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'Cavendish' Strawberry

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'Cavendish' strawberry (*Fragaria* × *ananassa* Duchesne) offers strawberry growers of the Northeast climatic zone (Himelrick and Galletta, 1990) a cultivar that is high yielding and resistant to red stele, producing large fruit of good quality in the midseason. Breeding for resistance to red stele root rot (caused by *Phytophthora fragariae* Hickman) began at Kentville, N. S., in 1969, after Gourley and Craig (1968) demonstrated the field resistance of 'Guardsman'. Significant progress was not made until 'Earliglow' was included in the crossing program in 1977, and the sand bench screening method (Scott et al., 1976) was adopted in 1978. The 'Earliglow' derivatives 'Annapolis' and 'Cornwallis', released in 1984, provided immediate relief for those growers with soils infested with *P. fragariae*. These two early midseason cultivars have achieved only moderate yields when compared with the midseason cultivars Kent and Cavendish.

'Cavendish' is named after the most popular tourist location of Prince Edward Island, famous for its warm-water beaches preserved in a National Park, and as the site of inspiration of Canadian novelist Lucy Maud Montgomery.

Origin

'Cavendish', tested as 'K83-4, is a seedling from a 'Glooscap' × 'Annapolis' cross made under the direction of D. L. Craig in 1981 at Kentville (Fig. 1). 'Glooscap' is a high-yielding, winter-hardy cultivar released from the Agriculture Canada, Kentville breeding program in 1983. 'Annapolis', released in 1984, is an early maturing Kentville cultivar that is resistant to red stele root

rot. Seedlings of the cross were screened for red stele resistance using the sand bench method of Scott et al. (1976) with six isolates of race A-6 as inoculum. Symptomless plants were moved to a field infested with *P. fragariae* located at Robinsons Corner, Lunenburg Co., N. S., in Spring 1982. 'Cavendish' was selected in 1983 by A. R.J., D.L. Craig, and G.W. Bishop.

Description

'Cavendish' plants are moderately vigorous, running well under good growing conditions but not excessively. Crown size is small to medium. Leaves are trifoliate

and pinnate: the central leaflet is roundish-ovate with a slightly attenuated leaflet base, the side leaflets are oblique. Leaflets are medium green on the upper surface and light waxy green on the lower surface. Leaflets commonly cup upwards at the margins exposing the lower surface and giving the foliage a light green appearance. Leaf blade serrations (21 to 28 per leaflet) are moderately shallow and moderately blunt. Leaf petioles are of medium length with moderately numerous lateral to weakly descending hairs.

Flowers are produced on peduncles of medium length, and flowers open at the canopy height or below. Primary fruit are large, globose conic to short wedge in shape (Fig. 2), beginning to ripen between 'Honeoye' and 'Kent'. Secondary and later ripening berries are of medium size and short conic to conic in shape. The fruit surface is deep red except under the calyx, where it is white. Fruit glossiness is tempered somewhat by a minute pubescence. Internal color fades from red near the skin to white just beneath the calyx at the core. 'Cavendish' flesh is firm and skin is medium firm. The calyx is moderately re-

Table 1. Fruit production of 'Cavendish' and three standard cultivars, averaged over two harvest seasons (1988 and 1989), in plots established in 1987 at Kentville, N.S., and Fredericton, N.B.

| Cultivar | Total yield (t·ha ⁻¹) | Unmarketable (%) | Seasonal wt/fruit (g) |
|-----------------------------------|-----------------------------------|------------------|-----------------------|
| <i>Kentville</i> | | | |
| Kent | 31.7 | 4.4 | 11.1 |
| Cavendish | 27.8 | 3.6 | 15.5 |
| Redcoat | 21.8 | 4.2 | 8.9 |
| Annapolis | 21.3 | 3.1 | 11.3 |
| Significance | *** | * | *** |
| SEM (n = 4, df = 24) ^z | 0.91 | 0.39 | 0.35 |
| <i>Fredericton</i> | | | |
| Kent | 24.1 | 9.9 | 18.4 |
| Cavendish | 20.8 | 4.9 | 19.8 |
| Redcoat | 16.3 | 4.7 | 14.9 |
| Annapolis | 15.9 | 1.1 | 19.7 |
| Significance | * | *** | *** |
| SEM (n = 3, df = 14) ^z | 1.58 | 0.87 | 0.38 |

