'Primetime' Strawberry

G.J. Galletta¹, J.L. Maas², and J.M. Enns³

Fruit Laboratory, Plant Science Institute, Beltsville Agricultural Research Center, Agricultural Research Service, U.S. Department of Agriculture, Beltsville, MD 20705

J.C. Scheerens⁴

Department of Horticulture and Crop Science, The Ohio State University, Ohio Agricultural Research and Development Center, Wooster, OH 44691

R. Rouse⁵

Cooperative Extension Service, University of Maryland Wye Research and Education Center, Queenstown, MD 21658

R.F. Heflebower, Jr.⁶

Cooperative Extension Service, University of Maryland Western Maryland Research and Education Center, Keedysville, MD 21756

Additional index words. *Fragaria ×ananassa*, *Phytophthora fragariae*, red-stele root-rot resistance, fruit breeding

'Primetime' Junebearing strawberry (*Fragaria ×ananassa* Duch.) was introduced to nurseries for propagation in Apr. 1995 by the U.S. Dept. of Agriculture/Agricultural Research Service (USDA/ARS). 'Primetime' was selected for its attractive, large, symmetrical, and good-quality fruit; midseason ripening period; and plants that are vigorous, runner well, and are resistant to the red-stele root-rot disease (caused by *Phytophthora fragariae* Hickman). 'Primetime' also is resistant to several leaf diseases and fruit rots. 'Primetime' fruit are medium in skin firmness and toughness, with bright scarlet skin and pink flesh, and have a pleasant, mild, and lightly aromatic fresh flavor. 'Primetime' yielded as well as and was as large-fruited as 'Allstar' in Maryland and Ohio and has performed well in New Jersey and Pennsylvania, but it was not commercially productive in Minnesota. 'Primetime' produces well on either light or heavy soils and in matted-row or raised-bed culture. 'Primetime' usually ripens with or slightly ahead of 'Redchief', 'Lester', and 'Allstar'. Maximum productivity of this cultivar may be realized at USDA hardiness zones 6 and 7.

'Primetime' is suggested for trial in the Mid-Atlantic and adjacent regions and is

Fig. 1. Pedigree of 'Primetime' strawberry.

Table 1. Fruit production of 'Primetime' and several standard strawberry cultivars grown in matted rows in Beltsville, Md., in 1990, 1991, 1992, and 1994.

Cultivar	Yield			Proportion	
	Total (t·ha ⁻¹)	Marketable ^y (%)	Fruit mass ^z (g)		through fourth harvest (%)
			Primary	Season	
1990					
Allstar	19.4 b*	84 a	23.5 a	13.3 ab	32 d
Earliglow	20.8 b	86 a	14.3 c	8.5 b	90 a
Glooscap	27.6 a	74 b	17.6 b	9.7 b	45 c
Jewel	20.4 b	81 a	21.3 ab	15.2 a	10 e
Lateglow	17.7 b	88 a	20.8 ab	10.7 ab	21 de
Primetime	14.6 b	85 a	19.6 ab	11.0 ab	73 b
1991					
Allstar	20.6 ab	80	21.1	12.7	8 cd
Earliglow	24.2 a	84	17.9	10.0	70 a
Kent	21.3 a	77	21.2	11.8	22 bc
Lateglow	22.5 a	83	20.4	10.2	3 d
Primetime	13.3 b	83 ^{ns}	21.3 ^{ns}	12.9 ^{ns}	39 b
1992					
Allstar	17.6	77	23.8	14.0 ab	11 b
Earliglow	16.7	75	18.7	11.8 b	73 a
Lateglow	14.6	75	22.6	11.2 b	1 c
Lester	21.7	80	23.1	12.7 b	34 b
Primetime	14.6 ^{ns}	78 ^{ns}	21.7 ^{ns}	16.6 a	26 b
1994					
Allstar	14.2 b	89 a	20.5 ab	12.2 b	41 cd
Chambly	22.5 ab	73 c	16.4 b	9.9 b	55 bc
Earliglow	10.1 b	63 c	15.0 b	8.7 b	77 a
Jewel	17.1 b	80 bc	19.4 b	11.6 b	29 d
Lester	14.2 b	84 ab	21.4 ab	10.9 b	59 b
Primetime	27.7 a	84 ab	26.0 a	15.0 a	41 cd

Received for publication 16 Feb. 1996. Accepted for publication 22 June 1996. We are indebted to A. Funk, Millersville, Pa.; E. Hanson, Michigan State Univ.; Joseph Fiola, Rutgers Univ.; and James J. Luby and David Wildung, Univ. of Minnesota, for evaluating the suitability of 'Primetime' strawberry to their areas. The cost of publishing this paper was defrayed in part by the payment of page charges. Under postal regulations, this paper therefore must be hereby marked *advertisement* solely to indicate this fact.

