	23.8
UC157 MWF *	6988	46.9	3944	1828	1881	27.0	17.2
LSD (0.05)	4183	7.7	1165	2108	2766	8.7	2.6

*Data from three replicated plots

** Represents cumulative data from entire harvest for 2004-2006, the first 60 days of the 2007 harvest and the full 2008 harvest.

Table 2. Daily vs MWF Harvest on Selected Varieties, 2002 Riverside Trial. Mean yield, grade, and spear size data of the cumulative 2006-2008 harvest from three replicate plots of five selected varieties that were harvested daily compared with three plots harvested on Mondays Wednesdays, and Fridays.

	Line	Total Yield (lbs/ac)	Total Marketable Yield		Small Dom. Yield (lbs/ac)	Large Dom. Yield (lbs/ac)	Export Yield (lbs/ac)	Number marketable spears		Avg. Wt. Mkt. Spears (g/spear)
			(lbs/ac)	(%)*				#/acre	(%)	
MWF	F132 x MCE4	15258	9403	61.4	4965	498	5501	299961	46.4	12.3
	FCE1 x M256	15297	9180	60.2	3909	1875	4945	219871	44.4	16.2
	FCE2 x M256	15013	8537	57	4048	1638	4135	194983	45.1	17.6
	DePaoli	15037	8411	56.1	4896	699	4100	229628	45.5	14.6
	UC157	9031	3183	36.4	2212	698	947	69928	17.9	15
	Mean	13927	7743	54	4006	1082	3926	202874	39.9	15
Daily	F132 x MCE4	25301	22417	88.6	9285	1107	14399	728863	77.3	12.6
	FCE2 x M256	23165	18430	78.8	7297	2809	9959	440008	63.3	16.9
	DePaoli	23936	17210	71.3	8572	2118	8107	459495	56.2	15.1
	FCE1 x M256	20305	16138	78.9	4360	5370	7748	345788	60.6	19.3
	UC157	14947	8345	55.8	4870	1337	2803	188904	32.4	16.9
	Mean	21531	16508	75	6877	2548	8603	432612	58.0	16
	LSD (0.05)	4674	4744	10.9	964	1809	3522	109714	9.6	2.3

* Represents cumulative data from entire harvest for 2006, the first 60 days of the 2007 harvest and the entire harvest for 2008.

Table 3. Daily vs MWF Harvest on Selected Varieties, 2002 Riverside Trial. Mean yield, grade, and spear size data of the 2006 harvest from three replicate plots of five selected varieties that were harvested daily compared with three plots harvested three days per week.

	Line	Total Yield (lbs/ac)	Total Marketable Yield		Small Dom. Yield (lbs/ac)	Large Dom. Yield (lbs/ac)	Export Yield		Wt. Mkt. Spears (g/spear)
			(lbs/ac)	(%)			(lbs/ac)	(%)	
MWF	FCE1 x M256	5307	3701	69.4	1379	671	1652	44.9	18.8
	DePaoli	4745	3335	70.4	1585	50	1700	50.4	15.8
	FCE2 x M256	4533	3024	66.9	1286	330	1408	46.6	18.5
	F132 x MCE4	4011	2988	74.6	1272	164	1551	52.0	14.1
	UC157	2806	1317	50.9	544	79	333	27.7	24.4
	Mean	4280	2873	66.4	1213	259	1329	44.3	18.3
Daily	F132 x MCE4	6455	6138	94.9	2219	213	3382	55.1	14.4
	DePaoli	6245	5406	86.3	1979	369	2480	44.3	17.8
	FCE2 x M256	5592	4818	85.7	1414	386	2632	53.9	18.7
	FCE1 x M256	5354	4740	87.2	1005	1253	2185	46.2	21.1
	UC157	4199	3134	74.5	1095	240	1068	32.5	24.9
	Mean	5569	4847	85.7	1542	492	2349	46.4	19.4
	LSD (0.05)	1815	1598	12.2	506	504	1115	15.7	3.1

Table 4. Daily vs MWF Harvest on Selected Varieties, 2002 Riverside Trial. Mean yield, grade, and spear size data of the 2007 harvest from three replicate plots of five selected varieties that were harvested daily compared with three plots harvested three days per week.