^zDegrees of freedom for the SE of the mean (SEM) reflect a total number of clones of eight at Kentville and seven at Fredericton. Plots were 55 cm wide matted rows developed from an initial 60 cm in-row plant spacing. Plots at Kentville were 6.0 m long with four replications, and plots at Fredericton were 4.2 m long with three replications.

***Significant differences at *P* < 0.05 and 0.001, respectively.

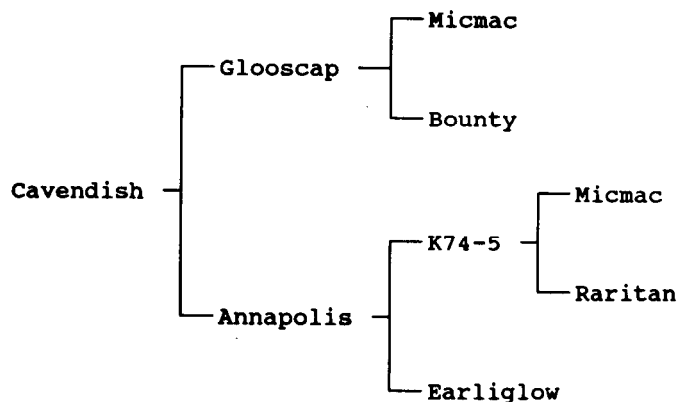


Fig. 1. Pedigree of 'Cavendish' strawberry.

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Table 2. Sensory panel evaluation of flavor components and instrumental measurements of soluble solids concentration (SSC) and acidity of 'Cavendish' and three other strawberry cultivars grown at Kentville, N.S.

| Cultivar | Flavor component ratings ^z (n = 40, df = 60) | | | | | | | | | Instrumental measurements (n = 8, df = 7) | |
|--------------|---|-------|------|-----------------|------------|------------|-------|--------|------------|---|-------------------------------|
| | Aroma | Sweet | Tart | Flavor strength | Melon-like | Honey-like | Musty | Bitter | Astringent | SSC (%) | Titrateable acids (mg/100 ml) |
| Cavendish | 7.2 | 7.1 | 6.0 | 6.4 | 4.7 | 2.8 | 3.3 | 4.2 | 5.9 | 8.1 | 0.84 |
| Honeoye | 8.3 | 5.7 | 7.8 | 6.6 | 3.9 | 2.4 | 3.4 | 5.2 | 7.4 | 8.2 | 1.14 |
| Annapolis | 7.3 | 6.7 | 6.6 | 6.8 | 3.0 | 2.5 | 3.9 | 4.3 | 5.4 | 8.8 | 1.00 |
| Kent | 4.7 | 6.0 | 6.3 | 4.7 | 3.4 | 2.2 | 2.6 | 3.4 | 4.9 | 7.9 | 0.93 |
| Significance | *** | *y | * | ** | ** | NS | NS | NS | * | NS | ** |
| SEM | 0.44 | 0.38 | 0.47 | 0.47 | 0.42 | 0.30 | 0.57 | 0.53 | 0.54 | 0.29 | 0.042 |

^zMean values of 40 ratings (10 panelists × 2 harvests × 2 years). Ratings were on a scale of 0–15 representing weak–strong (aroma, flavor strength, melon-like, honey-like, and mustiness) and slightly–extremely (sweetness, tartness, bitterness, and astringency).

^yA significant ($P < 0.05$) harvest × cultivar interaction indicated that 'Annapolis' was rated more sweet at the second harvest.

^xA significant ($P < 0.05$) harvest × cultivar interaction indicated that 'Honeoye' was rated more intense in melonlike flavor at the first harvest.

NS,*,**,*NSignificant or nonsignificant at $P < 0.05$, 0.01, or 0.001, respectively.