¹Research Geneticist.

²Research Plant Pathologist.

³Horticulturist.

⁴Associate Professor of Horticulture.

⁵Regional Specialist, Fruits and Vegetables.

⁶Regional Specialist, Fruits.

²Mean individual primary and season fruit mass were estimated from four replicate samples of 25 fruit during early harvest (primary fruit) and for all harvests (season) of each cultivar.

³Total yield less culls due to small size, misshapen berries, disease, etc.

^{*}Means separation in columns within years by Duncan's multiple range test at $P \leq 0.05$. ns indicates no significant differences among cultivars.

introduced there as a high-quality, mid-season, shipping, and local market cultivar with multiple fungus disease resistance. 'Primetime' was named to suggest that it fruits during the middle, or "prime," strawberry production season in the Mid-Atlantic region.

Origin and testing history

'Primetime', tested as MDUS 5069, was a seedling from the MDUS 4377 ('Sunrise' × MDUS 3082) × 'Earliglow' cross made by G.J.G. at Beltsville, Md., in 1978 (Fig. 1). MDUS 3082 is a large-fruited sibling of 'Redchief' and 'Guardian'. Seedlings from this cross were screened for resistance to a five-race composite of the red-stele root rot-inciting fungus *P. fragariae* in a greenhouse test (Scott et al., 1975) in Beltsville during Winter 1978–79. Resistant seedlings were transplanted in Spring 1979 to a field at the Univ. of Maryland experimental farm at Wye Research and Education Center, Queenstown, on Maryland's eastern shore. 'Primetime' was selected in 1980 by G.J.G. Plants of this selection were retested for reaction to five races of *P. fragariae*.

'Primetime' was evaluated at Beltsville from 1981 to 1995 and was sent for testing to cooperators in Maryland, Minnesota, Ohio, New Jersey, and Pennsylvania. Regional testing of 'Primetime' was postponed after 1988 until sufficient virus-free plants became available for planting in replicated trials in Beltsville and for distribution to cooperating locations. 'Primetime' plants were increased by micro-propagation from virus-negative mother stock and were released to nurseries in 1995.

Production test methods. In 1989, 1990, 1991, and 1993, 'Primetime' was established in Beltsville on a sandy soil with several standard cultivars (Galletta, 1989) in 1.5-m-long plots and 1 m between plots in a matted-row system. Overhead irrigation for frost protection and drip-tubing for supplemental irrigation were provided. Cultivars were compared for runner-plant production, leaf disease reactions, plant vigor, earliness of flowering, total and marketable yields, and ripening season. Mean mass of primary and total fruit over the season were estimated from four replicate samples of 25 fruit during early harvests (primary fruit) and for all harvests (total fruit) for each cultivar. Fruit of each cultivar were evaluated for appearance, symmetry, skin and flesh firmness, external and internal color, and flavor, from which an overall fruit quality index was computed for each genotype. Fruit of 'Primetime' and several other cultivars from the 1993 planting were evaluated in laboratory tests for percent total soluble solids concentration (TSS), soluble sugar, titratable acidity (TA), and organic acid and ascorbic acid concentrations (Wang et al., 1996).

'Primetime' and several standard cultivars were established in 6.5-m-long, matted-row plots and replicated four times on a nonfumigated Matapeake silt loam soil in 1993 at the Univ. of Maryland Wye Research and Education Center. Beds were 0.6 m wide and spaced 1.3 m apart. A duplicate planting was established on a heavy, nonfumigated soil (Hagerstown silt loam) at the Univ. of Maryland Western Research and Education Center in Keedysville. Entire plots at each location were harvested in 1994 and the center 3.5-m-long portions were harvested in 1995. Mean individual fruit mass was estimated by averaging four replicate samples of 25 fruit at the midharvest time for each cultivar.

