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California Strawberry Cultivars

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In recent years, California has continued to dominate U.S. commercial strawberry production as it has done since the release of the first "University of California" cultivars ('Shasta' and 'Lassen') by Thomas and Goldsmith in 1945 (Table 1). This has included the processed as well as the fresh market fruit. The percentage of each varies considerably from year to year depending on the price. In 1986, 23% of the California crop went to the freezer in contrast to about 28% of the 1987 harvest. For the 1977-86 decade the freezer average was about 30%. The dual market is important to California growers but no California grower depends upon the processing market as their only outlet as has been the case in neighboring Oregon and Washington.

Table 1. Post-World War II strawberry area and production of west-coast states compared as percentages of U.S. totals.

	California		Oregon		Washington		West Totals	
Period	Area	Crop	Area	Crop	Area	Crop	Area	Crop
1951-60 avg.	12	36	14	13	7	9	33	59
1966	12	38	19	21	8	8	39	67
1967	13	44	21	19	9	6	43	69
1968	15	55	20	13	9	7	44	75
1969	16	55	22	14	8	5	46	74
1970	17	58	23	14	8	6	48	78
1971	16	58	22	16	8	5	46	79
1972	18	62	20	12	9	5	47	79
1973	20	67	19	10	9	5	44	82
1974	22	72	18	8	9	4	49	84
1975	26	40	16	8	9	4	51	82
1976	32	74	15	8	10	4	57	86
1966-76 avg.	19	59	19	13	8	5	46	77
1977	34	80	15	5	10	3	59	88
1978	38	79	14	5	9	3	61	87
1979	34	76	15	7	9	3	58	86
1980	29	75	16	7	9	2	54	84
1981	29	74	14	7	7	2	50	83
1982	28	72	14	7	7	2	49	81
1983	28	70	16	9	7	2	51	81
1984	31	76	15	6	7	2	53	84
1985	32	76	15	5	7	2	54	83
1986	35	77	16	6	6	1	57	84
1977-86 avg.	32	75	15	6	8	2	55	83

Source: Federal-State Market News Service.

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Increased production per unit area occurred in all commercially important states during the past decade except for Washington where it actually dropped and the increases have been particularly large in Florida and California (Table 2; 57% and 39%, respectively). The introduction of superior, higher yielding cultivars in California has accounted for about 50% of the increase and improved cultural practices the rest. It is important to note that the California cultivars are used almost exclusively in Florida and that their introduction and use in Florida coincided with the relatively large increase in yield per hectare shown in Table 2.

Table 2. Average yield in metric tons/ hectare of commercially important strawberry states.

Period	Calif.	Fla.	Ore.	Wash.	Mich.
1951-60 avg.	14.8	—	4.7	5.3	3.9
1966	25.5	10.1	8.5	7.6	4.0
1967	29.1	9.9	7.6	8.2	4.7
1968	37.6	9.0	6.7	8.1	4.9
1969	35.8	11.2	6.5	6.7	6.5
1970	38.1	9.0	6.9	8.1	4.9
1971	40.7	10.7	8.3	7.2	4.9
1972	41.0	14.1	7.2	7.2	6.0
1973	44.3	15.2	6.9	6.7	4.9
1974	48.2	15.2	6.5	7.2	4.5
1975	42.6	18.6	7.6	7.6	6.3
1976	43.7	16.8	10.1	8.7	6.7
1966-76 avg.	38.8	12.7	7.5	7.5	5.3
1977	50.4	16.3	7.4	6.9	6.0
1978	42.1	16.3	7.6	6.0	4.5
1979	45.9	17.9	9.2	5.8	6.0
1980	52.2	21.3	10.1	6.7	6.0
1981	55.3	23.5	10.7	6.7	7.6
1982	61.4	21.7	11.2	6.9	9.0
1983	56.9	21.3	13.0	6.9	6.7
1984	59.8	19.0	10.3	7.8	7.8
1985	59.4	22.4	8.3	7.8	7.2
1986	56.0	20.6	9.6	5.6	6.7
1977-86 avg.	53.9	20.0	9.7	6.7	6.7

Source: Federal-State Market News Service.

