most of the wax from the 'Hamlin' (Fig. 4C-D) and 'Valencia' (Fig. 4G thru I) orange surfaces. The remaining wax was left as droplets (Fig. 4C, 4G, 4H) or in reticulate patterns (Fig. 4G). High magnification of the dewaxed surface revealed many small bumps on the orange peel surface (Fig. 4I, observed at 22,000X, printed at 14,700X). Whether these are real structures or preparation artifacts was not determined.

The orange peel epicuticular wax layers still appear to be a principal factor in retarding water loss even though, unlike grapes (6), oranges have some functional stomata (1). The amount of wax deposited on the surface of the orange under a given set of environmental conditions could ultimately determine the susceptibility of that orange to many physiological peel disorders. The relative importance of the surface platelet wax and of the wax plugging stomata is difficult to evaluate (5) but should not be overlooked. Lack of any stomata near the button may contribute to its resistance to SERB. It seems likely, however, that the wax coating is so heavy that stomata would not function even if present.

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Changes in Soluble Solids, Red Pigment Content, and Firmness of Table Beet Cultivars with Growing Time and Season[1]

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Abstract. Changes in soluble solids, red pigment, and firmness of 2 table beet cultivars with growing time were evaluated during 3 seasons. In 1969 and 1970 there were significant cultivar differences in soluble solids. There were significant changes in soluble solids with growing time all 3 seasons due primarily to drought. Highly significant differences existed in the red pigment content of cultivars. Red pigment content of the roots increased with growing time during 2 seasons, but the opposite was true during the 3rd season. Firmness of the processed product increased greatly with growing time during all 3 seasons. There was a highly significant difference in firmness of 2 cultivars grown all 3 seasons. All 3 quality attributes varied with root size, small roots having higher soluble solids and red pigment contents and slightly lower firmness than medium sized roots.

Color, flavor, and texture are important quality attributes of table beets. All 3 are subject to considerable variation in the commercial pack of canned beets and some of the variation is related to differences in the raw product.

Color of the raw product has been reported to be influenced by cultivar (5, 6, 8, 9, 18, 19), location (10, 15), planting dates and harvest dates (1, 5, 6, 8, 9, 10, 18), soil moisture (5, 11, 14, 18), and soil fertility (1, 11, 15). Temperature during the growing season is probably the most important factor affecting color (1, 5, 6, 8, 9, 11, 18) with poor color resulting from high temp (over 25°C) during growth. For this reason, most table beets for processing are grown in the cool climate of northern states or as a winter crop in Texas. Color generally tends to improve with later harvest dates as seasonal temp decrease (5, 6, 8, 9). However, Lusas et al. (10) reported that the amount of red pigment changed little as the season progressed but that the amount of yellow pigment increased. Adequate soil moisture and fertility are required for good color but pigment concn can be lowered slightly by irrigation (14) or high rates of N fertilization (15) Black spotting of beets due to boron deficiency can adversely affect root quality but can be controlled (13).

Sweetness is believed to be one of the major factors influencing flavor (4). Sucrose is the main storage sugar in table beets and its concn has been found to vary with cultivar (9), temp as influenced by location, planting dates and harvest dates (1, 6, 9, 10, 18), and by soil fertility (1). Soluble solids in the juice of beet roots is directly related to sucrose content (4) and has been reported to be lowered by irrigation (14), high rates of nitrogen fertilization (15), or by removing some of the leaves (17).

Texture of beets has received little attention. Soil fertility was found to influence crude fiber content of roots (1) and softness of cooked roots as measured with a penetrometer needle (12). Patten (12) also noted that roots grown for a shorter time required less cooking time to soften. Sistrunk and Bradley (18) reported that shear press values of canned beets were influenced by cultivar, planting dates, harvest dates, and irrigation interval.

The present study was undertaken to measure changes in soluble solids, red pigment, and firmness as a function of growing time. Two cultivars were included during 3 seasons to evaluate genetic and seasonal differences.

Materials and Methods

Beet roots were grown at the Vegetable Research Farm,

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Table 1. Mean air temp, number of days above 30°C, and total precipitation for 10-day periods at Geneva, New York.

