A Comparison of American and European Strawberry Cultivars and Selections in the Po Valley, Italy

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Abstract

Twenty-four strawberry cultivars and selections that had originated at 11 widely separated places were compared in the Po Valley at Cesena, Italy. 'Vesper', 'Pocahontas', 'Tardiva di Romagna', 'Tioga', 'MdUS 3816', 'Aliso', 'Shuksan', and 'Sequoia' were most productive. 'MdUS 3816', 'Sequoia', 'Shuksan', and 'Atlas' had the largest fruits. Yield, fruit size, and some other characteristics may indicate a range of adaptability of cultivars and selections. A new method of determining season of ripening of strawberries is given.

Strawberry cultivars are notable for their adaptation to specific environments as to photoperiod, temperature, length of chilling, disease, and soil type. Some cultivars appear to have rather narrow zones of adaptation, and others seem to be fairly widely adapted. Environment at a place of origin of cultivars usually indicates other places where cultivars can be expected to perform well. However, if a test location is at some distance from where a cultivar originated, the environments usually differ somewhat, and cultivar performance reflects a wide or narrow adaptation. Wide adaptation of cultivars bears directly on choice of parents in regional strawberry breeding programs.

In 1972, the performance and adaptation of European and American strawberry cultivars and selections at three places in Italy (North, Central, and South) were studied. Full results were obtained only at Cesena, Italy, in the Po Valley (Central), because of difficulties at the other locations. Cesena is at latitued 44° with a mild marine climate. Minimum winter temperatures are −6° or −7°C normally, and day temperatures from flowering to ripening of fruit range from 10° to 26°C. Rainfall averaged 798 mm for 39 years (1921-1960), with 197 mm in the spring, 137 mm in the summer, 261 mm in the fall, and 203 mm in the winter (1).

Fresh strawberry plants of 17 cultivars and 7 selections potted in square plastic pots, 60 x 60 mm, were planted on September 1, 1972, in a black polyethylene mulched field at Cesena, Po Valley, Italy. The plots consisted of five plants; four plants were set in the form of a square spaced 35 cm apart, with the fifth plant in the middle of the square. A randomized block was used with four replications. The soil was a silt loam with the following analyses: colloidal clay, 13.5%; fine sand, 28.8%; large sand, 2.4%; lime, 55.3%; active calcium, 2.5%; total calcium, 4.9%; organic matter, 2.93%; and pH 8.0. All plants had been propagated directly from indexed stock. Origins and description of the cultivars have been published (2, 3, 4).

In the field, sprinkler irrigation was used after planting and as needed through the season. Fungicides were not used for control of any foliage diseases or fruit rot, and none was present.

The fruit was picked nine times from May 19 to June 20, 1973, at 4-day intervals. Fruit weight and number

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of berries were recorded for each picking on each plot.

On May 10, plant vigor was rated, and on May 23 and 28, berry appearance, firmness, smoothness, and color. The ratings were on a 1 to 10 scale, in which 1 represents the poorest expression of a character, 10 the best, and 6 minimum acceptability for commercial use.

The data were analyzed by analysis of variance, and means were compared by Duncan's multiple-range test (5).

An index of earliness (IE) was calculated as follows:

$$IE = \frac{g1t1 + g2t2 + \ldots gntn}{\Sigma g}$$

in which g1, g2, and gn are the weight in grams of the pickings, 1, 2, n; t1, t2, and tn the days from May 10 to the picking date, and Σg the weight of the total crop per plot in grams.

The plants grew well and had two to three branch crowns each in the spring. There was no evidence of winter injury, nor was there any frost at blossom time.

Yield. 'Vesper', 'Pocahontas', and 'Tardiva di Romagna' yielded at a rate equivalent to 18.5 tons per hectare (7.5 tons per acre), a very good crop considering the late setting of the plants on September 1 (Table 1). Also, 'Tioga', 'MdUS 3816', 'Aliso', 'Shuksan', 'Sequoia', and 'Cambridge Fa-

Table 1. Production, fruit size, and index of earliness for 24 strawberry cultivars and selections, Po Valley, Italy, 1973.