In the ten years since the last review of the strawberry cultivars grown in California (*Fruit Varieties Journal* 33 No. 2:45-48, 1978), there has been a complete change and the two most important cultivars then grown in California 'Tioga' and 'Tufts' (51% and 19% of the hectareage, respectively in 1978) are not grown at all (Tables 3 & 4).

'TIOGA'—'Tioga' (released in 1964), long the dominant cultivar of California statewide, was replaced first by 'Tufts' and 'Aiko' (released in 1972 and 75, respectively) and finally by 'Douglas' and 'Pajaro' (both released in 1979). 'Tioga' had too short a harvest season, was deficient in fruit size particularly as the season advanced and it was also somewhat difficult to pick for the fresh market because the fruit tended to "cap" too easily and came off without the calyx. This was fine for processing but not for fresh harvest.

'TUFTS'—'Tufts' was superior to 'Tioga' in most of the traits noted above and was particularly useful in winter plantings in southern California. The fruit was large, firm and particularly attractive, and was easy to harvest. However, the early fruit tended to be malformed due to incomplete pollination, probably as a result of poor pollen production early in the season.

Relatively short commercial life of 'Tufts' (12 years) did not result primarily from the above deficiencies since its prime production pattern was very complementary to that of 'Tioga.' Rather, 'Tufts' was discarded because of affliction with moderately severe "June Yellows." Early in the season, the plants became chronically yellow (not variegated or striped). Fortunately, we obtained some normal green 'Tufts' plants and increase them side-by-side with the yellow plants in a high elevation nursery at MacDoel during 1986 and compared them in adjacent winter plantings at the Watsonville Research Facility and the South Coast Field Station during 1987. The results

Table 3. Cultivar, year of release and % of California hectarage.

Year	Shasta '45	Fresno '61	Tioga '64	Tufts '72	Aiko '75	Douglas '79	Pajaro '79	Chandler '83	Selva '83	Parker '83	Others
1971	20	19	43	-	-	-	-	-	-	-	18
72	17	15	53	-	-	-	-	-	-	-	15
73	6	13	61	?	-	-	-	-	-	-	20
74	?	11	63	?	-	-	-	-	-	-	26
75	0	9	60	?	-	-	-	-	-	-	31
76	0	6	61	?	-	-	-	-	-	-	33
77	0	?	59	18	?	-	-	-	-	-	23
78	0	?	51	19	?	-	-	-	-	-	30
79	0	?	40	30	?	-	-	-	-	-	30
80	0	?	26	28	?	?	?	-	-	-	46
81	0	?	10	34	21	15	5	-	-	-	15
82	0	?	?	29	18	27	9	-	-	-	17
83	0	0	?	8	16	46	13	-	-	-	17
84	0	0	?	?	13	48	14	3	?	3	19
85	0	0	0	0	9	52	13	7	?	3	16
86	0	0	0	0	4	41	19	16	'7	?	13
87	0	0	0	0	2	22	17	24	10	?	25
88	0	0	0	0	?	16	16	38	17	?	13

at the two locations were essentially identical and only those for the Watsonville Facility are presented in Table 5. Except for the color difference, the plants and fruits were identical in appearance and the electrophoretic profile. However, the devastating effect of the malady was obvious over the two planting dates with an 85% and 69% reduction in total yield over the two dates, respectively. There is no question as to the cause of the loss of 'Tufts' as a productive cultivar.

Table 4. Comparing the most important University of California strawberry cultivars by periods & areas of usefulness.

