Fruit Varieties Journal 47(2):103-109 1993

Comparison of Tree Growth, Fruit Characteristics, and Fruit Quality of Five 'Gala' Apple Strains

DUANE W. GREENE[1] AND WESLEY R. AUTIO[1]

Abstract

A 'Gala' strain trial was established in 1988 that included 'Kidd's D-8,' 'Royal,' Tenroy 'Scarlet,' 'Imperial,' and 'Regal' Fulford on M.26. All strains bloomed profusely in the third and fourth leaf on both 1-year-old and 2-year-old wood. Bloom density on 'Imperial Gala' was generally lower than on the other strains. Strains differed little in vegetative growth. The fruit of all strains colored well, but the red-coloring selections generally had better color. Quantitative differences in red color among strains was not consistent. 'Regal Gala' was an early maturing strain, based on higher ground color index, starch index, soluble solids, and incidence of fruit cracking and lower flesh firmness. Fruit appearance and quality were evaluated with a trained panel using a quantitative descriptive analysis method. 'Regal Gala' was rated as the most attractive strain. Taste panelists judged 'Royal,' 'Scarlet,' and 'Regal' to have better flavor and to be, overall, more desirable than 'Kidd's D-8 Gala.'

Introduction

'Gala' is an apple that has experienced a recent and rapid rise in popularity throughout the world. It is being heavily planted in Europe, South America, New Zealand, and the United States (13). 'Gala' represented 25% of all trees sold by Washington State nurseries in 1990 (1).

'Gala' has many desirable attributes including very high flesh quality, attractive appearance, precocity, and high production. The original strain of 'Gala' is not a red apple but it is cream-yellow with an orange-red cheek. Mutations in fruit skin coloring occur readily (13). Red coloring sports were described by Norton et al. (6). Growers generally prefer red coloring strains because of the ease that they develop red color, and nurserymen are looking for new strains that will give them a competitive edge. It is commonly accepted that the red coloring strains of 'Delicious' that are being sold today, although very attractive, have decidedly inferior quality compared with the original 'Delicious' strain (5). Stebbins (8) further pointed out that production from some 'Delicious' strains may differ by as much as 300%.

Walsh and Voltz (11) and Walsh et al. (12) evaluated ripening and fruit characteristics of some 'Gala' strains growing in New Zealand and in Maryland. Kappel et al. (4) recently reported on a sensory comparison of several strains of 'Gala' in British Columbia; however, there has been no comprehensive evaluation of 'Gala' strains. This study reports on the growth, flowering, fruit characteristics, and fruit quality of five strains of 'Gala' apples.

Materials and Methods

'Kidd's D-8' and 'Royal Gala' Tenroy were obtained from Stark Bros. Nursery, Louisiana, Missouri, and 'Imperial' and 'Regal Gala' Fulford were obtained from Newark Nursery, Hartford, Michigan. All trees were on M.26 and were similar in caliper at planting. Propagating wood of 'Scarlet Gala' was obtained from Turkey Hollow Nursery in the spring of 1987, bench grafted on M.26 rootstock and then lined out in the nursery. In the spring of 1988 all trees were planted at the University of Massachusetts Horticultural Research Center in Belchertown, Massachusetts as eight single-tree replicates in a randomized complete block design. Each tree was supported by a 2.5 cm x 3 m metal conduit post (set 1 m in the ground).

[1]Department of Plant and Soil Sciences, University of Massachusetts, Amherst, MA 01003.

The first data on these trees were taken in 1990. Prior to bud break in 1990 a line was painted 50 cm above the soil surface and the truck circumference was measured. Two limbs per tree were selected at the pink stage of flower development and the circumference was measured. The number of blossom clusters on 1-year-old and 2-year-old wood was counted. At the normal harvest date on September 14, fifteen fruit per tree were harvested. Fruit were weighed and the percent red color on each fruit was estimated to the nearest 10%. A ground color chart was adapted from a New Zealand chart provided by Dr. Ian Warrington using the Pantone® Color Specifier Book 747XR (Table 1). Flesh firmness was determined with an Efegi penetrometer using two punctures per fruit. Soluble solids was determine with a hand refractometer from a composite sample of juice collected during the penetrometer test. Ten fruit were cut in half, dipped in iodine solution and the starch remaining was rated using a 'Golden Delicious' starch chart (Saltveit and Hale, 1982). After leaf fall, height, spread, and trunk circumference was measured.