Cultivar or Selection	Yield g/plant	Fruit size[1] g/berry	Index of earliness[2] days
Vesper	316.5 A[3]	7.9 dEFG[3]	27.37 L
Pocahontas	297.2 AB	8.2 cDEFG	20.61 DEF
Tardiva di Romagna	297.0 AB	9.9 BCD	29.54 L
Tioga	276.2 ABC	9.7 BCDE	22.95 fGHI
MdUS 3816	271.5 ABCD	15.2 A	24.19 hI
Aliso	256.0 ABCDE	10.8 B	21.13 DEFG
Shuksan	253.0 ABCDE	11.1 B	24.55 hI
Sequoia	238.5 ABCDEF	13.0 A	20.58 DEF
Cambridge Favourite	223.7 aBCDEFG	8.3 cDEFG	21.98 dEFGH
Belrubi	174.0 cdEFGH	9.2 BCDEF	19.97 CDEF
Apollo	162.5 cdeFGHI	8.8 bCDEFG	18.94 abCD
Atlas	158.0 deFGHI	10.9 B	19.60 CD
Gorella	155.7 eFGHI	8.7 bCDEFG	19.09 bCD
MdUS 3082	148.7 eFGHI	10.3 BC	22.89 efGHI
Badgerbelle	143.5 efGHI	9.3 BCDEF	24.16 hI
Titan	134.2 fgHI	9.9 BCD	19.07 bCD
Guardian	126.0 fgHI	10.2 BC	20.16 CDEF
Stoplight	106.0 HI	10.5 BC	19.70 cDE
MdUS 3364	98.5 HI	7.5 deFG	19.02 bCD
Earlibelle	93.2 HI	8.8 bCDEFG	16.13 A
MdUS 3968	88.2 HI	10.7 B	20.08 CDEF
MdUS 3694	80.5 HI	9.7 BCDE	19.43 CD
MdUS 3413	73.0 hI	7.5 fG	16.40 AB
MdUS 3849	67.5 hI	9.7 BCDE	17.39 ABC

[1]Weighted mean calculated from berry size and fruit yield at each harvest date.
[2]See text for explanation.
[3]Duncan's multiple-range test: values followed by the same capital letters do not differ significantly at the 5 percent level; those followed by lower case letters do not differ significantly at the 1 percent level.

vourite' had acceptable yields equivalent to over 15 tons per ha.

All other cultivars and selections had significantly lower yields, with four of the MDUS selections being least productive. These four have been among the least productive at Beltsville, Maryland, also.

Fruit size. 'MdUS 3816' was significantly larger than any other clone (Table 1) and maintained large, uniform size through all seven pickings (Table 2). 'Sequoia', 'Shuksan', and 'Atlas' were the second largest. Cultivars with small fruits (less than 9 g) were 'Apollo', 'Earlibelle', 'Gorella', 'Cambridge Favourite', 'Pocahontas', 'Vesper', 'MdUS 3364', and 'MdUS 3413'.

'Belrubi', 'Guardian', 'Sequoia', and 'MdUS 3968' were uniform in size through all harvests. The size of 'Shuksan', 'Tardiva di Romagna', 'Vesper', and 'MdUS 3082' decreased near the end of the season.

Earliness. The earliest ripening cultivars were 'Earlibelle', 'MdUS 3413', and 'MdUS 3849' (Table 1). The second early group was 'Apollo', 'MdUS 3364', 'Titan', and 'Gorella'. The latest were 'Vesper' and 'Tardiva di Romagna'.

Plant vigor. 'Aliso' was outstanding in vigor (Table 3), with all plants having multiple crowns and large leaves borne on long petioles. 'Sequoia', 'Shuksan', and 'Tioga' were also vigor-

Table 2. Berry weights (grams) by dates of harvest, Po Valley, Italy, 1973.