Cultivar	Release	Use period	Years	Areas
Lassen	1945	45-64	19	So. coast
Shasta	1945	45-74	26	Cent. coast
Fresno	1961	61-78	17	Cent. coast
Tioga	1964	64-84	20	Statewide
Tufts	1972	72-84	12	Statewide
Aiko	1975	75-88	13	Cent. coast
Douglas	1979	79-	?	So. coast
Pajaro	1979	79-	?	Cent. coast
Chandler	1983	83-	?	Statewide
Selva*	1983	83-	?	Cent. coast

*First successful day-neutral.

'AIKO'—The 'Aiko' variety (released in 1975) was unique among the University cultivars at the time of its release because of the ability to repetitively fruit throughout the summer in the cool environment of the central coast. It is not a day-neutral type since it does not initiate flower buds under nursery conditions as is the case with 'Selva' which is a true day-neutral. 'Aiko' along with 'Tufts' replaced the remaining 'Tioga' hectareage and was confined to summer planting (long-term cold stored plants usually set out in late August or early September, characterized by high production over a longer period of time than winter plantings).

'Aiko' has several serious problems, the most important of which was the tendency to produce malformed fruit of small size with concurrent high cost of harvest and lower market value, particularly during the early part of the season. 'Aiko' was last grown in significant quantity during 1986-87 and has been replaced by day-neutral 'Selva,' released in 1983.

It should be noted that 'Soquel,' an 'Aiko' hybrid with very similar charac-

Table 5. Comparing the 1987 yield and fruit size of normal green plants of *'Tufts'* (green) with that of "June Yellows" plants (yellow) dug from a high elevation (MacDoel) nursery and planted over 2 dates at Watsonville.

Stock	Planted	G/Plant by 6 wks ending: 4/20	6/4	7/13	8/24	10/5	Total Yield G/pl	S.D.	Size G/fr
Green	Oct. 22	211	512	195	179	46	1146	83	16.6
Yellow	"	153	235	90	113	27	620	132	16.1
% Gain	(G/Y)	38	118	117	58	70	85		3
Green	Nov. 4	179	836	320	159	42	1538	48	19.0
Yellow	"	122	503	146	116	20	910	139	18.8
% Gain	(G/Y)	47	66	119	37	110	69		1

*2 row, 130 cm bed, 35.6 cm spacing = 42,584 pl/hectare.

teristics but smoother and larger, was released in 1983 with 'Selva' but has failed to compete favorably with 'Selva.'

'DOUGLAS'—In the aforementioned Fruit Varieties paper, *C51* was discussed as a promising new selection and data were presented showing that it was particularly early, large-fruited and high yielding. C51 was named 'Douglas' and released in 1979 and has been useful ever since, predominating as the principal south coastal cultivar in winter plantings until the rise of 'Chandler,' released in 1983.

In a manner of speaking the success of 'Douglas' (52% of the total acreage of California in 1985) was its own undoing. The early fruit was of excellent quality and commanded high prices. The problems developed as the harvest season advanced and because the fruit of 'Douglas' was softer and didn't ship as well and was seedier in appearance than competitive fruit from the California central coast, 'Douglas' fruit was diverted to processing early. Consequently by 1984 almost two-thirds of the freezer pack was 'Douglas,' although flavor and color of frozen 'Douglas' was about equal to those of other cultivars, the product was faulted because it lacked "character" and had low drained weight. 'Chandler' has now replaced most of the 'Douglas' acreage because of the superiority of the fresh and processed fruit and because of higher yield even though it is not as early as 'Douglas.'

At this point, the direct linear descent of succeeding cultivars should be noted. 'Lassen' the original cultivar adapted to south coastal growing conditions was one parent of 'Tioga' which replaced it; 'Tioga' was one of the parents of 'Tufts' which largely replaced it; 'Tufts' was one of the parents of 'Douglas' which replaced it and

Table 6. Comparing 1987 harvest from high and low elevation plants of 3 standard, short-day type cultivars in winter plantings at Watsonville.

