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An Evaluation of 'Melrose' Strains and Selections[1]

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Abstract

Trees produced from irradiated 'Melrose' scion wood were selected for improved fruit color and yield. These selections were compared to improved commercial color strains from France and experimental selections from England and a mutation from a commercial orchard. After 10 years, none of the selections differed from standard 'Melrose' in tree size or yield. Fruit color of standard 'Melrose' declined during the study and several irradiated selections and the strains from France and England had a higher percentage of red fruit surface. 'Dugast' and 'Melrouge' had consistently well colored fruit with darker and more intense red than standard 'Melrose' and are recommended for future plantings of 'Melrose.'

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'Melrose' originated as a cross of 'Jonathan' x 'Delicious' and was selected in 1937 by Dr. Freeman S. Howlett and released as a cultivar by OARDC in 1944 (6). According to the 1993 Ohio Orchard and Vineyard Survey, 226 orchards have planted a total of more than 36,000 trees of 'Melrose' and it remains an important cultivar in on-farm markets in Ohio and several other midwestern states. When compared with other cultivars, 'Melrose' has above average yields (2, 4, 5) and has less fluctuation in yield between years than several cultivars (3). 'Melrose' retains flavor and quality in storage and is a good apple to include in cider blends (6). Fruit color development of 'Melrose' is very sensitive to light and it responds remarkably to pruning treatments that improve light penetration (12).

Although 'Melrose' has many desirable attributes, there are several conditions that limit its production. Although it is productive over many years, it is relatively slow to come into bearing and it results in a large vigorous tree that can be difficult to contain in intensive plantings. In some years, red color is less than desirable and it is prone to russet in some years. In fact in a popular article it was referred to as "Big Ugly" and indicated that "the homely Melrose apple is an Ohio native whose fame has spread worldwide, strictly by word of mouth." (9)

One method that has been used to induce mutations to change the undesirable characteristics and retain the desirable features of an apple has been ionizing radiation (1, 8, 10, 11). Ionizing radiation has been used to induce spur habit in sweet cherry (7) and apple (8), reduce russeting and biennial bearing of apple (8), and influence apple fruit color (11). The objective of the present study was to improve fruit red color and secondarily tree growth and performance by subjecting 'Melrose' scions to ionizing radiation in hopes of inducing desirable mutations.

Table 1. Elite selections from 200 trees produced from irradiated 'Melrose' scion wood and grown for eight years at the Jackson branch of the Ohio Agricultural Research and Development Center.

		Avg yield 84 & 85		% Surface red				Russet[z]				
Selections	Irradiation level (Gy)	kg/t	kg/cm² TCA	84	85	86	87	84	85	86	87	Reason for selection
19	60	158	.43	61	54	64	58	2.6	3.0	2.5	2.6	high yield
82	70	126	1.67	—	43	71	49	—	3.4	2.6	3.3	yield efficiency
85	70	135	1.45	56	49	65	71	2.6	3.5	3.2	2.7	red color, yield efficiency
116	70	79	1.06	78	32	59	64	2.3	3.5	2.7	3.0	spury
131	70	162	1.20	83	73	59	67	2.5	2.7	2.7	2.5	bright color,high % surface red
139	70	177	1.61	—	67	58	72	—	2.9	2.4	3.0	bright color, large fruit
141	70	64	.91	—	—	74	68	—	—	2.9	2.7	bright color
162	60	71	.88	71	66	64	74	2.4	2.4	2.4	2.1	spury, precocious
Standard		64	1.20	66	55	78	65	2.5	2.5	2.6	2.7	control
Dugast		178	2.26	83	65	80	63	2.9	2.8	3.0	3.0	red color

[z]Russet rating: 1 = no russet to 5 = 100% russet.

Materials and Methods

INITIAL FIELD SCREENING

Current season growth of 'Melrose' was collected while still dormant in March 1977 from mature trees at Wooster, Ohio. The scion wood was surrounded by moist sphagnum and packed in ice chests for transportation to Columbus. Approximately 800 scions were loaded into chambers of 4-inch plastic pipe and placed in contact with the core of the Ohio State University Nuclear Reactor. The gamma radiation was at a level of 16 Gy/hr when the chamber was inserted. The scions were left in the chamber for approximately 4.75 hours. Due to different locations in the core, some scions received 60, 70 or 80 Gy total dose. The scions were united to 1000 M.7 rootstocks by a whip and tongue graft, kept at room temperature for five days and then returned to storage for planting out in the field in April at the Lane Avenue Farm in Columbus. Survival of the grafts depended on total dose and was as follows: 60 Gy–74 survived (21%); 70 Gy–28 survived (11%); 80 Gy only 1 survived. Where possible a single shoot was retained from the rootstocks of the failed grafts to serve as a rootstock for budding.