Similar data were taken in 1991 with the following changes. In addition to bloom density, fruit set was assessed on the two tagged limbs in July by determining separately the fruit persisting on 1-year-old wood and on older wood. Fifteen fruit per tree were harvested on 3, 12, and 19 September and evaluated similarly to that described in 1990. Fruit were evaluated on each date for stem-end cracking. In addition, the length and diameter on each fruit was measured and the L/D ratio calculated.

On September 19, twenty kg of fruit were harvested from each strain and placed in air storage at 0°C. Fruit were removed from storage on 10 October, and the sensory, visual, and overall characteristics were evaluated with a trained panel, using a quantitative descriptive analysis method described by Kappel et al. (4). The 17 judges used in this evaluation included pomology faculty, pomology graduate students, technical assistants, and students in an orchard management class who were previously exposed to two apple cultivar evaluation laboratories. Each panelist evaluated 3 replications. A replication included 1 fruit of each of the five 'Gala' strains and one reference fruit to which all of the strains

Table 1. 'Gala ground color chart.

Ground color number	Pantone® number	Ground color
1	383 c	Green
2	390 c	Green
3	584 c	Light green
4	585 c	Green-yellow
5	586 c	Yellow-green
6	587 c	Yellow-green
7	127 c	Yellow
8	121 c	Yellow-orange
9	128 c	Orange-yellow
10	141 c	Orange

Table 2.

Code number ☐

Gala Strain Sensory Evaluation

		Reference fruit	
Visual			
Brightness of color	dull		bright
Uniformity of color	blotchy		uniform
Attractiveness	dislike		like
Sensory			
Aroma	like		dislike
Skin toughness	low		high
Flesh crispness	low		high
Flesh juiciness	low		high
Sweetness	low		high
Acidity	bland		tart
Starchiness	low		high
Flavor	dislike		like
Overall			
Desirability	dislike		like

were compared. The reference fruit was 'Kidd's D-8,' and this fact was not divulged to the panelists.

Judges scored each fruit on an 8.5 cm horizontal scale with opposite descriptive terms at each end of the line and the center represented by the reference fruit (Table 2). The intensity of deviation of each fruit from the reference fruit was recorded by a pencil mark either to the right or left of the reference fruit. Responses were quantified by measuring the distance in cm that the response was to the left (—) or to the right (+) of the line representing the reference fruit.

All data were subjected to analysis of variance. The treatment means were compared using Duncan's new multiple range test.

Results

All strains of 'Gala' bloomed extensively and comparably on 1-year-old wood (Table 3). Spur bloom density was lowest on 'Scarlet Gala' and highest on 'Royal Gala' in 1990, but there were no differences in 1991. In general, the bloom density on 'Imperial Gala' was lower than on the other strains. Fruit set on all strains of 'Gala' was comparable and very heavy. Over two-thirds of the bloom on 'Gala' strains were lateral flowers on 1-year-old, wood and following June drop over two-thirds of the fruit persisting originated from lateral flower clusters.

One harvest was made in 1990; whereas, fruit were harvested three times in 1991. Since there were no strain x time interactions, fruit harvest data in 1991, except for cracking, represent the average of three harvests. There were no differences in fruit weight among strains in 1990, but in 1991 'Regal Gala' stood alone as the strain with the heaviest fruit. Strains differed in flesh firmness but the differences were not consistent in the two years evaluated. 'Royal,' 'Scarlet,' and 'Imperial' were firmer than 'Regal' in 1990, while in 1991 'Scarlet' was firmer than 'Imperial' and 'Kidd's D-8.' Differences in soluble solids were inconsistent; however in both years, 'Regal' had higher soluble solids than 'Kidd's D-8,' 'Royal,' and 'Imperial.' All strains of 'Gala' colored well, although red coloring selections generally had more red color. Quantitative differences in red color among red coloring sports were not consistent. 'Regal' had the highest ground color rating indicating a greater loss of chlorophyll than the other strains. Strains did not differ in either starch index or

Table 3. Flower bud formation and fruit set of five strains of 'Gala'/M.26.