In Wooster, Ohio, standard cultivars (Luby, 1989) and 'Primetime' were established in 2-m-long plots in a matted-row system on Wooster silt loam soil in 1990. Beds were 0.6 m wide and spaced 1 m apart. Fruit samples were obtained at full ripeness in 1991 and 1992 and objectively evaluated for quality characteristics. Fruit from the second harvest of each cultivar were combined over replications; representative samples of seven fruit were obtained and fruit were evaluated individually for TSS by refractometry of hand-expressed juice; skin and flesh firmness (in 1992) by the method of Ourecky and Bourne (1968) using an Instron 1101 firmness tester (Instron Corp., Canton, Mass.) equipped with a 0.95-cm star punch (Dunkley Co., Kalamazoo, Mich.); cortex firmness (in 1991)

Table 2. Yield characteristics of 'Primetime' strawberry and several standard cultivars grown in matted rows in Queenstown^a and Keedysville^b, Md., in 1994 and 1995.

Cultivar	Total yield (t·ha ⁻¹)		Mean individual fruit mass at midharvest ^c (g)	
	Queenstown	Keedysville	Queenstown	Keedysville
<i>1994</i>				
Allstar	21.7 a ^w	15.1 b	15.1 bc	12.1 b
Cavendish	23.3 a	15.0 b	17.3 a	14.0 a
Delmarvel	12.9 c	10.6 c	16.4 ab	10.3 c
Earliglow	11.7 c	10.3 c	13.5 c	11.0 bc
Glooscap	15.7 bc	14.8 b	13.8 c	10.6 c
Primetime	17.8 b	21.2 a	16.5 ab	10.4 c
<i>1995</i>				
Allstar	24.2 bc	--- ^v	18.2 b	---
Cavendish	28.1 a-c	---	19.6 a	---
Delmarvel	20.0 c	---	15.5 c	---
Earliglow	28.7 a-c	---	15.0 c	---
Glooscap	29.5 ab	---	12.7 d	---
Primetime	36.9 a	---	16.8 c	---

^aUniversity of Maryland, Wye Research and Education Center.

^bUniversity of Maryland, Western Maryland Research and Education Center.

^cMean individual fruit mass was estimated by averaging four replicate samples of 25 fruit at the midharvest time for each cultivar.

^wMeans separation in columns within years by Duncan's multiple range test at $P \leq 0.05$.

^vData not taken.

Table 3. Two-year means of total and marketable yields and mean fruit mass and plant stand ratings of 'Primetime' and several standard strawberry cultivars grown in Wooster, Ohio, in 1991 and 1992.

Cultivar	Yield		Individual fruit mass ^y (g)	Stand (rating) ^x
	Total (t·ha ⁻¹)	Marketable ^z (%)		
Allstar	22.7 a ^w	74 b ^w	14.3 a ^w	9
Earliglow	17.0 b	82 a	9.1 c	8
Lateglow	18.7 ab	75 b	13.2 ab	8
Primetime	19.5 ab	80 a	12.0 b	7

^zTotal yield less culls due to misshapen fruits, disease, insect damage, etc.

^yIndividual fruit mass mean estimated from five replications of 25 fruit taken at the second harvest of each cultivar.

^xPlant stand ratings on a subjective scale from 1 (not established) to 10 (fully established) in a matted-row bed. Not analyzed for significant differences.

^wMeans separation in columns by Duncan's multiple range test at $P \leq 0.05$.

Table 4. Yield and mean individual fruit mass of 'Primetime' and several other strawberry cultivars summer-planted and grown on raised beds with black plastic mulch and trickle irrigation in Beltsville, Md., in 1995.

Cultivar	Yield		Individual fruit		Proportion through third harvest (%)
	Total (t·ha ⁻¹)	Marketable ^z (%)	mass (g) ^y		
			Primary	Season	
Allstar	12.6 a–c ^x	76 a	17.5 bc	11.2 a	70 b
Guardian	13.2 a	69 ab	13.4 c	9.3 ab	72 b
Jewel	8.5 c	65 b	23.1 a	11.4 a	77 ab
Lester	12.1 a–c	77 a	15.0 bc	9.1 b	81 a
Primetime	13.0 ab	72 ab	19.3 ab	10.9 ab	83 a

^zTotal yield less culls due to small size, misshapen berries, disease, etc.