Table 3. Sensory panel evaluation of appearance and texture, instrumental measurement of firmness, and consumer acceptance of 'Cavendish' and three other strawberry cultivars grown at Kentville, N.S.

| Cultivar | Appearance ^z | | Texture ^z | | | Firmness (N) | Acceptance ^y |
|--------------|-------------------------------|-------|----------------------|-------|-------|------------------------------|--------------------------------|
| | Color | Gloss | Firm | Juicy | Pulpy | | |
| | <i>n</i> = 40, <i>df</i> = 60 | | | | | <i>n</i> = 40, <i>df</i> = 7 | <i>n</i> = 112, <i>df</i> = 11 |
| Cavendish | 11.1 | 9.2 | 5.5 | 10.1 | 4.6 | 4.0 | 5.6 |
| Honeoye | 10.5 | 6.7 | 5.4 | 8.9 | 4.7 | 3.8 | 4.5 |
| Annapolis | 7.1 | 7.7 | 4.0 | 10.6 | 3.5 | 3.7 | 4.9 |
| Kent | 6.7 | 10.0 | 6.7 | 8.0 | 6.1 | 4.8 | 5.2 |
| Significance | *** | *** | ** | ** | ** | NS | ** |
| SEM | 0.51 | 0.47 | 0.45 | 0.51 | 0.47 | 0.33 | 0.22 |

^zMean values for 40 ratings (10 panelists × 2 harvests × 2 years). Ratings were on a scale of 0–15 representing light red–dark red (color), flat–glossy (gloss), soft–firm (firmness), dry–juicy (juiciness), and none–extremely (pulpiness).

^yMean values for overall acceptance (1 = extremely unacceptable, 8 = extremely acceptable) as measured at each of two harvests in 1989 by a 56-member panel. As part of a larger, unbalanced experiment, these four cultivars were compared with eight others.

NS,*,**,*NSignificant or nonsignificant at $P < 0.01$ or 0.001, respectively.



Fig. 2. A quart box of 'Cavendish' strawberry.

flexed at maturity and calyx removal (capping or hulling) is moderately difficult.

Performance

'Cavendish' consistently yielded higher

than 'Redcoat' and 'Annapolis' (Table 1). 'Cavendish' equalled the yield of 'Kent' at Fredericton, N. B., in 1988. The seasonal fruit weight of 'Cavendish' exceeded that of all other cultivars at Kentville (Table 1). As an

estimate of primary fruit size, fruit weights were averaged at Kentville over the first two harvest dates in 1988 and 1989. 'Cavendish' primary fruits averaged 25.1 g compared with 'Kent' at 17.0 g.

Disease response

The response of 'Cavendish' to *Verticillium* wilt (*V. dahliae* Kleb.) has been evaluated in the greenhouse with methods similar to those of Galletta et al. (1982). One isolate, obtained from a diseased 'Micmac' plant, was used as inoculum. 'Cavendish', 'Annapolis', 'Cornwallis', and 'Veestar' proved more resistant than 'Glooscap', 'Micmac', 'Kent', 'Honeoye', and 'Bounty'. 'Cavendish' was rated as resistant by the criteria of Galletta et al. (1982); however, in the field, plants with *Verticillium* wilt have been observed.

'Cavendish' is highly resistant to *P. fragariae* races A-4, A-6, and A-7, the three races known to occur in commercial strawberry fields in Nova Scotia (N. L. N., unpublished). Resistance to red stele has been effective in grower trials on soils heavily infested with *P. fragariae*.

Fruit rot, principally caused by *Botrytis cinerea* Pers. ex Fr., was the primary cause for categorizing fruit as unmarketable in our trials. The proportion of the total yield of 'Cavendish', 'Kent', and 'Redcoat' considered unmarketable ranged from 2% to 7% over 2 years with no consistent differences between cultivars. The incidence of post-harvest fruit rot was recorded after 3 days of incubation of fruit at 20C and high relative humidity. 'Cavendish' has consistently produced fewer fruit with postharvest fruit rot than 'Kent' (Jamieson and Nickerson, 1989). In addition, the extent of colonization was less than on 'Kent'.