In August 1977 scion wood from the same parent trees was cut, leaf blades removed immediately, and the terminal 20% discarded. Scions were packed with moist sphagnum in ice chests and transported to the reactor. The same procedure was used to irradiate the scions, but they were removed when they received a total dose of 67Gy. Two buds were placed on 390 remaining M.7 that had developed single shoots after the grafts above failed, on August 24, 1977. In addition to the irradiated scion wood, 10 buds of the standard 'Melrose' at OARDC and 'Dugast' a red strain from France were made and handled as previously described. After natural leaf fall in 1978, the finished trees were dug, stored in refrigerated storage until planting at the Jackson Branch of the Ohio Agricultural Research and Development Center in Jackson, Ohio on May 4, 1978. Trees were spaced 3.0 m x 6.1 m and 'Pioneer Scarlet,' 'Golden Delicious' and 'Empire' were used as pollenizers. A total of 208 trees were planted with 103 originating from grafts and 105 from buds.

Table 2. Tree size and cumulative yield and yield efficiency of 16 strains of 'Melrose' apple trees. (5 replications)

Selections	Trunk cross-sectional area (cm^2)	Tree size (m)		Cumulative (1990-1999)	
		height	spread	(kg/tree)	(kg/cm^2TCA)
Standard	75.9abc[z]	3.0ab	3.0	152.7abc	1.99ab
Ohio Irradiated					
19	64.4c	2.8ab	2.8	127.9abc	1.99ab
82	111.8ab	3.2ab	3.6	200.8a	2.04ab
85	70.3bc	3.1ab	3.4	160.5abc	2.26a
116	61.2bc	2.7ab	3.0	137.3abc	2.22ab
131	58.5bc	2.9ab	2.6	136.8abc	2.17ab
139	138.0a	3.3a	3.2	180.7ab	1.99b
141	63.9bc	3.3a	3.1	159.8abc	2.22a
162	55.2bc	2.9ab	3.1	109.5bc	1.95ab
English					
B10	54.3bc	2.9ab	2.8	117.9abc	2.08ab
B17	55.6bc	3.0ab	2.8	142.8abc	2.58a
B18	47.7bc	2.7ab	2.6	96.7bc	1.95ab
Commercial					
French Red	65.0bc	3.1ab	2.9	155.7abc	2.40a
Sage	41.3c	2.4b	2.7	90.7c	2.17ab
Dugast	56.9bc	2.7ab	2.5	136.4abc	2.40a
Melrouge	56.3bc	2.8ab	2.9	130.9abc	2.31a

[z]Mean separation by Duncans Multiple Range Test P > 0.05.

Trees were unpruned and given no training except to remove low branches that interfered with weed control. Soil management was a herbicide strip with mown row middles and an annual application of nitrogen applied as 56 g of ammonium nitrate per year of tree age. Trees received normal insect and disease control sprays.

Observations were recorded annually for flowering, spuriness, fruit color and productivity. In 1984, 40 trees were selected that appeared to have some promise for one or more of these characteristics.

In addition to yield and trunk circumference, a random sample of 10 fruit from each of these trees was collected, weighed, rated for redness (1 light red to 5 dark red), russet (1 = no russet to 5 = 100% russet), % fruit surface red, and a chromometer reading on the red cheek (Model CR-100; Minolta, Ramsey, NJ). After four years (1984-1987) of these measurements, eight advance selections were made.