^yMean individual primary and season fruit mass were estimated from four replicate samples of 25 fruit during early harvest (primary fruit) and for all harvests (season) of each cultivar.

^xMeans separation in columns by Duncan's multiple range test at $P \leq 0.05$.

by Instron analysis using a 3.2-mm cylindrical probe passed through the cortical tissue of a 1-cm-thick axial fruit slice; and external (skin) color at three sites and internal (flesh) color at two sites per fruit using equipment (CR-100 chromameter; Minolta Corp. Meter Div., Ramsey, N.J.) and techniques similar to those described by Sacks and Shaw (1993). Raw color data (L^* , a^* , b^*) were transformed according to Setser (1984) to values of L , hue angle ($\arctan b/a$), and saturation index ($a^2 + b^2$)^{1/2}. In addition, ≈ 200 g fruit of each cultivar was frozen for TA analysis. At a later date,

these samples were thawed and then pureed; duplicate 10-g subsamples were extracted with 90 mL of neutralized H₂O. The extracts were filtered through a qualitative grade filter paper, then 25-mL aliquots of filtrate were titrated against 0.1 N NaOH to an endpoint of pH 8.1. Indices of earliness and concentration of fruit maturation also were calculated for each cultivar (Brenneman and Scheerens, 1994; Khanizadeh and Fanous, 1992).

In 1994, 'Primetime' was established in double rows on nonfumigated raised beds mulched with black plastic in Beltsville. Plants

Table 5. Field rating scores for fruit characters of 'Primetime' strawberry and several standard cultivars in Beltsville, Md., in 1990 and indices of fruit quality ratings in 1990, 1991, 1992, and 1994.

Cultivar	Ratings							Fruit quality index ^z			
	Appearance	Symmetry	Flesh	Skin	Color		Flavor	1990	1991	1992	1994
			firmness	toughness	External	Internal					
Allstar	7.5 ^y	7.5	8	8	7	7	7	74	75	75	--- ^x
Earliglow	7.3	7.3	7.3	7.3	7.3	7.3	7.8	74	78	77	77
Honeoye	7.4	7.4	6.3	6.3	7.2	7.2	6.8	69	---	---	---
Lateglow	8.3	8.3	6.6	6.6	7.6	7.6	8	76	77	---	---
Lester	7.6	7.6	7.7	7.7	7.5	7.5	7.5	76	---	76	79
Jewel	6.8	6.8	7.8	7.8	7	7	6.7	71	---	---	75
Primetime	7.4	7.4	7.3	7.3	7.6	7.6	7.5	75	74	73	73

^zAverages of the seven listed characters in the first part of the table multiplied by 10 to give whole numbers (90 is a perfect score).

^yRatings on a scale from 1 to 9, where 9 = the best quality and 6 = acceptable.

^xCultivar not in the trial of that year.

Table 6. Fruit total soluble solids concentration (TSS), titratable acidity (TA), and firmness of 'Primetime' strawberry and several standard cultivars grown in Wooster, Ohio, in 1991 and 1992.

Cultivar	TSS (%)		TA (%)		Firmness (N)		
	1991	1992	1991	1992	Cortex	Flesh	Skin
					1991 ^z	1992 ^y	1992 ^y
Allstar	6.2 a ^x	6.0 b	0.61	0.51 c	0.72 a	9.07 a	4.10 a
Earliglow	6.4 a	7.7 a	0.58	0.67 b	0.35 c	2.71 c	2.64 b
Lateglow	6.1 a	8.1 a	0.67	0.88 a	0.46 bc	4.28 b	2.57 b
Primetime	4.6 b	6.2 b	0.64 ^{ns}	0.64 b	0.48 b	4.72 b	2.75 b

^zDetermined in 1991 by Instron analysis using a 3.2-mm cylindrical probe passed at 50 mm·min⁻¹ through the cortical tissue of a 1-cm-thick axial fruit slice from each of seven representative fruits of each cultivar.

^yDetermined in 1992 by Instron analysis using a 0.95-mm-diameter star punch passed at 50 mm·min⁻¹ equatorially through the skin, cortex, and pith tissues of each of seven representative intact fruits of each cultivar.