Strain	Bloom density (blossom clusters/cm² limb cross-sectional area)			Fruit set (fruit/cm² limb cross-sectional area)		
	Spur	Lateral	Total	Spur	Lateral	Total
	1990					
Kidd's D-8	8.1 ab	19.2 a	27.3 ab	---	---	---
Royal	9.7 a	19.1 a	28.8 a	---	---	---
Scarlet	2.5 c	19.8 a	22.3 bc	---	---	---
Imperial	5.3 bc	15.9 a	21.2 c	---	---	---
Regal	7.1 ab	15.8 a	22.9 bc	---	---	---
	1991					
Kidds's D-8	10.4 a	22.8 a	33.2 a	5.5 a	13.2 a	18.8 a
Royal	10.2 a	19.7 a	29.9 ab	6.8 a	12.0 a	18.7 a
Scarlet	9.4 a	20.5 a	29.8 ab	4.7 a	12.0 a	16.7 a
Imperial	7.4 a	18.1 a	25.4 b	3.9 a	10.4 a	14.3 a
Regal	8.0 a	20.7 a	28.6 ab	3.6 a	10.6 a	14.2 a

Mean separation within columns and years, Duncan's new multiple range test, P = 0.05.

Table 4. Fruit characteristics and fruit quality of five strains of 'Gala'/M.26 at harvest.

Strain	Fruit weight (g)	Flesh firmness (N)	Soluble solids (%)	Red color (%)	Ground[z] color index	Starch[y] index	L/D ratio	Pedicle-end cracking[x] (%)
				1990				
Kidd's D-8	171 a	88.1 ab	14.2 b	74 b	7.1 b	5.6 a	---	---
Royal	166 a	91.3 a	14.6 b	88 a	7.1 b	5.0 a	---	---
Scarlet	160 a	90.4 a	15.0 ab	80 ab	7.2 b	5.4 a	---	---
Imperial	172 a	91.7 a	14.5 b	86 a	7.2 b	4.7 a	---	---
Regal	177 a	83.9 b	15.7 a	84 ab	8.1 a	6.8 a	---	---
				1991				
KIdd's D-8	141 b	83.9 b	13.0 c	70 c	6.7 b	5.4 a	0.86 a	2.2 b
Royal	145 b	86.7 ab	13.2 b	77 b	6.8 b	5.2 a	0.87 a	1.1 b
Scarlet	150 b	89.9 a	14.2 a	78 b	6.9 b	5.1 a	0.86 a	4.6 b
Imperial	151 b	85.7 b	13.3 b	87 a	6.9 b	5.3 a	0.87 a	6.7 b
Regal	169 a	85.7 ab	14.4 a	89 a	7.5 a	5.9 a	0.86 a	21.1 a

[z]Adapted from a New Zealand Gala ground color chart provided by Dr. Ian Warrington, 1 = green; 10 = orange.
[y]Starch chart, 1 = immature; 9 = overmature.
[x]Cracking on the third harvest, September 19, 1991.
Mean separation within columns and years by Duncan's new multiple range test, P = 0.05

L/D ratio. No stem-end cracking was observed on fruit in the first harvest, and only 5 fruit in total (involving three cultivars) were noted in the second (data not shown). 'Regal Gala' showed significant cracking on the third harvest date, while fruit of the others strains were comparable and had much lower levels of cracking (Table 4).

At the end of the third leaf, 'Gala' strains differed little in vegetative growth. The height of all 'Gala' strains was comparable, while the spread of 'Scarlet' was smaller than the others (Table 5). The trunk circumference increase of all 'Gala' strains in 1990 was similar, but the total cross-sectional area of 'Scarlet' was less.

Taste panelists were able to distinguish differences in quality and appearance among the 'Gala' strains. 'Royal,' 'Scarlet,' and 'Regal Gala' all were judged to have better flavor than 'Kidd's D-8.' 'Royal' and 'Scarlet' had the crispest flesh. The flesh of all red coloring strains was more acid than 'Kidd's D-8.' There were no differences among strains in aroma, skin toughness, juiciness, sweetness, and starchiness.

'Regal Gala' was judged to be the most attractive 'Gala' strain. It also had the brightest red color and the most uniform color. 'Royal,' 'Scarlet,' and 'Imperial Gala' had brighter red color than 'Kidd's D-8.'

When panelist considered all factors and rated overall desirability; 'Royal,' 'Scarlet,' and 'Regal' were selected as being better than 'Kidd's D-8.'

Discussion

'Gala' is a new apple cultivar that was selected because it had superior taste. Its preference in taste panel evaluations has been confirmed (2, 9). There is legitimate concern that the

Table 5. Growth in 1990 of five strains of 'Gala'/M.26 planted in 1988.