COMPARISON OF ADVANCED SELECTIONS

Mark rootstock was planted in a nursery in Wooster in the spring of 1988 and budded in August to the 8 Ohio irradiated selections; standard 'Melrose'; three 'Melrose' selections from England (B10, B17, B18) chosen for improved red color; 'Sage Melrose' selected from a commercial orchard near Chardon, Ohio, because it had spur growth habit and the three named selections from France with improved color: 'French Red,' 'Melrouge,' 'Dugast.' These trees were dug following leaf fall in November of 1989, stored in refrigerated storage and set out in the spring of 1990 with five replications at OARDC, Wooster. The trees were spaced 2.5m x 5m, supported with wooden stakes, trained to a central leader with minimal pruning. Trees of five other cultivars were interspersed to serve as pollinizers. The selections were arranged as a randomized block with five replications.

Table 3. Fruit color of 16 strains of 'Melrose' apples.

	% Fruit surface red						Color 4-year average[z]		
Selections	1992	1993	1994	1997	1998	1999	L	Hue angle	Saturation index
Standard	98.0	86.7abcd[y]	83	84abc	76	54b	37.0a	40.9ab	32.6a
Ohio Irradiated									
19	91.6	86.0abcd	71	84abc	82	80a	36.9a	40.8ab	31.7a
82	97.4	88.0abcd	87	88abc	83	69ab	36.2a	40.1abc	30.3a
85	—	84.2bcd	83	776	76	79a	35.9a	40.2abc	31.7a
116	97.2	88.2abcd	86	91abc	82	82a	35.1a	39.8abc	30.7a
131	90.2	89.5abcd	80	84abc	83	83a	35.9a	39.6abc	31.3a
139	89.0	85.0abcd	83	87abc	87	75a	35.4a	39.6abc	32.1a
141	97.0	88.1abcd	91	80abc	78	79a	35.6a	38.9ab	31.0a
162	93.8	81.1cd	70	92ab	84	90a	36.1a	39.5abc	29.9ab
English									
B10	96.2	86.2abcd	83	92ab	79	76a	36.1a	39.9abc	30.7a
B17	98.4	89.5abcd	84	86abc	88	75a	36.3a	40.3ab	30.5a
B18	93.4	79.0d	72	90abc	85	78a	36.9a	40.9ab	31.1a
Commercial									
French Red	94.4	90.9abc	91	78bc	83	74ab	35.6a	39.4abc	31.5a
Sage	—	88.7abcd	69	77c	82	54b	37.0a	41.1a	31.7a
Dugast	99.6	94.7ab	91	93a	90	89a	73.2b	38.6bc	27.7bc
Melrouge	95.8	95.8a	87	87abc	89	91a	82.9b	38.1c	26.6c

[z]Data from 1993, 1994, 1997, 1999. Lightness = lower the value the darker the color; Hue Angle, the lower the value the brighter red; Saturation index the lower the value the denser the pigment.
[y]Mean separation by Duncans Multiple Range Test $P \leq 0.05$.

Flower clusters per tree were counted in 1992 and 1993. Trunk circumference and yield were recorded annually. A random sample of 10 fruit per tree was taken annuallly and rated for the following: % fruit surface red, russet (1 no russet to 5 severe scarf skin); chromometer reading on red side of fruit. In 1999 tree height and spread in two directions was measured.

Results and Discussion

INITIAL FIELD SCREENING

Previous work with apple indicated that apple could survive doses of 60-77 Gy and the occurrence of reversions did not differ between irradiating dormant or vegetative summer buds (11). These investigators found that 'Rome Beauty' was more tolerant of irradiation than 'Delicious.' Due to the way their scion wood received the radiation, the base where the graft union was made received a minimal dose and the tip received a higher dose. They had a very high rate of survival. Our success was much lower possibly because 'Melrose' is more sensitive to irradiation or because the wood at the graft union received a higher dose. A dose of 80 Gy caused nearly a total loss and with 70 Gy only 11% survived and 60 Gy 21%. The buds taken in August received 67 Gy and resulted in 27% survival.

Six of the eight final selections received a total dose of 70 Gy (Table 1). Selections 19, 82, 85, 131, 139 and 'Dugast' appeared to have higher early yields than standard 'Melrose.' Several selections may have had higher percentage red fruit color or lower russet in some years, but the pattern was not consistent. Several trees that were not selected had completely russeted fruit each year. Since it is difficult to draw firm conclusions from data on a single tree, these eight were selected for a more detailed replicated study.

COMPARISON OF ADVANCED SELECTIONS

In 1992 the first bloom occurred and there were no differences among the selections. In 1993 differences among selections were small, but selection 85 and 'French Red' had more flower clusters than the standard 'Melrose.' (Data not presented.)