		Mean air temp (C)			No. of days above 30°C			Precipitation (cm)		
Month	Period	1968	1969	1970	1968	1969	1970	1968	1969	1970
May	11-20	12.1	12.4	14.8	0	0	0	4.8	4.0	2.6
	21-31	12.0	14.9	15.2	0	0	0	3.1	0.2	3.0
June	1-10	19.0	15.4	18.5	2	0	1	0.2	3.1	3.1
	11-20	17.0	19.3	19.6	0	1	0	2.1	2.2	2.6
	21-30	17.5	19.0	16.8	0	1	0	10.6	5.2	2.5
July	1-10	20.1	18.1	20.9	3	1	0	1.2	0.9	1.4
	11-20	23.5	22.6	20.6	5	3	0	2.2	3.4	4.7
	21-31	20.2	21.0	22.2	1	0	4	1.6	4.4	0.9
August	1-10	22.9	22.5	20.9	1	0	0	4.6	3.3	1.9
	11-20	18.3	21.4	23.1	0	0	3	0.8	0.4	1.1
	21-31	19.0	20.2	19.7	2	2	0	3.9	0.0	10.4
September	1-10	18.2	21.9	17.8	0	3	0	2.6	0.2	0.7
	11-20	17.3	17.1	15.7	0	0	0	5.1	1.5	4.6
	21-30	17.2	13.6	17.7	0	0	1	0.5	0.9	3.4
October	1-10	12.3	13.1	14.2	0	0	0	2.2	2.5	1.6
	11-20	15.6	11.7	11.2	0	0	0	4.9	0.8	5.6

Geneva, New York. The 1968 crop was grown on Honeoye sandy loam and the 1969 and 1970 crops were grown on a Lima loam soil. Both are calcareous, fertile soils typical of those on which table beets are grown commercially in New York. Fertilizer (670 kg/ha of 10-9-17) was applied with a drill after plowing. The plots received an additional 45 kg/ha of N as NH_4NO_3 topdressed 8-10 weeks after planting. Weeds were controlled with a pre-emergence applications of 4.5 kg/ha of pyrazon, cultivation, and hand weeding. The 1968 and 1970 crops were planted in rows 91 cm apart, and the 1969 crop was planted in 1.83 m beds with 4 rows 38 cm apart. The 1968 planting was a split-plot design consisting of 4 replications of 3 planting dates as main plots. Two cultivars were randomized in each of the main plots of the 2nd and 3rd planting dates (June 28 and July 31). The 1st planting date main plots were split into 3 harvest date sub-plots and 2 cultivars were randomized in each of these subplots. The 1969 planting (planted May 6) was also a split-plot design with 4 replications of 3 harvest dates as main plots with 4 cultivars randomized in each main plot. 'Ferry's Strain of Detroit Dark Red' (Ferry-Morse Seed Co.) and 'Ruby Queen' (Northrup-King Seed Co.) were grown all 3 years, and other cvs., Firechief (Ferry-Morse) and Mono-King Explorer (Northrup-King), were also grown in 1969.

The plots were hand-harvested and mechanically topped and graded (15). In 1968 the small size roots (2.5-4.4 cm) were processed and the medium roots (4.4-6.4 cm) were used for raw product quality determinations. In 1969 small and medium roots were used for raw product determinations and all 3 sizes, when in sufficeint quantity, were processed. In 1970 only the medium roots were utilized.

Raw product quality methods.

Samples of 10 roots of a given size grade from each cultivar sub-plot were washed, blotted dry, and cut in half. The top half of each root was grated 5 times on a stainless steel kitchen vegetable grater to give 6-10 g of pulp. The pulp was squeezed through 2 thicknesses of Chem-wipe tissues to give 2-4 ml of juice. The soluble solids in the juice samples were determined with a hand refractometer and red pigment was determined colorimetrically (10, 15).

Processing of beets.

The washed samples were cooked in rapidly boiling water, 15 min for the small size, 20 min for the medium size, and 30 min for the large size roots. They were then cooled 5 min in cold running water before peeling in an abrasion peeler for sufficient time to remove skin, top, and secondary roots. In 1968, only the small roots were processed and packed whole. In 1969 all 3 sizes were diced in an Urschel dicer, 9.5 mm size. In 1970 the medium roots were packed as 6.4 mm thick slices. Cans were

Table 2. Soluble solids (%) and red pigment content (absorption units at 535 nm) of raw juice of medium-sized roots and extrusion force (kg) of canned small roots at 3 harvest dates in 1968. Planted June 7.