	Line	Total Yield	Total Marketable Yield		Small Dom. Yield	Large Dom. Yield	Export Yield		Wt. Mkt. Spears
		(1 st 60 days) (lbs/ac)*	(lbs/ac)	(%)*	(lbs/ac)	(lbs/ac)	(lbs/ac)	(%)	(g/spear)
MWF	F132 x MCE4	2513	3530	77.6	1590	358	1749	48.5	14.2
	FCE1 x M256	2097	3088	73.2	1006	638	1711	56.0	17.9
	FCE2 x M256	2169	2901	74.1	1311	662	1157	39.7	18.9
	DePaoli	1925	2430	59.8	1345	1376	979	40.0	15.7
	UC157	1283	1620	47.8	1004	422	355	23.0	17.7
	Mean	1997	2714	66.5	1251	691	1190	41.4	16.9
	LSD (0.05)	1500	2012	17.2	458	567	1464	14.4	3.4
Daily	F132 x MCE4	6623	8581	88.9	3439	191	4785	54.8	13.6
	FCE2 x M256	6366	7007	77.7	3077	371	3292	45.8	16.5
	DePaoli	5686	6365	73.3	3066	433	2638	40.9	15.8
	FCE1 x M256	4927	5593	78.7	1651	106	2566	45.1	18.8
	UC157	3548	3425	57.6	2145	261	857	24.9	17.0
	Mean	5430	6194	75.2	2676	272	2828	42.3	16.3
	LSD (0.05)	1500	2012	17.2	458	567	1464	14.4	3.4

* Represents data from only the first 60 days of the 2007 harvest.

Table 5. Daily vs MWF Harvest on Selected Varieties, 2002 Riverside Trial. Mean yield, grade, and spear size data of the 2008 harvest from three replicate plots of five selected varieties that were harvested daily compared with three plots harvested three days per week.

	Line	Total Yield	Total Marketable Yield		Small Dom. Yield	Large Dom. Yield	Export Yield		Wt. Mkt. Spears
		(lbs/ac)	(lbs/ac)	(%)	(lbs/ac)	(lbs/ac)	(lbs/ac)	(%)	(g/spear)
MWF	F132 x MCE4	8734	4446	50.1	2103	142	2201	48.0	14.4
	FCE1 x M256	7893	3939	49.8	1525	833	1582	40.4	19.8
	Depaoli	8367	3931	47.3	1966	543	1421	35.9	18.6
	FCE2 x M256	8312	3895	47.2	1451	875	1570	40.5	22.9
	UC157	4942	1282	25.8	664	358	260	20.7	18.8
	Mean	7650	3499	44.0	1542	550	1407	37.1	18.9
	LSD (0.05)	2301	2323	12.9	635	1170	1322	14.7	3.7
Daily	F132 x MCE4	12223	10397	85.1	3627	536	6233	59.8	14.2
	FCE2 x M256	11207	8626	76.2	2806	1785	4035	46.7	21.1
	DePaoli	12005	7605	62.5	3528	1087	2990	38.8	17.7
	FCE1 x M256	10024	7444	74.4	1705	2742	2998	40.6	23.3
	UC157	7199	3183	43.4	1630	675	878	27.5	19.1
	Mean	10532	7451	68.3	2659	1365	3427	42.7	19.1
	LSD (0.05)	2301	2323	12.9	635	1170	1322	14.7	3.7

Table 6. 2003 Riverside Trial. Cumulative production (2005-2008) for the replicated portion of the 2003-planted Riverside asparagus trial in Field 9B.

Line	Marketable Yield		Sm Domestic Yield	Lg Domestic Yield	Export Yield		Marketable Spear Wt.
	lbs/ac	%*	lbs/ac*	lbs/ac*	lbs/ac	% of mkt	g/spear
F582 x MCE4	16118	60.0	6010	600	5419	33.5	14.5
DePaoli	14483	64.7	6099	890	4908	33.4	15.2
F600 x MCE1	12973	68.5	5041	411	4688	35.1	13.4
F132 x MCE1	12627	67.6	5252	230	4593	36.1	12.8
F133 x MCE2	11959	57.4	4085	1369	3367	28.0	18.1
FCE3 x M256	11931	69.0	4228	1139	4225	35.0	16.0
UC 157	8019	48.8	3646	682	1902	23.4	16.4
LSD (0.05)	2615	7.0	684	611	1413	5.9	2.2

* Represents cumulative data from entire harvest for 2005, 2006, the first 60 days of the 2007 harvest and the entire 2008 harvest.

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Executive Summary. In order to develop new, more productive asparagus cultivars for California, new cultivars were developed by hybridization and selection and evaluated in a series of field trials. In 2008, new and existing cultivars were compared in 1.9 ac of field trials planted in Riverside in 2002, and 2003. In the 2002 trial, ten experimental lines, DePaoli, and Atlas, had higher cumulative 2004+2005+2006+2007+2008 marketable yield than UC 157. All of these lines have a California x European backcross plant as one parent, and several have high percentages of export yield and moderate spear sizes. This material appears quite promising. In the 2005+2006+2007+2008 cumulative harvest of the 2003 trial F582 x MCE4 had the highest marketable yield followed by DePaoli, and four other lines with a California x European backcross plant as one parent. Three male lines, each having A1 as their male parent, also had higher marketable yield than UC157. Some progress was made toward further development of a marker to predict sex of asparagus plants. Research and crossing was continued on developing new hybrids using new male-andromonoecious crosses to develop improved supermale parents.