Cultivar	High Elevation (MacDoel) plants dug 15 Oct., planted Nov. 4° G/plant by periods ending: 4/20	6/4	7/13	8/24	Total Yield G/pl	S.D.	Size G/fr
Chandler	371	987	426	373	2015	125	22.2
Douglas	138	841	300	214	1495	15	19.7
Oso Grande	154	787	276	215	1435	161	23.2
	Low Elevation (WEO) plants dug Nov. 5, planted Nov. 12°						
Oso Grande	142	880	535	142	1701	68	24.6
Chandler	164	895	455	45	1560	26	23.2
Douglas	215	672	350	93	1333	20	21.0

*2 row, 132 cm bed, plants spaced at 36 cm = 42565 pl/hectare.

Table 7. Comparing three standard, short-day type cultivars over two years of time of summer planting.

	1986 harvest, summer planting Watsonville						
	G/plant by periods ending:				Total Yield		Size
Planted*	5/5	6/18	7/29	8/18	G/pl	S.D.	G/fr
Oso Grande							
Sept. 11	606	1285	627	125	2645	327	26.8
" 25	157	1108	863	126	2255	262	27.1
Chandler							
Sept. 11	351	1346	644	156	2498	204	22.5
" 25	162	1065	744	128	2100	306	24.9
Pajaro							
Sept. 11	359	881	621	111	1973	66	24.4
" 25	208	763	652	65	1690	89	23.8

*2 row, 132 cm beds, plants spaced at 38 cm = 39727 pl/hectare.

	1987 harvest, summer planting Watsonville						
	G/plant by periods ending:				Total Yield		Size
Planted*	5/6	6/17	7/29	8/16	G/pl	S.D.	G/fr
Chandler							
Sept. 3	436	917	576	297	2227	255	16.5
Sept. 16	174	1075	513	256	2020	307	17.8
Oct. 1	9	825	501	212	1548	18	23.5
Oso Grande							
Sept. 3	500	638	241	177	1559	49	20.5
" 16	189	737	306	154	1388	155	21.5
Oct. 1	2	452	313	148	918	239	21.9
Pajaro							
Sept. 3	423	621	300	202	1548	85	18.8
" 16	245	616	338	181	1382	170	22.3
Oct. 1	144	605	406	192	1348	2	19.2

**2 row, 132 cm bed, plants spaced at 40 cm = 37243 pl/hectare.

'Douglas' was one of the parents of 'Chandler' which is replacing it. In each case, the replacement cultivar has carried the major genes for adaptation plus target genes conditioning improvement in other traits, a typical "backcross" type breeding strategy.

'PAJARO'—A second "promising" selection (C45) was also emphasized in the Fruit Varieties paper and was subsequently named 'Pajaro' at its release in 1979. As shown in Tables 3 and 4, since its acceptance by Califronia growers at the beginning of the 1980's 'Pajaro' has been consistently popular with central coast growers. While it does not yield enough under the winter planting system it is very successful under the summer system. The fruit is of high dessert quality, large, symmetrical, attractive and firm. While it is very satisfactory for processing most of it is marketed fresh because of steady demand. The fruit is quite susceptible to physical damage from rain, but since most of it is harvested during the dry season in California, cullage is generally very low. It is likely to remain popular for sometime to come.

'CHANDLER'—Currently occupying about 38% of the California strawberry area, 'Chandler' (released in 1983) as shown in Tables 3 and 4 is now the most popular cultivar in California. The fruit is of exceptionally high dessert quality with outstanding color, flavor and character. 'Chandler' fruit is quite resistant to physical damage from rain. While most of it is grown in the Santa Maria area and the south coastal

Table 8. Comparing 1987 harvest from low elevation plants of 3 day-neutral cultivars in winter plantings at Watsonville.