Variable	Solids	Soluble solids	Red pigment	Extrusion force
Harvest date	Days after planting	(Each figure is a mean of 4 replications x 2 cultivars = 8 plots)		
August 13	67	10.2A[z]	134B	55A
September 24	109	11.1B	118A	88B
October 15	130	11.4B	113A	98C
Cultivar (Each figure is a mean of 4 replications x 3 harvest dates = 12 plots)				
Detroit Dark Red, Ferry's Strain		11.0	130B	92B
Ruby Queen		10.8	114A	68A
Interaction				
Harvest date x cultivars		NS	NS	**
Coefficient of variation (%)		2.2	9.9	6.7

[z]Means without letters or means followed by the same letter are not significantly different at the 1% level.
**Indicates significance at 1% level of the harvest date x cultivar interaction.

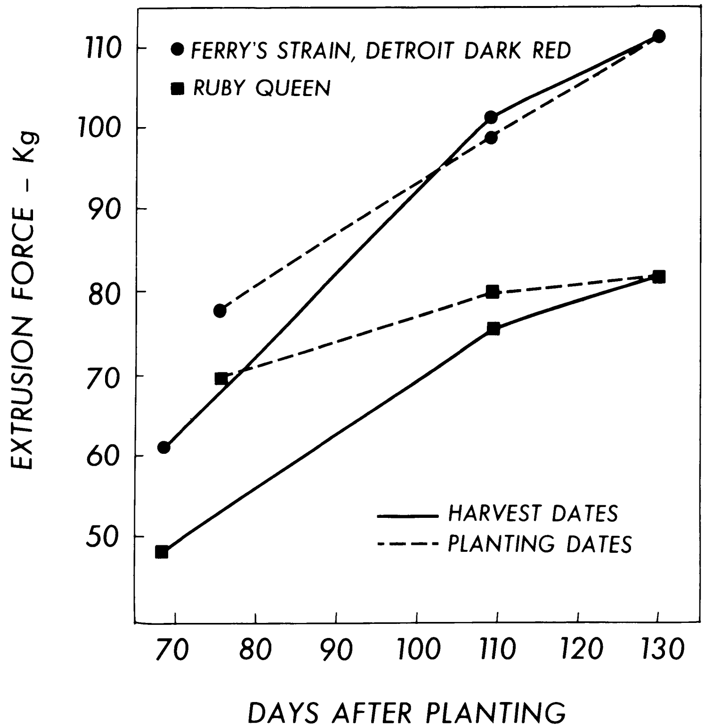

Fig. 1. Changes in extrusion force of diced small roots fo 2 cultivars with growing time varied by planting dates or harvest dates, 1968.

packed and processed by a standard method (15).

Texture measurement.

Texture measurements were made with an Instron Universal testing machine (3) using a cylindrical back extrusion cell 10.2 cm I.D. by 12 cm internal height with an extruding plunger having a 4 mm annular clearance with the cylinder wall (2, 16). The 1968 values were for a single extrusion test per plot and the 1969 values were avg of 3 extrusion tests (from 3 different cans) per plot.

All data were subjected to analysis of variance and significant mean comparison were made by Duncan's Multiple Range Test (7).

Results and Discussion

The air temp and precipitation records for the 3 growing seasons are summarized at 10-day intervals in Table 1. All 3 growing seasons were relatively cool with the mean daily air temp seldom exceeding 25°C. There were few days in which the max temp went above 30°C. Rainfall was plentiful and fairly well distributed except for dry periods from August 11 to September 10 in 1969 and from July 21 to August 20 in 1970.