^xMeans separation within and between years by Duncan's multiple range test at $P \leq 0.05$. ns indicates no significant difference.

Table 7. Fruit skin and flesh color of 'Primetime' strawberry and several standard cultivars grown in Wooster, Ohio, in 1991 and 1992.

Cultivar	Color criterion					
	L ^z		Hue angle ^y		Saturation index ^x	
	1991	1992	1991	1992	1991	1992
<i>Skin</i>						
Allstar	35.8 a ^w	37.5 a	35.7 a	33.3 a	24.4 a	28.7 a
Earliglow	29.4 c	31.4 c	32.5 b	30.8 b	17.2 c	21.3 c
Lateglow	30.7 c	35.1 b	32.4 b	31.9 ab	21.7 b	26.7 a
Primetime	32.9 b	33.4 b	34.9 a	33.5 a	21.1 b	23.8 b
<i>Flesh</i>						
Allstar	51.5 a	47.7	48.1 a	43.6	29.3	27.9
Earliglow	45.7 b	47.8	38.8 c	43.0	33.2	25.9
Lateglow	45.8 b	46.8	41.8 bc	42.4	31.4	28.5
Primetime	50.6 a	46.0 ^{ns}	45.0 b	40.1 ^{ns}	31.1 ^{ns}	26.6 ^{ns}

^zL [raw data transformed according to Setser (1984)] = lightness to darkness; 100 = pure white, 0 = pure black.

^yHue angle (arctan b/a) in degrees [raw data transformed according to Setser (1984)]; 90 = pure yellow, 0 = pure red.

^xSaturation index $(a^2 + b^2)^{1/2}$ [raw data transformed according to Setser (1984)]; higher values indicate greater pigment intensity.

^wMeans separation in columns within years by Duncan's multiple range test at $P \leq 0.05$. ns indicates no significant differences among cultivars.

were spaced 0.3 m apart and 0.3 m between rows in each bed. Each raised bed had supplemental irrigation and fertigation using trickle tubing. Raised-bed plots consisted of six plants as double rows of three plants each.

Matted-row and raised-bed plantings at all locations were established in a randomized complete-block design with four replications for each entry. Due to the varying number of cultivars, harvests, and sites represented, a separate analysis of variance was performed for each set of plant-season-location data. All means comparisons were made by Duncan's multiple range test at $P \leq 0.05$.

Production test results. 'Primetime' produced attractive fruit in Minnesota but did not survive the winter well. Michigan, New Jersey, and Pennsylvania trial results were adequate but inconclusive due to plant stand establishment difficulties and these trials were not included in the analyses. 'Primetime' plants yielded as much or more than did the standard cultivars in 1990, 1991, 1992, and 1994 in Beltsville, except in 1990 when it yielded less than 'Glooscap' and in 1991 when it yielded less than either 'Earliglow', 'Kent', or 'Lateglow' (Table 1). In first-year matted rows (1994), 'Primetime' yielded as much as

'Glooscap', but less than 'Allstar' and 'Cavendish' in Queenstown, and more than the standard cultivars in Keedysville (Table 2). In its second production year (1995), 'Primetime' yielded as much or more than did the standard cultivars in Queenstown (Table 2). The 2-year mean of yields for 'Primetime' was as high as for 'Allstar', 'Earliglow', and 'Lateglow' in Wooster (Table 3). On raised beds, following summer planting in Beltsville, 'Primetime' yielded as much as did 'Allstar', 'Guardian', and 'Lester', and more than 'Jewel' (Table 4).

The percentage of cull fruit produced by 'Primetime' usually was quite low. Marketable yields of 'Primetime' fruit were as high or higher than for the standard cultivars in all test years in matted rows in Beltsville (Table 1) and Wooster (Table 3), and on raised beds in Beltsville (Table 4).

The mean primary fruit mass of 'Primetime' was as high or higher than those of the standard cultivars in all test years in Beltsville, as was the mean fruit mass for each harvest season (Table 1). In Queenstown, the first-year midseason mean fruit mass of 'Primetime' was the same as those of 'Allstar', 'Cavendish', and 'Delmarvel', and higher than those of 'Glooscap'. However, in Keedysville, 'Primetime' fruit weighed less than those of 'Allstar' and 'Cavendish' (Table 2). In Wooster, the 2-year mean of individual fruit mass for 'Primetime' was higher than that for 'Earliglow', equal to that for 'Lateglow', and less than that for 'Allstar' fruit (Table 3). The mean individual mass of 'Primetime' fruit on raised beds in Beltsville was similar to those of the standard cultivars (Table 4).