Strain	Tree height (m)	Tree spread (m)	Trunk cross-sectional area (cm^2)	
			Increase in 1990	Total cross-sectional area
Kidd's D-8	2.9 a	2.4 a	3.6 a	13.4 a
Royal	3.0 a	2.3 a	3.9 a	14.2 a
Scarlet	2.7 a	1.5 b	3.5 a	10.2 b
Imperial	3.1 a	2.3 a	4.3 a	13.2 a
Regal	2.8 a	2.1 a	4.1 a	12.5 a

Mean separation within columns, Duncan's new multiple range test, P = 0.05.

Table 6. Visual and sensory evaluation of five strains of 'Gala'/M.26 fruit at harvest.

	Sensory							
Strain	Aroma	Skin toughness	Flesh crispness	Juiciness	Sweetness	Acidity	Starchiness	Flavor
Kidd's D-8	-0.12 a	0.19 a	0.11 b	0.18 a	0.17 a	-0.29 c	0.00 a	0.14 c
Royal	-0.33 a	0.49 a	0.76 a	0.40 a	0.50 a	0.59 ab	-0.24 a	0.92 a
Scarlet	0.00 a	0.49 a	0.75 a	0.34 a	0.36 a	0.81 a	-0.11 a	0.71 ab
Imperial	-0.63 a	0.53 a	0.18 b	0.33 a	0.09 a	0.26 b	-0.15 a	0.39 bc
Regal	-0.13 a	0.56 a	0.36 b	0.41 a	0.73 a	0.49 ab	-0.03 a	1.07 a

	Visual			
	Color brightness	Color uniformity	Attractiveness	Overall desirability
Kidd's D-8	0.11 c	-0.05 c	0.12 b	0.19 b
Royal	0.84 b	0.91 b	0.71 b	0.77 a
Scarlet	0.72 b	0.59 bc	0.47 b	0.72 a
Imperial	0.71 b	0.75 b	0.79 b	0.46 ab
Regal	1.68 a	1.70 a	1.55 a	0.98 a

Mean separation within columns, Duncan's new multiple range test, P = 0.05.

'Gala' strains, selected solely on the basis of red skin color, may not have the same high quality characteristic of the original 'Kidd's D-8' strain. Overall, 'Regal,' 'Royal,' and 'Scarlet Gala' emerged as having superior flavor, being more attractive, and being overall more desirable. When the potential for larger fruit size and brightness of fruit skin color are also considered, 'Regal Gala' may be considered the best 'Gala' strain. However, 'Regal Gala' may suffer from a lack of consumer recognition because it is less similar in appearance to 'Kidd's D-8' than the other red-coloring strains (6). In a similar evaluation of 'Gala' strains, but lacking 'Scarlet Gala,' Kappel et al. (4), were unable to detect taste differences among strains. Visual differences were detected, however. 'Regal Gala' had the brightest red color, similar to that reported in this investigation. Judges in their study, however, perceived 'Royal Gala' to be most attractive; whereas, we selected 'Regal Gala.' Stebbins et al. (9) reported that in one taste evaluation 'Imperial Gala' was preferred over 'Kidd's D-8,' 'Royal,' and 'Regal Gala.'

There were clear indications that 'Regal Gala' was an early maturing strain. As 'Gala' ripen ground color index, starch index, red color, soluble solids and fruit cracking increase while firmness decreases (12). 'Regal Gala' was consistently different from the other strains in each category in a way that indicates advanced ripening. Therefore, we suggest that 'Regal' is an early maturing strain of 'Gala.' The other red-coloring strains appeared to ripen at a similar time to 'Kidd's D-8 Gala.' Walsh and Voltz (11) compared ripening of 'Royal' and 'Regal Gala,' and they concluded that these strains ripened at a similar time, based primarily on ethylene evolution, even though the fruit of 'Regal Gala' were frequently less firm.