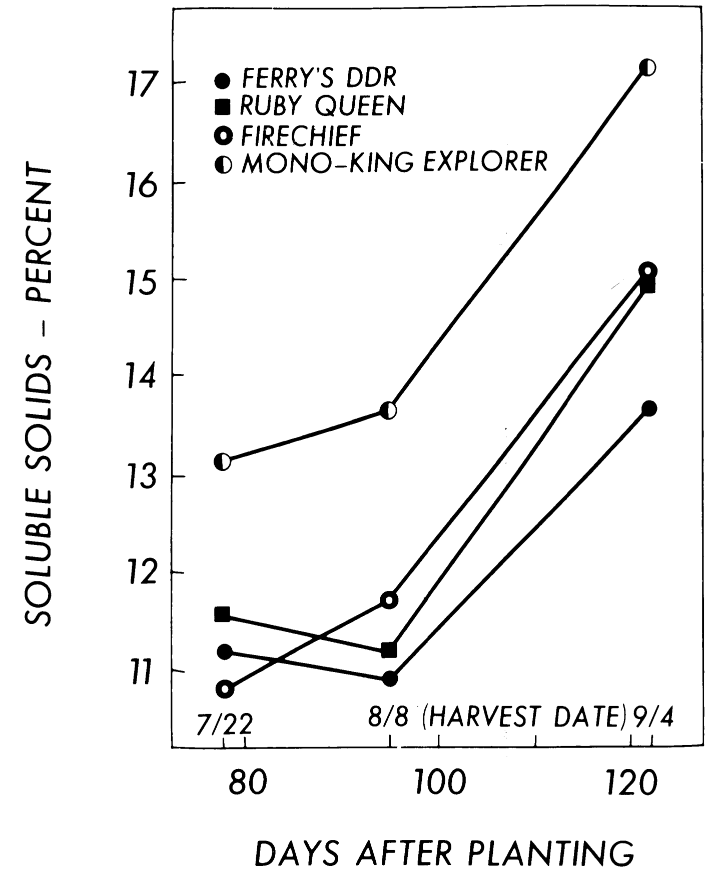

Fig. 2. Changes in soluble solids of 4 cultivars with growing time. Planted May 6, 1969.

The soluble solids and red pigment contents of the medium-sized raw beets and the extrusion force measure of texture of the processed small-sized beets grown in 1968 are summarized in Tables 2 and 3. In Table 2 growing time was varied by a harvest sequence of plots planted at the same time,

Table 3. Soluble solids (%) and red pigment content (absorption units at 535 nm) of raw juice of medium-size roots and extrusion force (kg) of canned small roots planted at 3 dates and harvested October 15, 1968.

Variable		Soluble solids	Red pigment	Extrusion force
Planting date	Days to harvest	(Each figure is a mean of 4 replications x 2 cultivars = 8 plots)		
July 31	76	11.6a[z]	188C[z]	74A
June 28	109	12.0b	157B	89B
June 7	130	11.4a	113A	98C
Cultivar (Each figure is a mean of 4 replications x 3 harvest dates = 12 plots)				
Detroit Dark Red, Ferry's Strain		11.6	157	97B
Ruby Queen		11.7	149	78A
Interaction				
Planting date x cultivar		*	NS	**
Coefficient of variation (%)		2.6	12.6	5.2

[z]Means without letters or means followed by the same letter are not significantly different. Small letters indicate 5% level and capital letters indicate 1% level.
*Indicates 5% level of significance, ** indicates 1% level, NS means not significant.

Table 4. Soluble solids (%) and red pigment content (absorption units at 535 nm) of raw juice and extrusion force (kg) of canned roots; planted May 6, 1969.

Variable		Soluble solids	Red pigment	Extrusion force
Harvest date	Days after planting	(32)[z]	(32)	(24)
July 22	77	11.7A[y]	156B	58A
August 8	94	11.8A	156B	69B
September 4	121	15.2B	140A	90C
Cultivar		(24)	(16)	(18)
Detroit Dark Red, Ferry's Strain		11.9A	131AB	94D
Ruby Queen		12.5B	119A	71C
Mono-King Explorer		14.7C	200C	60A
Firechief		12.5B	142B	63B
Root size		(48)	(32)	(36)
Small (1-1 3/4" diameter)		14.3B	160B	70A
Medium (1 3/4-2½" diameter)		12.5A	136A	74B
Interactions				
Harvest date x cultivar		*	NS	**
Harvest date x size		NS	NS	NS
Cultivar x size		NS	NS	**
Harvest date x cultivar x size		NS	NS	NS
Coefficient of variation (%)		5.9	12.4	3.9

[z]Numbers in parentheses indicate the number of plots included in each mean value.
[y]Means followed by the same letter are not significantly different at the 1% level.
[x]Asterisks indicate a significant interaction at the 5% level (*) or 1% level (**).

and in Table 3 growing time was varied by harvesting at one time plots which were planted at different dates.