Fruit characteristics. In Beltsville, fruit of 'Primetime' were consistently rated high in the field for appearance, symmetry, flesh firmness, skin toughness, exterior and interior color, flavor, and for overall fruit quality (Table 5). In Wooster, measurements of cortical firmness (1991) or flesh firmness (cortex + pith, 1992) indicated 'Primetime' fruit to be as firm as 'Lateglow' fruit, firmer than 'Earliglow', but softer than 'Allstar' (Table 6). The skin toughness of 'Primetime' fruit was similar to that of 'Earliglow' and 'Lateglow' fruit, but less than that of 'Allstar' fruit (Table 6).

Tristimulus reflectometry of 'Primetime' fruit skin and flesh characterized the new cultivar as bearing bright red fruit with lightly pigmented interiors (Table 7). Although the

Table 8. Earliness of flowering and plant characters (field rating scores) of 'Primetime' and several standard cultivars in Beltsville, Md., in 1990 and 1994.

		Plant characteristic (rating) ^z					
Cultivar	Flower stage ^y	Stand		Vigor		Leaf diseases	
		Fall	Spring	Fall	Spring	Fall	Spring
1990							
Allstar	--- ^x	7.3 ab ^w	7.1 bc	7.1	7.8 ab	7.1 a	6.8 ab
Lester	---	8.0 ab	7.9 ab	7.5	7.5 ab	7.0 a	7.8 a
Earliglow	---	8.4 a	8.8 a	8.0	8.6 a	6.1 b	7.0 ab
Primetime	---	7.0 b	6.1 c	7.4 ^{ns}	7.1 b	6.6 ab	6.5 b
1994							
Allstar	5.0 b	6.5 b	6.3 b	7.8	8.0 a	7.5 a	5.8 b
Lester	7.8 a	7.0 b	6.8 ab	7.8	7.5 a	7.0 ab	6.5 ab
Earliglow	8.8 a	7.5 b	7.3 ab	7.3	6.8 b	6.3 b	5.9 b
Primetime	4.5 b	8.8 a	8.3 a	8.3 ^{ns}	8.0 a	6.5 b	6.6 a

^xRatings on a 1–9 scale with 9 being the most desirable.

^yRatings on a 1–9 scale with 1 = few flowers open, 3 = all primary flowers open, 5 = 50% open, 7 = 75% open, and 9 = 100% of the flowers open at the rating time.

^zNot rated.

^wMeans separation in columns within years by Duncan's multiple range test at $P \leq 0.05$. ns indicates no significant differences among cultivars.

Table 9. Indices of earliness and concentration for fruit production of 'Primetime' and several standard strawberry cultivars grown in Wooster, Ohio, in 1991 and 1992.

Cultivar	Index of earliness ^z		Index of concn ^y	
	1991	1992	1991	1992
Allstar	1.52 c ^x	1.81 c	5.63 a	3.37
Earliglow	3.22 a	5.84 a	5.74 a	3.76
Lateglow	1.50 c	1.25 d	5.31 a	3.57
Primetime	2.09 b	2.27 b	4.86 b	3.54 ^{ns}

^xIndex of earliness (Brenneman and Scheerens, 1994) calculation method adapted from Khanizadeh and Fanous, 1992; larger values indicate earlier ripening of fruit compared.

^yIndex of concentration (Brenneman and Scheerens, 1994) calculation method adapted from Khanizadeh and Fanous, 1992; larger values indicate a more concentrated ripening season.

^zMeans separation in columns within and between years by Duncan's multiple range test at $P \leq 0.05$. ns indicates no significant differences among cultivars.

skin color of 'Primetime' was similar in redness (hue angle) to that of 'Allstar', it was darker (lower L value) and less highly pigmented (lower saturation index) than 'Allstar' fruit. Conversely, the skin color of 'Primetime' was more highly pigmented, but not nearly so dark, or as deeply red, as 'Earliglow' fruit. Thus, color measurements of 'Primetime' fruit classified this cultivar as exhibiting a "typical strawberry" red external fruit color, which concurred with visual ratings (Table 5), indicating its color to be slightly more desirable than that of 'Allstar's light red or 'Earliglow's darker red. Tristimulus ratings for internal fruit color were not as consistent or as definitive as those obtained for external color. However, in 1991, L and hue angle values suggested the internal fruit color of 'Primetime' to be similar to but slightly redder than that of 'Allstar' fruit, but not as highly colored as that of 'Earliglow' fruit.