Cultivar	May 19	May 23	May 28	June 1	June 6	June 9	June 13	June 16	June 20	Wgtd. season mean[1]
Aliso	12.8	13.3	11.8	11.2	9.5	8.3	6.6	—	—	10.8
Apollo	9.8	9.8	9.6	7.2	9.7	5.7	5.9	—	—	8.8
Atlas	13.3	12.0	9.8	10.9	12.5	5.0	6.7	—	—	10.9
Badgerbelle	18.3	10.0	11.9	10.0	9.6	10.1	7.8	6.9	—	9.3
Belrubi	8.2	15.1	11.2	8.3	8.3	8.0	6.7	7.5	8.0	9.2
C. Favourite	11.7	9.3	10.8	8.7	6.9	5.6	5.0	5.7	—	8.4
Earlibelle	11.1	10.8	8.0	8.3	5.5	—	—	—	—	8.8
Gorella	9.4	9.1	10.0	8.5	7.9	6.3	5.0	—	—	8.7
Guardian	10.0	11.5	10.2	10.2	10.7	9.9	—	—	—	10.2
Pocahontas	7.4	9.4	9.6	8.0	7.2	7.4	6.1	—	—	8.2
Sequoia	13.5	14.5	13.4	13.5	12.1	12.3	7.5	—	—	13.0
Shuksan	13.3	12.5	20.1	13.1	10.8	9.2	7.0	5.1	4.9	11.1
Stoplight	12.0	9.8	10.8	9.2	8.6	7.7	5.0	—	—	10.5
T. di Romagna	—	—	20.6	17.5	13.4	10.9	7.9	6.9	5.0	9.9
Tioga	12.7	11.2	11.4	10.0	10.2	9.2	6.9	6.3	5.0	9.7
Titan	—	17.0	10.7	6.8	9.4	7.5	—	—	—	9.9
Vesper	—	—	14.9	10.7	9.4	8.2	5.3	4.5	3.5	7.9
MdUS 3082	15.0	12.7	10.3	12.0	8.8	10.6	9.4	5.4	4.5	10.3
MdUS 3364	9.4	10.2	8.1	6.9	6.1	5.7	—	—	—	7.5
MdUS 3413	7.6	8.2	6.3	6.4	6.0	—	—	—	—	7.2
MdUS 3694	10.3	12.5	8.9	9.9	9.4	6.7	—	—	—	9.8
MdUS 3816	17.5	14.2	13.9	15.0	18.0	19.2	8.8	—	—	15.2
MdUS 3849	13.2	10.0	9.8	9.0	8.9	—	—	—	—	9.7
MdUS 3968	15.6	11.4	11.3	9.9	10.1	10.0	—	—	—	10.7

[1]Weighted season mean calculated from berry size and fruit yield at each harvest date.

ous. The weakest were 'MdUS 3413', 'MdUS 3364', and 'MdUS 3968'.

Berry characteristics. 'MdUS 3082', 'MdUS 3413', 'MdUS 3816', 'Tioga', and 'Atlas' were all very firm. The softest were 'Aliso', 'Badgerbelle', 'Cambridge Favourite', 'Gorella', 'Stoplight', 'Tardiva di Romagna', and 'Vesper' (Table 3).

Only 'Earlibelle' and 'MdUS 3816' displayed greater smoothness and symmetry than the others (Table 3). The roughest was 'Tardiva di Romagna', with many misshapen berries from lack of seed development at the tip end of the fruit. The fruit had few achenes per berry, and the black styles remained attached to the achenes.

'Earlibelle', 'Pocahontas', and 'MdUS 3413' were superior in color of their fruits (Table 3). The poorest was 'Tardiva di Romagna', which had a purplish-red color.

The data reported here are of interest because of the performance of clones that had originated under widely different conditions. The performance of the clones indicates the wide or narrow adaptation of cultivars and selections. 'Tardiva di Romagna' was originated in the Po Valley at Bologna; 'Belrubi' in southern France;

Table 3. Strawberry plant vigor and characteristics of fruit. Po Valley, Italy, 1973.