Soluble solids tended to increase with growing time in the sequential harvest experiment (Table 2) similar to that reported by Lusas et al. (10), but this was not the case when growing time was varied by planting date (Table 3). The significant planting date x cultivar interaction was due to relatively large differences in soluble solids content of 'Ruby Queen' (11.2% to 12.3%), while 'Ferry's Strain of Detroit Dark Red' did not vary with planting date.

Red pigment content of both cultivars decreased with growing time as reported by Lusas et al. (10). The difference was greatest in the case of varying plant dates with the largest amount of pigment in the late planting. This is in agreement with Enzie's (8) observations on beet root color.

There were large and highly significant differences in texture of cultivars and with growing time which is best shown in Fig. 1. This graph illustrates the highly significant interaction between growing time and cultivar. With both methods of varying growing time 'Ferry's Strain of Detroit Dark Red' was higher and increased in firmness more rapidly than did 'Ruby Queen'.

Two additional cultivars were included in the 1969 experiment to demonstrate the wide variation in quality attributes of table beets due to genetic differences. The effect of root size was also included to demonstrate the necessity of specifying the size of roots used when evaluating quality attributes of this crop.

Growing time in the 1969 experiment was varied by harvest sequence only (Table 4). Again soluble solids increased late in the season and in this case the large increase between the second and third harvest dates occurred during an extended dry period (see Table 1). This large increase in soluble solids was probably due in part to water stress (14). Figure 2 illustrates the small but significant harvest date x cultivar interaction and also the relatively large cultivar differences in soluble solids. 'Mono-King Explorer' was consistently higher in soluble solids than the other 3 cultivars. 'Ruby Queen' was slightly higher in soluble solids than 'Ferry's Strain of Detroit Dark Red' in 1969 but not in 1968. Both soluble solids and red pigment were lower in the medium roots than in the small roots and this trend has been observed to continue with increasing size of roots (19).

In contrast to the change in soluble solids between the last 2 harvests in 1969, red pigment content was lower at the 3rd harvest than at the 2nd harvest. There was a large difference in red pigment content of cultivars and 'Mono-King Explorer' was much higher in red pigment than in the other 3 cultivars. It is possible that such a high amount of red pigment may result in a finished product which is darker red than is generally acceptable.

The 1969 experiment revealed large cultivar and growing

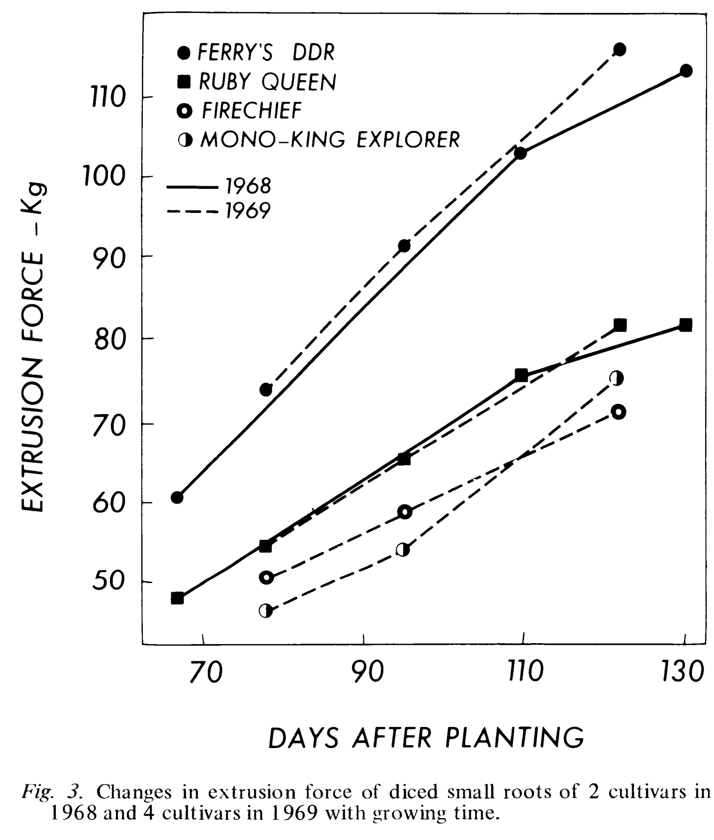

Fig. 3. Changes in extrusion force of diced small roots of 2 cultivars in 1968 and 4 cultivars in 1969 with growing time.