Dug	Planted*	G/plant by periods ending: 4/20	6/4	7/13	8/24	10/5	Total Yield G/pl	S.D.	Size G/fr
Selva									
Nov. 7	Dec. 10	221	386	390	355	97	1452	15	20.2
Nov. 25	Dec. 23	106	290	273	376	156	1204	53	17.5
Dec. 12	Jan. 6	95	213	423	421	160	1316	60	19.2
Muir									
Nov. 7	Dec. 10	110	383	415	431	203	1545	35	20.2
Nov. 25	Dec. 23	58	311	426	533	258	1588	245	17.8
Dec. 12	Jan. 6	33	241	363	567	302	1509	38	20.9
Fern									
Nov. 7	Dec. 10	147	435	537	391	185	1699	17	18.7
Nov. 25	Dec. 23	88	232	483	508	287	1601	51	16.2
Dec. 12	Jan. 6	72	131	531	506	203	1446	327	17.4

*2 row, 132 cm bed, plants spaced at 36 cm = 42565 pl/hectare.

counties under the winter system it is gaining in popularity in the central coast area where the early fruit is superior to that from 'Pajaro' harvested at the same time. It is likely to remain popular for sometime because of the characteristics mentioned above and high yield.

'SELVA'—The first true University bred day-neutral type cultivar to become important commercially in California is 'Selva,' released in 1983. As noted 'Selva' quickly replaced 'Aiko' in the central coast as a summer cropping cultivar. It has the capability of producing off-season fruit generally, as well as high yield during the main harvest period of May in California. The fruit is characteristically large, firm, conic to blocky. The early crop does not have as good a dessert quality as the later crop generally, particularly if it is not harvested when fully ripe. It handles and ships particularly well.

'Selva' is different from most day-neutral and/or everbearing types in that it will consistently produce large fruit even when the plants are relatively small and it makes adequate numbers of runners in the nursery. Only the mother plants and first daughter plants tend to flower in a nursery situation.

The day-neutral trait of 'Selva' is inherited as a simple dominant and originated from a *Fragaria virginiana* glauca plant from Utah as a fourth backcross derivative from the original hybrid (Shasta x *F. virginiana* g.)

OTHER CULTIVARS—Much of the "other" cultivars have been private varieties of the Driscoll Associates, Watsonville. The principal one over the years has been the excellent 'Heidi' (= G3). Recently, there have been significant changes in what they grow and there are likely to be more in the future.

The "?" in Table 3 designates what much of the unspecified acreage was. In addition there has been significant usage of minor UC cultivars such as 'Torrey' (contemporary with 'Fresno'), 'Sequoia' (1968 release), 'Toro' (used quite extensively as an early cultivar until the release of 'Douglas'), 'Brighton' (first day-neutral group 1979), 'Soquel' (1983) and 'Fern' (a 1983 day-neutral).

SHORT-DAY TYPE PROSPECTS—'Oso Grande' a standard short-day type was released in 1987 as a possible supplemental cultivar to 'Chandler,' 'Douglas' and 'Pajaro' for potential use in winter and summer plantings. Table 6 presents data for winter planting at

Table 9. Comparing 1987 harvest from 3 day-neutral cultivars in time of summer planting at Watsonville.

Planted°	G/plant by periods ending: 5/6	6/17	7/29	8/16	Total Yield G/pl	S.D.	Size G/fr
Selva							
Sept. 3	568	356	207	208	1404	317	17.1
" 16	538	645	394	296	1876	173	20.8
Oct. 1	417	522	266	219	1425	287	22.1
" 15	260	619	399	268	1548	617	21.8
Muir							
Sept. 3	521	510	409	282	1705	121	17.2
" 16	584	544	277	280	1687	9	18.9
Oct. 1	359	596	332	232	1521	26	22.3
" 15	247	604	336	227	1416	23	21.0
Fern							
Sept. 3	513	85	489	439	1528	156	12.6
" 16	552	134	483	346	1518	229	13.1
Oct. 1	533	230	343	266	1374	182	15.4
" 15	382	453	230	200	1267	14	18.9

°2 row, 132 cm bed, plants spaced at 40 cm = 37243 pl/hectare.