None of the selections differed from standard 'Melrose' in tree size after 10 years in the orchard (Table 2). Selection 139 had a larger trunk cross-sectional area than all selections except 82 and standard 'Melrose.' Irradiation did not markedly

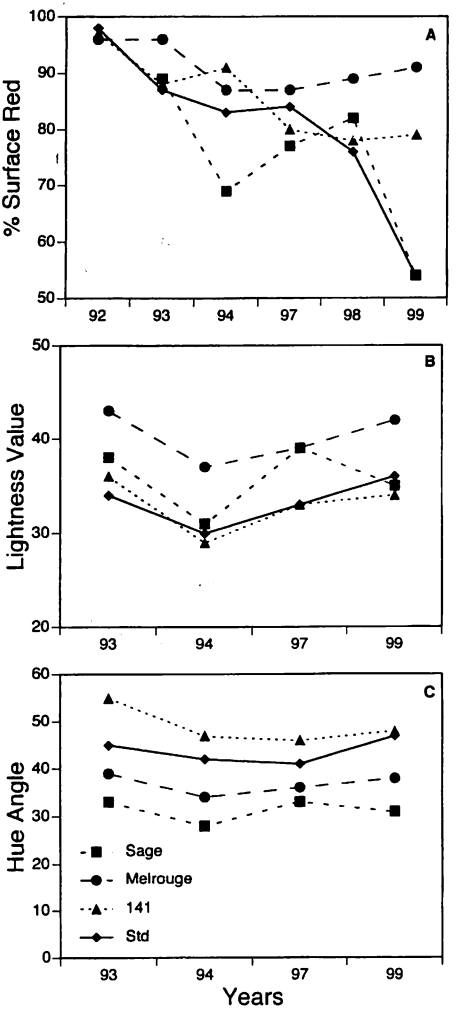

Figure 1. Comparison of the percentage of the fruit surface that was red (A), lightness (B), and hue angle (C) with the lower the value the brighter the red of fruit color over time of selected 'Melrose' strains.

change growth habit or shoot type as occurred in some previous work (7, 8), and the only true spur type tree was 'Sage Melrose' that occurred as a natural mutation in a commercial orchard. All selections had similar cumulative yields and yield efficiency to standard 'Melrose.' In evaluating yields for each year the same pattern existed, except for 1994, when 'French Red' had a higher yield than standard 'Melrose.'

Since improving fruit color was a primary goal of this study, the values for the average percentage of the fruit surface being red are presented for the first and last three years (Table 3, Fig. 1A). Differences among selections were significant in 1993, 1997 and 1999. In 1993 and 1997, none of the selections differed from standard 'Melrose,' but in 1999 most selections had redder fruit than standard 'Melrose.' The 'Sage Melrose' selection had a spur type upright tree habit with generally poorly colored fruit (Fig. 1A). Generally fruit color of standard 'Melrose' declined during the course of the study, while the commercial selections particularly 'Dugast' and 'Melrouge' had consistently high levels of fruit color. These selections generally were slightly better colored than the best irradiated selections, although the differences were generally not statistically significant. An evaluation over four years found that 'Dugast' and 'Melrouge' fruit were darker than other strains. These strains also tended to have redder color on the red cheek, as measured by hue angles, than standard 'Melrose,' but were similar to several other strains. Saturation index was also lower for 'Dugast' and 'Melrouge' than all strains except 162. A paired comparison analysis indicated that of the irradiated strains, 116 had darker fruit than standard 'Melrose,' but none of the irradiated strains differed from standard 'Melrose' in hue angle. None of the selections differed from standard 'Melrose' in the following parameters (data not presented): russet, scarf skin, firmness, length/diameter (shape). Average fruit size of the 'Sage Melrose' was smaller than standard 'Melrose' and selection 162 in 1994. In 1997, average fruit size of selection B10, B18 and 'Sage' was smaller than standard 'Melrose.' In other years, fruit size did not differ among the selections.

In summary, irradiation did result in several strains with slightly better color than standard 'Melrose,' but none were better than the French strains 'Dugast' and 'Melrouge.' Since yield and other fruit characteristics of these strains were similar to standard 'Melrose,' 'Dugast,' or 'Melrouge' would be suggested for planting for their consistency of red color formation.

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