Fruit of 'Primetime' contain less TSS than those of 'Earliglow' and 'Lateglow', and in 1991, less than 'Allstar' (Table 6). However, as is typical of most strawberry cultivars, the amount of TSS in 'Primetime' fruit varied by year and location; 4.6% and 6.2% in 1991 and 1992, respectively, in Wooster (Table 6), and 7.3% in 1994 in Beltsville (Wang et al., 1996). The principle carbohydrates in 'Primetime' fruit grown in Beltsville in 1994 were glucose (2.2%), fructose (2.1%), and sucrose (0.6%) (Wang et al., 1996).

In Wooster in 1991, 'Primetime' fruit had

TA values similar to those of the standard cultivars, but in 1992 'Primetime' fruit had higher TA than 'Allstar' fruit, but lower TA than did 'Lateglow' (Table 6). In Beltsville in 1994, the TA of 'Primetime' fruit (0.58%) was higher than that for fruit of 'Allstar' and 'Lester', similar to that of 'Earliglow' (0.59%), and less than that of 'Lateglow' fruit (Wang et al., 1996). 'Primetime' fruit had an average ascorbic acid content of 75 mg/100 g fresh mass—less than that of 'Lateglow' and 'Allstar' fruit. 'Primetime' fruit contained 0.44% citric acid, the major organic acid in strawberry fruit, compared to 0.31% in 'Allstar' and 0.62% in 'Lateglow' fruit (Wang et al., 1996).

Time of flowering and ripening. Plants of 'Primetime' flowered with those of 'Allstar' and later than those of 'Earliglow' and 'Lester' in Beltsville in 1994 (Table 8).

Fruit of 'Primetime' tend to ripen in midseason; however, ripening in relation to other cultivars may be affected by crop load and spring weather conditions. In Beltsville, 'Primetime' ripened ahead of 'Allstar' in 1990 and 1991, but with 'Allstar' in 1992 and 1994 (Table 1). On raised beds in Beltsville, 'Primetime' ripened ahead of 'Allstar', but with 'Lester' and 'Jewel' (Table 4). However, on matted rows, 'Primetime' ripened later than did 'Lester' in 1994 (Table 1). In Wooster, an index of earliness showed that 'Primetime' ripened earlier than 'Allstar' and 'Lateglow' and later than 'Earliglow' in 1991 and 1992

(Table 9). Relative differences in ripening periods for 'Primetime' fruit in different years and locations may be due to its lower responsiveness to some environmental conditions than other cultivars, resulting in a less concentrated ripening season for fruit of 'Primetime' compared to the standard cultivars. This phenomenon was observed in Wooster in 1991 (Table 8) when relatively high spring day/night temperatures resulted in an earlier emergence of flowers and subsequent compression of ripening that was greater for 'Allstar', 'Earliglow', and 'Lateglow' than for 'Primetime' (Brenneman and Scheerens, 1994). However, under more normal spring weather conditions in 1992, the indices of concentration of fruit ripening were similar among the cultivars (Table 8).

Plant growth and characteristics. Plants of 'Primetime' generally are moderate runner-plant producers, producing an adequate number of daughter plants to fill the bed and produce high fruit yields the following year. In Beltsville (Table 6) and Wooster (Table 3), plant stands of 'Primetime' were rated lower than for those of the vigorous runner-plant-producing cultivars Allstar, Earliglow, and Lateglow. This pattern also held in Keedysville and Queenstown (data not presented). In Beltsville, 'Primetime' plants generally were as vigorous as those of standard cultivars in all years tested.