Watsonville for high elevation (top) and low elevation (bottom) nursery plants. Table 7 presents data for summer plantings at Watsonville for 1986 harvest (top) and 1987 harvest (bottom). From these data we conclude that 'Oso Grande' may yield as much or more than 'Chandler' in both plantings and that the fruit is likely to be larger. We also conclude that 'Oso Grande' may be less flexible as to planting dates than 'Chandler' or 'Pajaro' in summer plantings. 'Oso Grande' fruit is at least as firm as that of 'Pajaro,' and firmer than that of 'Douglas' or 'Chandler' (data not shown).

DAY-NEUTRAL TYPE PROSPECTS—Three day-neutral cultivars were released in 1987; *'Muir,' 'Mrak'* and *'Yolo.'* Data for 'Muir' are compared with those for 'Selva' and 'Fern' in relatively late winter plantings (Table 8) and summer planting (Table 9). 'Mrak' and 'Yolo' are omitted because they are similar to 'Fern' and there is more interest in 'Fern' at present. 'Muir' is included because it is a sister to 'Selva' with considerable interest in its potentiality.

In both the winter and summer plantings 'Muir' behaved similarly to Selva except that 'Selva' was earlier. The patterns of production change as the plantings go in later and the cycles occur in sequences that are similar in nature but not in timing. This affords an opportunity to stagger the production of quality fruit so that some is available at all times using selected day-neutrals.

SUMMARY—For southern California, there is a need for short-day type of cultivars as early or earlier than 'Douglas' with fruit equal to the best in flavor, firmness, and general quality while maintaining high yield.

For the central coast there is a need for improved summer cropping cultivars equal to the best in flavor, firmness and general quality with high yield.

Some of the answers to certain problems including the above will be found as better day-neutral types are devel-

oped and more information is obtained on how to program them for optimum exploitation.

In general, more attention in breeding cultivars will have to be given to disease and pest reaction.

The prospects are still bright for a strong California strawberry industry continuing to flourish even as much of the prime area where strawberries have traditionally been grown is lost to urban developments.

NOTE: All University of California cultivars are now patented or patents are pending. For information regarding this please contact:

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Pacific Northwest Strawberry Cultivars

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The commercial strawberry industry of the Pacific Northwest is found west of the Cascades and from southwestern British Columbia on the north, to Salem, Oregon on the south. There are distinct climatic differences in the region that have some effects on cultivar performance, such as: 1) colder winters in southwest British Columbia and northwest Washington, 2) warmer harvest temperatures in southwest Washington and Oregon and 3) more late spring frosts in Oregon. Although these differences in seasonal harvest and cultivar adaptability exist, the region is considered a single entity for strawberry production for the processing market.

The production acreage has fluctuated over the past 20 years, but has gradually increased during the last 10 years from about 10,000 acres to nearly 14,000 acres in 1987 (2). The crop is nearly 90% for the processing industry and production has increased from less than 100 million lbs in 1979 to about 150 million lbs in 1987 (2). Smaller acreages for local fresh fruit or "U-pick" operations may be found in eastern Washington and Oregon in areas such as Walla Walla, WA or Milton-Freewater, OR, and in central and southern Oregon.

A very limited number of cultivars have dominated the industry for many years. 'Marshall' was the single most important cultivar until the 1950's when it was replaced by the cultivar, 'Northwest.'

'Northwest' was more virus tolerant, had high yields under irrigation in the valley and the berry was superior in the marketing of a sliced frozen product. The release of 'Hood' by the USDA and Oregon State University (USDA OSU) in 1965 was an important step because this cultivar was easier to harvest and could be made into a "non-browning" preserve, two important characters lacking in the cultivar 'Northwest.'

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