'Cavendish' shows an intermediate reaction to powdery mildew [*Sphaerotheca macularis* (Walls. ex Fr.) Jacz.] on the foliage. This level of resistance is higher than that of 'Annapolis' but lower than that of 'Kent'. Powdery mildew has rarely been observed on the fruit.

Virus diseases of strawberries are uncommon in Atlantic Canada, and the virus tol-

erance of 'Cavendish' is unknown. 'Cavendish' is highly susceptible to green petal disease, as is its seed parent 'Glooscap'.

Fresh fruit evaluation

The fruit of 'Cavendish' was compared with that of 'Honeoye', 'Annapolis' and 'Kent'. Three methods of assessment were used to measure the quality of the cultivars: 1) A trained sensory panel rated the intensity of color, appearance, flavor and texture attributes. Methods used for the selection and training of panelists along with attribute definitions and reference material were those of Sanford et al. (1989). All experimental conditions, including sample preparation, presentation and experimental design were similar to those described by Sanford and Jamieson (1989), where for each grouping of four cultivars, harvest and panelist were treated as blocks. Harvest, panelist, and cultivar effects were estimated through an analysis of variance for each sensory attribute. 2) Selected instrumental measurements were made. At each harvest, firmness of 10 berries of each cultivar was measured using a notched head probe attached to an Accuforce II model AF-100 digital force gauge (Ametek, Hunter Spring Division, Hatfield, Pa.). Twice at each harvest, the soluble solids concentration (SSC) of juice expressed from the fruit was measured using a refractometer and total acidity was measured by titrating a 50 ml sample with 0.5 N NaOH to pH 8.1 with a Mettler DL40RC automatic titrator (Mettler Instruments, Zurich, Switzerland). 3) An acceptance test was conducted with a panel composed of 56 staff members rating each cultivar for overall acceptability at each of two harvests in 1989. Histograms describing the distributions of the responses in each category of the eight-point scale were produced

for each cultivar. After determining that the distributions were unimodal, the cultivar effects were estimated in a regression using a general linear model for the normal distribution.

The sensory panel described 'Cavendish' as having a similar intensity of berry aroma and flavor as 'Honeoye', and 'Annapolis' but significantly stronger aroma and flavor than 'Kent' (Table 2). The cultivars did not vary in level of mustiness or honey-like flavor, but 'Cavendish' had a stronger melon-like flavor. 'Cavendish' was described as significantly sweeter and less tart than 'Honeoye'. While SSC did not differ significantly among the cultivars, the titratable acid levels were similar to the sensory data, with 'Cavendish' being less acid than 'Honeoye' (Table 2). The lower acid level also may have resulted in the berries being perceived as sweeter than 'Honeoye' even though the SSC was similar. 'Cavendish' fruit was described by the trained sensory panel as dark red and glossy, similar in depth of color to 'Honeoye' and in glossiness to 'Kent' (Table 3). According to both the sensory and instrumental measurements (Table 3), the firmness of 'Cavendish' and 'Honeoye' were similar. Also, the two cultivars received similar ratings for pulpiness. Like 'Annapolis', the fruit of 'Cavendish' was very juicy. 'Cavendish' received higher acceptance ratings than 'Honeoye' and 'Annapolis' (Table 3). Panelists rated 'Cavendish', 'Kent', 'Annapolis' and 'Honeoye' as acceptable (rating scale categories 5 to 8) in 76%, 73%, 66%, and 56%, respectively, of the acceptance tests.

Adaptability and use

'Cavendish' appears to be well adapted throughout the Atlantic provinces of Canada, when green petal disease is managed. Wider

suitability to the Northeastern United States and Quebec is likely, based on parental performance, but has not been demonstrated. 'Cavendish' will be of particular value on soils infested with *P. fragariae*, providing a high-yielding cultivar following 'Annapolis' in ripening. The fruit should meet the fresh-market requirements for pick-your-own and short-distance shipping.

Availability

The names of nurseries with certified 'Cavendish' plants will be supplied by the originating station on request.

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