Cultivar	Plant Vigor[1] May 10	Berry[1] Firmness May 23	Berry[1] Firmness May 28	Berry[1] Smoothness	Berry[1] Color
Aliso	10.0	5.7	5.2	6.8	6.6
Apollo	7.1	8.1	7.4	7.0	7.6
Atlas	7.2	8.6	8.0	7.0	7.5
Badgerbelle	6.4	6.0	4.5	7.0	6.5
Belrubi	7.5	6.9	8.0	7.0	6.6
C. Favourite	7.6	5.0	5.4	7.2	6.2
Earlibelle	6.7	8.4	8.2	8.0	8.6
Gorella	7.9	5.0	5.4	6.8	7.4
Guardian	8.5	6.6	6.4	6.2	6.8
Pocahontas	8.0	6.5	6.5	7.0	8.0
Sequoia	9.2	6.5	6.7	7.0	7.4
Shuksan	8.9	6.0	6.1	6.6	6.6
Stoplight	6.9	6.1	5.2	7.0	7.4
T. di Romagna	8.0	[2]	5.0	4.0	4.0
Tioga	9.1	8.9	8.4	6.8	7.0
Titan	7.0	7.7	7.9	7.0	7.8
Vesper	7.2	5.5	5.0	6.5	6.2
MdUS 3082	6.5	9.5	9.6	7.2	7.0
MdUS 3364	6.0	7.0	7.4	7.2	7.2
MdUS 3413	5.5	9.1	8.6	7.7	8.2
MdUS 3694	7.4	6.6	8.1	7.0	7.0
MdUS 3816	8.0	9.1	8.9	8.0	7.0
MdUS 3849	7.9	7.6	8.4	7.6	7.2
MdUS 3968	6.0	8.0	7.6	7.2	6.7

[1]Ratings are on a 1 to 10 scale, in which 1 means the poorest expression of a character and 10 the best.
[2]No ripe fruit.

'Cambridge Favourite' in southern England; 'Gorella' in the Netherlands; 'Aliso', 'Sequoia', and 'Tioga' in southern California; 'Shuksan' in western Washington; 'Badgerbelle' in Wisconsin; 'Stoplight' in Iowa; 'Apollo', 'Atlas', 'Earlibelle', and 'Titan' in North Carolina; 'Guardian,' 'Pocahontas', and all the MdUS selections in Maryland; and 'Vesper' in New Jersey.

The good performance of some of the cultivars in this trial displays their wide adaptation, considering where they were selected. The two cultivars in the trial that are grown extensively commercially in the Po Valley are 'Gorella' (53% of the total tonnage of Italy in 1973), originated in the Netherlands, and 'Pocahontas' (32% of total tonnage of Italy), originated in the USA. The 'Pocahontas' yield was nearly double that of 'Gorella' (Table 1), probably indicating wider adaptability than 'Gorella'. The high pH of the soil was unfavorable for the growth of 'Gorella' plants, which became dwarfed by black root in May 1973 when the weather became warm. This dwarfing affected total crop and berry size. In comparison, 'Pocahontas' performed normally.

The most interesting cultivars and selections appear to be:

Earlibelle for earliness, firmness, and attractiveness of fruit, but it was unproductive;

Pocahontas for high yield and attractiveness, but the berry was of medium size and firmness;

Sequoia for large fruit and productivity; under Po Valley conditions, it was not as early as was observed in southern Italy; the plant was vigorous, but only average in berry attractiveness and firmness;

Shuksan for high yield and high vigor, but the berries were dark and soft and had a tender surface;

Tardiva di Romagna for exceptional lateness, productivity, and large fruit in the first three pickings, but the berries were rough, soft, and unattractive;

Tioga for high yield, firm fruit, and vigorous plants, although the leaves were very chlorotic; the average berry size was good, but the size in the last three pickings was rather small;

Vesper for high yield and lateness, but the average fruit size was small and the fruit was soft;

MdUS 3816 for high yield, very large size which remained constant through the pickings, and very firm berries of uniform shape, but the fruit lacked flavor.

The generally good performance of 'Pocahontas', 'Tioga', Aliso', 'Sequoia', and 'MdUS 3816' indicates that they have wide adaptation and therefore, may be especially valuable as parents in breeding for this characteristic.

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