Disease resistance

In Beltsville, 'Primetime' plants rated well for freedom from leaf diseases during the fall of the planting years (1989 and 1993), and in the spring of the production years (1990 and 1994) (Table 8). Because we relied on natural infection in the field (with no applications of postharvest fungicides), incidence and severity of the commonly encountered leaf diseases may vary from season to season and from year to year, depending on availability of inoculum and weather conditions. 'Primetime' plants scored ≤ 6.5 of a maximum score of 9.0 for freedom from leaf diseases in fall and spring seasons in 1989–90 and 1993–94. These ratings were generally similar or superior to those of the standard cultivars in each year's test. The leaf diseases generally encountered in Beltsville were powdery mildew [*Sphaerotheca macularis* (Wallr. ex Fr.) Jacz. f.sp. *fragariae*], leaf scorch [*Diplocarpon earliana* (Ell. & Ev.) Wolf], and leaf blight [*Phomopsis obscurans* (Ell. & Ev.) Sutton]. In recent years, certain virus-negative bud-lines (subclones) of 'Primetime' have been susceptible to powdery mildew.

Initially screened as a seedling to a mixture of *Phytophthora fragariae* races A-1, A-2, A-3, A-4, and A-6 in a greenhouse bench test (Scott et al., 1975), 'Primetime' plants were retested as an advanced selection to confirm resistance to red-stele disease. On a scale from 1 to 9 (1 = dead plant; 9 = apparently healthy plant), 'Primetime' consistently rated 8.0 to 9.0, indicating that it is resistant to at least these five races of *P. fragariae* (data not shown).

Technical description

Plants are medium to large, dense, vigorous, and moderate running. The trifoliate leaves are dark green adaxially with broad, rounded crenate margins, and light-green abaxially with prominent veins. The equal-sized leaflets are broadly elliptic, and the side leaflets are oblique at their bases. Petiolule size of the leaflets is equal. Petioles are thick, moderately pubescent, and tend to bear trumpet-shaped bracts at the midpoint of mature leaf petioles. Stipules are narrow and pointed.

Fruit are wedge to short-conic in shape and have broad shoulders and blunt tips (Fig. 2). The fruit cap (calyx of mature fruit) is clasping to partially reflexed at maturity and is composed of two whorls of alternating narrow elliptic and lanceolate members. Fruit skin color is a glossy scarlet (bright medium red), and its texture is firm. Achenes are yellow at maturity, numerous, and flush to slightly recessed. Fruit flesh is firm and pink. Fruit flavor is mild, sweet, and lightly aromatic at full maturity.

Availability

The USDA does not have plants of 'Primetime' for general distribution. Contact G.J. Galletta, USDA/ARS, Fruit Laboratory, 10300 Baltimore Blvd., Beltsville, MD 20705, for nursery plant sources.

Fig. 2. Fruit of 'Primetime' strawberry. The coin is 24 mm in diameter.

Literature Cited

- Brenneman, G.L. and J.C. Scheerens. 1994. Performance of new or uncommon strawberry cultivars grown under Ohio cultural conditions. The Ohio State Univ., Ohio Agr. Res. & Development Ctr.-Wooster, Circ. 298:99-108.
- Galletta, G.J. 1989. Northeastern United States strawberry cultivars. *Fruit Var. J.* 43(1):31-33.
- Khanizadeh, S. and M.A. Fanous. 1992. Mathematical indices for comparing small fruit crops for harvest time and trait similarity. *HortScience* 27:346-348.
- Luby, J.J. 1989. Midwest and Plains States strawberry cultivars. *Fruit Var. J.* 43(1):22-31.
- Ourecky, D.K. and M.C. Bourne. 1968. Measurement of strawberry texture with an Instron machine. *Proc. Amer. Soc. Hort. Sci.* 93:317-325.
- Sacks, E.J. and D.V. Shaw. 1993. Color change in fresh strawberry fruit of seven genotypes stored at 0 °C. *HortScience* 28:209-210.
- Scott, D.H., J.L. Maas, and A.D. Draper. 1975. Screening strawberries for resistance to *Phytophthora fragariae* with single versus a composite of races of the fungus. *Plant Dis. Rptr.* 59:207-209.
- Setser, C.S. 1984. Color: Reflections and transmissions. *J. Food Qual.* 6:183-197.
- Wang, S.Y., G.J. Galletta, and J.L. Maas. 1996. Fruit quality characterization of 24 strawberry cultivars and selections. *J. Small Fruit Viticult.* (In press.)