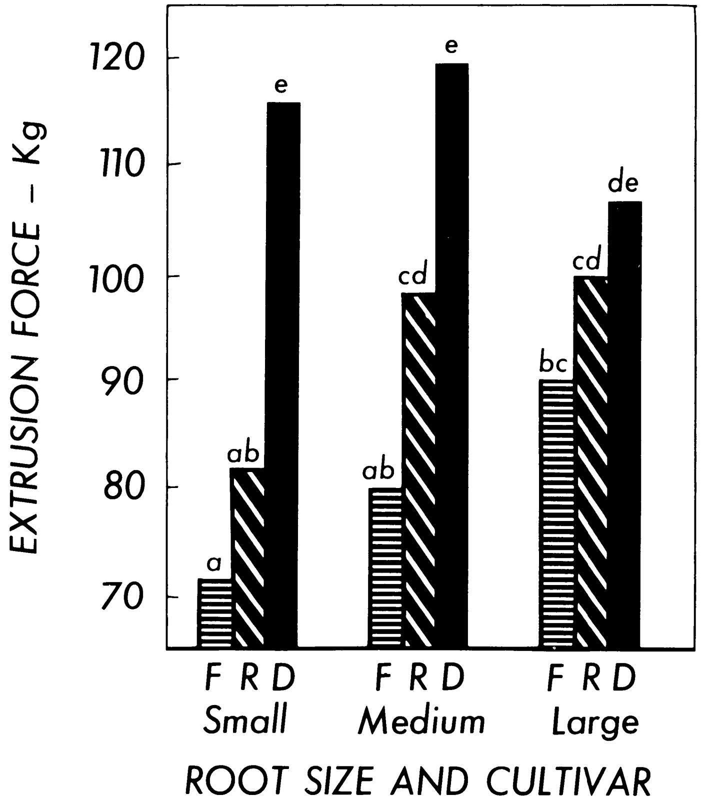

Fig. 4. Differences in extrusion force of canned diced beets from 3 sizes of roots of 3 cultivars (D='Ferry's Strain of Detroit Dark Red'; R='Ruby Queen'; and F='Firechief') at a single harvest date, September 4, 1969.

time differences in firmness like that observed in 1968. The striking similarity of these differences is shown in Fig. 3, showing the data for the 2 years superimposed on the same growing time scale. In 1969 the increase in firmness of 'Ruby Queen' and 'Detroit Dark Red' increased linearly with time. The drop in rate of increasing firmness of the same cultivars at the last harvest in 1968 was probably due to the lower temp before the last harvest (October 15) in that year compared to the September 4 final harvest in 1968.

There was a small but highly significant difference in firmness of the 2 sizes of roots included in Table 4. The significant cultivar x size interaction was due to a difference in firmness of the sizes of 3 of the 4 cultivars. This interaction is more completely shown in Fig. 4 in which 3 sizes of 3 of the cultivars at the last harvest date are compared. 'Detroit Dark Red' was firmest and there was a fairly large but statistically non-significant difference in firmness of the large (6.4-8.3 cm) size compared to the small and medium root sizes. The large size roots of the other 2 cultivars were significantly firmer than the small roots. This is just the opposite trend that was reported by Patten (12) who used a penetrometer to measure firmness of cortical tissues only. Our data show that cultivar differences in texture are more important than root size differences. The magnitude of the growing time changes in firmness overshadows cultivar differences unless one considers that at the 1st harvest date or shortest growing time there was not an economic yield of roots and they could be considered immature. If a certain degree of firmness is arbitrarily chosen to represent earliest harvest maturity, then the cultivars can be characterized by time required to reach harvest maturity. However, if one determines earliest harvest date by time to produce an economic yield then there will be marked cultivar differences in firmness as well as soluble solids and red pigment contents. When rating firmness of processed beets and their acceptability a taste panel considered only one commercial sample to be unacceptable and this was because it was too soft (16). This sample had an extrusion force reading of 57 which is greater than that of several of the samples in Fig. 3 and indicates that the softer cultivars should not be harvested early. One would also expect the firmer cv. Detroit Dark Red to become undesirably firm if grown too long.

The 2 cultivars were relatively the same for all 3 quality attributes in 1970 as in the 2 previous seasons (Table 5). Soluble solids were high at the 2nd harvest date which coincided with a dry period. In contrast to the 2 previous seasons, red pigment increased with growing time during 1970. The increase in firmness of the processed product with increasing growing time was quite similar to the 2 previous years.

