Flowering, Spur Formation and Limb Angles of Delicious Apple Strains[1]

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Abstract

Number of spurs per meter of limb, number of flowering spurs per spur and limb angles were counted or measured on 17 strains of Delicious apple (*Malus domestica* Borkh.) for 5 years. The spur type had more spurs per m and more flowering spurs per spur than did the standard types. Yearly variability in flowering indicated definite alternate bearing in some strains. There was no difference in the width of the limb angles among strains.

New strains of Delicious apple are introduced every year. In the selection process the primary attention has been given to the amount of red color of the fruit, its earliness and its pattern—stripe or blush.

The only other characteristic that has received much interest is a growth pattern in some selections in which a high proportion of lateral spurs develop lateral shoots and branches. This characteristic has been designated as a 'spur-type' tree, in contrast with the 'standard' type. Tukey and Ballard (6) add the term 'semi-spur.' It is sometimes difficult to classify strains into one of these three groups.

Spur-type trees produce a heavier crop during the early fruiting years (1, 4). Lord et al. (5) showed that the standard-type trees yielded more per tree but indicated that spur-type trees were more efficient and would possibly produce more per hectare.

Fisher and Ketchie (2) said upright-growing branches was another possible growth characteristic of spur-type Delicious trees. Preliminary studies, however, showed no difference in limb angles between strains.

In this work strains of Delicious were characterized with respect to the number of spurs and their productivity in a given length of limb. The relationship between number of spurs and limb angle was also studied.

Methods and Materials

A planting of 17 strains of Delicious apple on seedling rootstock was established at the Columbia View Research Orchard at Orondo, WA in 1972. There were four replications with a single tree. The trees were trained to central leader with mini-

Table 1. Number of spurs on strains of Delicious apple trees.

Strains	Spurs/meter
Spur-type	
Oregon Spur	42a[z]
Wellspur	40ab
Redspur	39ab
Hardispur	39ab
Atwood Spur	37bc
Sturdeespur	36bcd
Earlistripe	32de
Total spur-type	38a
Standard-type	
Ryan	30de
Imperial	30de
Chelan Red	29def
Red King	29def
Red Queen	26ef
Red Prince	26ef
Hi Early	26ef
Royal Red	26ef
Harrold	25f
Sharp Red	25f
Total standard-type	27b

[z]Mean separation by Duncan's multiple range test, 5% level.

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mum pruning. The spacing was 3.7 m X 6.2 m. Urea was applied by a weed sprayer annually with each tree receiving the same amount. Chemical thinning was not performed.

Four limbs between 1 and 1.5 m from the ground from each tree, north, south, east and west were chosen for measurements. Limb angles, number of spurs and number of flowering spurs were measured or counted for five consecutive years, 1979 through 1983. Total spurs were counted per limb including internal branches on that limb. Yearly variability of flowering spurs was calculated by dividing the range between years by the average.

Limb angles were measured each year with a homemade protractor. Each reading was made 12 cm from the crotch.

The data were analyzed by analysis of variance and where found significant was separated by Duncan's Multiple Range Test.

Results

The number of spurs, number of flowering spurs and the limb angle were the same on all four sides of the tree so the data for the whole tree were combined.

The number of spurs per m was stable from year to year. The number of spurs per m was significantly different between strains (Table 1). The spur-type had significantly more spurs per m than did the standard types; some individual spur-types (Sturdeespur and Earlistripe) were not significantly different from some standard-types (Ryan, Imperial, Chelan Red

Table 2. Flowering spurs on strains of Delicious apple trees.

Strain	Flowering spurs/spur						Yearly var.[z]
	1979	1980	1981	1982	1983	Ave.	
Spur-type							
Oregon spur	.26	.29	.26	.24	.43	.30a[y]	0.63
Earlistripe	.09	.47	.09	.34	.44	.29ab	1.31
Hardispur	.33	.23	.23	.21	.41	.28ab	0.71
Wellspur	.28	.25	.15	.23	.45	.27ab	1.11
Atwood spur	.23	.33	.10	.31	.28	.25b	0.92
Sturdeespur	.11	.36	.11	.39	.25	.24b	1.17
Redspur	.18	.28	.15	.23	.33	.23b	0.78
Average	.21	.32	.16	.28	.37	.27	0.78
Standard-type							
Chelan Red	.21	.24	.15	.14	.31	.21c	0.89
Red King	.21	.17	.17	.14	.24	.19c	0.53
Red Queen	.23	.12	.08	.08	.27	.16c	1.19
Red Prince	.12	.31	.12	.12	.12	.16c	1.19
Sharp Red	.20	.20	.12	.16	.12	.16c	0.50
Imperial	.07	.21	.13	.13	.20	.15c	0.87
Hi Early	.19	.19	.08	.12	.12	.14c	0.79
Harrold	.16	.20	.04	.12	.20	.14c	1.14
Ryan	.10	.23	.10	.13	.10	.13c	1.00
Royal Red	.12	.15	.12	.04	.19	.12c	1.25
Average	.16	.20	.11	.12	.19	.16	0.56

[z]Yearly variability calculated by dividing the range by the average.
[y]Mean separation by Duncan's multiple range test, 5% level.

and Red King). There was difference within spur types (e.g., Oregon Spur versus Atwood, Sturdeespur and Earlistripe) and within standard-type (e.g., Ryan and Imperial versus Harrold and Sharp Red). Earlistripe may have a low number of spurs because of the severe 'dead-spur disorder' described by Klaren and Ketchie (3).

The average number of flowering spurs per spur over a 5-year-period was significantly higher in the spur-type trees than on the standard-type trees (Table 2). Within the spur-type trees there were significant differences between strains whereas there was no difference within the standard-type strains.

The number of flowering spurs of Red King, Sharp Red, Hi Early, Oregon Spur and Hardispur did not vary much between years (Table 2). On the other hand, a tendency toward alternate bearing in Earlistripe, Sturdeespur, Red Queen, Red Prince and Royal Red caused increased variability.

Royal Red had wider angles than Imperial and Earlistripe (Table 3). Spur-type and standard-type were similar with respect to limb angles.

Table 3. Limb angle from trunk on Delicious strains of apple trees.

Strain	Angle (°)
Royal Red	61a[z]
Ryan	60ab
Atwood Spur	58ab
Wellspur	56ab
Oregon Spur	56ab
Sturdeespur	53ab
Red King	51ab
Redspur	51ab
Hardispur	51ab
Sharp Red	50ab
Red Prince	50ab
Chelan Red	50ab
Harrold	49ab
Hi Early	49ab
Red Queen	49ab
Imperial	47b
Earlistripe	46b

[z]Mean separation by Duncan's multiple range test, 5% level.

Discussion

Rather than use the loose terms of standard, spur or semi-spur, it may be advantageous when referring to a definite strain to designate approximately the number of spurs per m.

Using a combination of the average number of flowering spurs per spur and the yearly variability (Table 2) may be a better way to describe a strain. There is essentially no difference between Oregon Spur and Earlistripe in the yearly average number of flowering spurs but the difference in yearly variability clearly indicates Oregon Spur is more uniform. Sharp Red has the lowest yearly variability but averages only .16 flowering spurs per spur per year.

There is no relationship between number of spurs and limb angle.

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