Cracking at harvest has been cited as a problem with 'Gala' in some areas, and that problem may be associated with uneven ripening (12). If trees are thinned properly and pruned to allow good light exposure, we have observed that 'Gala' can be picked in just two harvests in Massachusetts. In this investigation, no significant cracking occurred until the last harvest, and even then, it was restricted to 'Regal Gala.' All strains could have been harvested before September 19, 1991, and 'Regal Gala' at least a week earlier, when

cracking was minimal. Therefore, we feel that cracking is not a problem with 'Gala' if fruit are harvested at the proper time. When cracking does become a problem, fruit maturity has advanced to a point where the fruit feel 'greasy,' and postharvest life has been diminished significantly. In areas where 'Gala' ripen over a longer time, and harvesting at the proper time is more difficult, cracking may be a more significant problem.

Apples generally flower and produce fruit on wood that is at least 2-years-old. Some cultivars produce a large amount of lateral bloom, but the amount is usually rather erratic, depending upon weather, and it is usually less than spur bloom. All 'Gala' strains produced a consistent and large percent of the total bloom on 1-year-old wood, and much of this bloom set fruit. Fruit produced from bloom on 1-year-old wood was generally small, and this was emphasized by Walsh (10) and confirmed in a recent study on 'Royal Gala' by Greene and Autio (2). Since fruit size in general is small on 'Gala,' and lateral fruit are even smaller, it is important to develop a thinning strategy for all strains of 'Gala' to selectively remove fruit developing from lateral bloom.

Bloom on 'Imperial Gala' was lowest of all strains and significantly different from 'Kidd's D-8' in both years. Bloom on all trees was considered 'snowball' and excessive when compared with most other cultivars. Although the reduced bloom on 'Imperial' may be real, it is of little practical significance because of the excessive bloom that occurred on all strains in this trial.

'Scarlet Gala' trees were smaller at planting because they were bench grafted and grown for only one year, while the other strains were larger because they were budded on roots that were in the ground for one growing season and grew an additional year. Therefore, the small spread and trunk cross-sectional area of 'Scarlet Gala' trees is probably a reflection of the tree size at planting rather than inherent vigor related to strain.

There is no consensus in the several reports on ripening, fruit characteristics, and taste of 'Gala' strains. This may be attributed to different environmental factors or to evaluation using fruit from very young trees. Alternatively, 'Gala' has shown a degree of genetic instability, to the extent that 'Royal Gala' propagating wood is reselected each year in New Zealand to assure uniformity (5). We have no assurance that the strains that are being evaluated in different locations are genetically identical.

Literature Cited

1. Buckner, L. R. 1991. Production, planting trends vital to planning decisions. Goodfruit Grower 42(4):28-31.
2. Greene, D. W. and W. R. Autio. 1990. Comparison of ripening and fruit quality of 'Gala' and 'McIntosh' apples at harvest and following air storage. Fruit Var. J. 22:1-4.
3. Greene, D. W. and W. R. Autio. 1992. Increasing fruit size of 'Gala.' Fruit Notes 57(2):1-4.
4. Kappel, F., M. Dever, and M. Bouthillier. 1992. Sensory evaluation of 'Gala' and 'Jonagold' strains. Fruit Var. J. 46:37-43.
5. Norton, R. A. 1991. The apple strain game. Good Fruit Gorwer 42(17):3.
6. Norton, R. A., R. A. Stebbins, W. D. Lane, and J. A. Ballard. 1989. The strains of 'Gala,' 'Fuji,' and 'Jonagold' described. Goodfruit Grower 40(7):7, 40.
7. Saltveit, M. and S. A. Hale. 1982. Determining the Maturity of North Carolina Apples: 'Golden Delicious.' North Carolina Agr. Ext. Serv. Bul. AG-282.
8. Stebbins, R. L. 1989. Apple varieties for the future. Proc. 95th Annual Meeting Mass. Fruit Growers' Assoc. 95:32-39.
9. Stebbins, R. L., A. A. Duncan, C. O. Compton, and D. Duncan. 1991. Apple variety trial 1990 progress report. Oregon State University Extension Service.
10. Walsh, C. S. 1990. Particulars about the 'Gala' apple. Proc. 96th Annual Meeting Mass. Fruit Growers' Assoc. 96:122-124.
11. Walsh, C. S. and R. Voltz. 1990. 'Gala' and the red 'Gala' sports: A preliminary comparison of fruit maturity. Fruit Var. J. 44:18-22.
12. Walsh, C., B. Slatler, T. Solomos, and A. Thompson. 1991. Determining 'Gala' maturity for different storage regimes. Good Fruit Grower 42(6):6-10.
13. White, A. G. 1991. The 'Gala' apple. Fruit Var. J. 45:2-3.