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Table 5. Soluble solids (%) and red pigment content (absorption units at 535 nm) of raw juice and extrusion force (kg) of canned roots; planted May 21, 1970.

Variable		Soluble solids	Red pigment	Extrusion force
Harvest date	Days after planting	(Each figure is a mean of 8 plots)		
July 28	68	9.2A[z]	90A	67A
August 17	88	12.4C	106B	72A
September 9	111	11.1B	108B	82B
Cultivar (Each figure is a mean of 12 plots)				
Detroit Dark Red, Ferry's Strain		10.6a	105b	82B
Ruby Queen		11.3b	97a	65A
Interaction				
Harvest date x cultivar		NS	NS	NS
Coefficient of variation (%)		5.7	7.0	7.4

[z]Means without letters or means followed by the same letter are not significantly different. Small letters indicate 5% and capital letters indicate 1% level. NS indicates the interaction was not significant.

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Anatomical Changes in Developing Graft Unions of *Juniperus* L.[1]

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Abstract. Comparative studies of clonal anatomy revealed visible differences in medullary ray cell diam in juniper cultivars with different chromosome numbers. Histological studies, made at 10-day intervals for 60 days after grafting showed no differences in developmental sequence but only differences in rate at which each stage occurred. Callus tissue formation began 10 - 20 days after grafting; first in 'Fountain' and last in 'Pfitzeriana Kallay'. Isodiametric cells from uninjured cambia appeared by the 20th day except with 'Pfitzeriana Kallay' scions. By an alternating series of radial and tangential divisions, these cells overwalled the injured graft surfaces, but was less pronounced in closely fitted grafts. Overwalling cells did not occur in 'Pfitzeriana Kallay' until 30 days after grafting. By 40 - 50 days, overwalling cells began, by radial divisions, to produce organized cells which filled voids between graft partners and crushed intervening callus. Mixing of newly formed cells between stock and scion cambia occurred 50 - 60 days after grafting. These cells assumed the spindle-shape of typical tracheids and were oriented into a "cambial bridge." New, normally oriented xylem subsequently formed from this new cambial tissue. In typical grafts, most new tissue arose from the understock prior to the 50th day after grafting. At 60 days, contribution from stock and scion were equivalent. Adjacent walls of mixed graft tissue were found to be unmodified and appeared as paired structures each with a middle lamella and secondary wall thickenings. Abnormally large numbers of pits were observed at the graft union.

Until the advent of the electron microscope and radioactive chemicals, most grafting studies were conducted at the morphological or gross anatomical levels. Histological studies date back to Waugh's (23) investigation of graft union callus tissue.

Although graft callus tissue has received much study, questions concerning relative proportions contributed by the scion, point of origin, and this tissue's ultimate fate remain controversial.

Callus has been suggested as arising principally from the scion (Kac, 10), from the understock (Kostoff, 11; Mergen, 15), and equally from stock and scion (Sharples and Gunnery, 21).

Although certain authors (Sharples and Gunnery, 21; Juliano, 9) suggested that cells in the xylem cylinder could contribute to callus formation, Sass (20) described its origin as being outside the xylem. Both views were supported by Juliano (9) who observed callus to first form in cortex, pith, and ray cells.

Though doubt exists about origin of cambial bridges, some authors (Sass, 20; Mosse and Labern, 17; Mosse, 16; Mathes, 14) considered new cambial cells to arise by differentiation of callus. Others (Camas, 4; Kuroda, 12,13; Gautheret, 6) proposed that new graft tissues could arise from mature cells by dedifferentiation and redifferentiation. Kostoff (11) and Kac (10), however, suggested that new cambial initials could arise by radial divisions of existing cambial initials adjacent to the graft incisions.

This study was undertaken to determine the anatomical sequence of graft union formation in junipers as well as the origin of callus tissue in the union.

Materials and Methods

The genetically stable clonal forms *Juniperus horizontalis* of 'Fountain', *J. chinensis* 'Hetzii', and *J. chinensis* 'Pfitzeriana Kallay' were used in this study and are hereafter referred to by their cultivar names. Ploidy levels of these junipers are 2n, 3n, and 4n respectively[2].

On October 24, 1966, the above listed junipers were obtained from a commercial nursery source[4], and after 9 weeks at 1.7°C, potted in 4-inch clay pots and benched in a 20-21°C

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