Dwarfing Rootstock for Peach

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Introduction

Dwarfing a tree is a very effective method to raise labor productivity and improve quality of labor input. Although growth regulators and ringing are also avaialble for that purpose, use of dwarfing rootstocks is most economical, if available. In growing apple trees, dwarfing rootstocks are already used widely, while in other fruit trees, this method is not yet in practical use. During the past several decades, every effort has been made to develop dwarfing rootstocks for peach, mainly in USA and Canada, using a number of varieties of *Prunus persica, insititia, davidiana, subcordata, maritima, tomentosa, pumila, bessei, glandulosa, cerasifera* and *triloba*[1-5]. However, promising dwarfing rootstocks are not made available yet.

In Japan, continued efforts have been exerted since 1974 to identify dwarfing rootstocks for peach. This paper presents some results of the two strains of Chinese bush cherry (*P. japonica*) and one strain of Nanking cherry (*P. tomentosa*) that would be suitable in dwarfing rootstocks for peach[6].

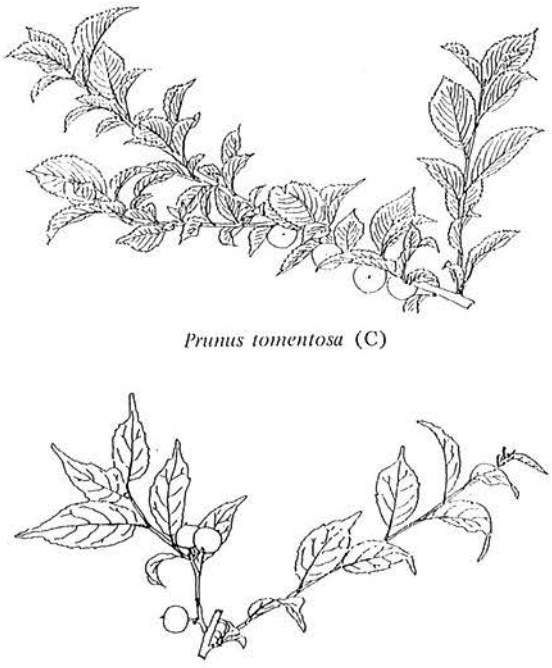
Materials and methods

(1) Tested rootstocks

Two strains each of Chinese bush cherry and Nanking cherry have been subjected to test at the Fruit Tree Research Station in Tsukuba, Japan during the period 1981 to 1988. The two strains for each rootstock are named (A), (B), (C) and (D) hereafter.

The selected two strains of Chinese bush cherry had similar morphological characteristics. In the (A) strain, the mean ratio of length/width of the leaves was 1.94; the fruits ripened in the middle of July; and the fruit color was deep red (4R4/11–2.5R3/9). In the (B) strain, the leaves were more slender than the (A) strain; the mean ratio of their length/width was 2.19; and the fruit color was faint deep red (4R4/10–3R3/10).

The difference between the two strains of Nanking cherry was related to fruit color. Fruit color of the (C) strain of Nanking cherry was white, while the (D) strain was red.



Prunus tomentosa (C)

Prunus japonica (A)

Fig. 1. *Prunus tomentosa* (C) and *Prunus japonica* (A)

Table 1. Rootstocks, cultivars, spacing and training used in the study

Rootstock	Cultivar*		Spacing (trees/ha)	Training type
	Hakuho	Hakuto		
Nanking cherry (*P. tomentosa* Thunb.) (C)	12		1,500	Central leader type
Nanking cherry (*P. tomentosa* Thunb.) (D)		24	1,500	Central leader type
Chinese bush cherry (*P. japonica* Thunb.) (A)	8		1,500	Central leader type
Chinese bush cherry (*P. japonica* Thunb.) (A)		12	1,500	Y type
Chinese bush cherry (*P. japonica* Thunb.) (B)	16		1,500	Central leader type
Chinese bush cherry (*P. japonica* Thunb.) (B)		24	1,500	Central leader type
Chinese bush cherry (*P. japonica* Thunb.) (B)		12	1,500	Y type
Juseito (*P. persica* Batsch)	17	15	1,000	Central leader type
Juseito (*P. persica* Batsch)	7	5	500	Y type

* These trees were planted after two growing seasons in the nursery.

Juseito (*P. persica*) was used as a control rootstock.

(2) Tested cultivars

Two peach cultivars, i.e. Hakuto and Hakuho, were subjected to test in the present study.

(3) Training system

The following two types of training systems were used in this study; a central leader type and a Y type. The central leader type was similar to the slender spindle bush in apple with a cylinder shape of the trees grafted on dwarfing rootstocks. In the Y type, the main branches of the trees grafted on dwarfing rootstocks were trained at right angles with a row of the trees, while the main branches grafted on Juseito rootstocks were trained in parallel with the row.

(4) Planting density

Planting density of the trees grafted on dwarfing rootstocks was 1,500 plants/ha. Planting density of the trees trained in the central leader type and the Y type each grafted on Juseito were 1,000 plants/ha and 500 plants/ha, respectively. The details of the above-stated materials and methods are shown in Table 1.

Results and discussion

1) Effects of rootstocks on scion survival

The lowest survival rate of peach plants, or 66.7% at the age of 8 years after grafting, took place with the trees grafted on the Nanking cherry (D) and only 17% of the total trees grafted grew healthy. On the other hand, all the trees grafted on the Nanking cherry (C) survived and grew healthy. In the case of the 72 trees grafted on the Chinese bush cherry, only one plant died. All the trees grafted on Juseito survived and grew vigorously (Table 2).

2) Effect of rootstock and training system on the growth of peach

(1) Seasonal growth pattern of the shoots

Seasonal growth pattern of the shoots of peach trees at the age of 3 years after being grafted is shown in Fig. 2. The trees of Hakuto grafted on Juseito grew very vigorously and their branches were excessively thick. To regulate the plant growth, the first trimming was made in the second half of June 1983, by pruning a half length of the shoots. Since the vigorous growth further continued, the second pruning was made in the middle of July 1983. On the other hand, the peach trees grafted on the Chinese bush cherry and the Nanking cherry did not require any pruning. In early September 1983, total length of the shoots grafted on Chinese bush cherry and Nanking cherry were only of 33% and 11%, respectively, as compared with that of the shoots grafted on Juseito. A similar seasonal growth pattern was seen in the grafted shoots of Hakuho and Hakuto.

Table 2. Survival at the age of 8 years after grafting

Rootstock	Cultivar	Number of trees planted	Number of trees dead	Percentage of survival
				%
P. tomentosa (C)	Hakuho	12	0	100.0
P. tomentosa (D)	Hakuto	48	10	79.2
P. japonica (A)	Hakuho	8	1	87.5
P. japonica (A)	Hakuto	12	0	100.0
P. japonica (B)	Hakuho	16	0	100.0
P. japonica (B)	Hakuto	36	0	100.0
Juseito	Hakuho	24	0	100.0
Juseito	Hakuto	20	0	100.0

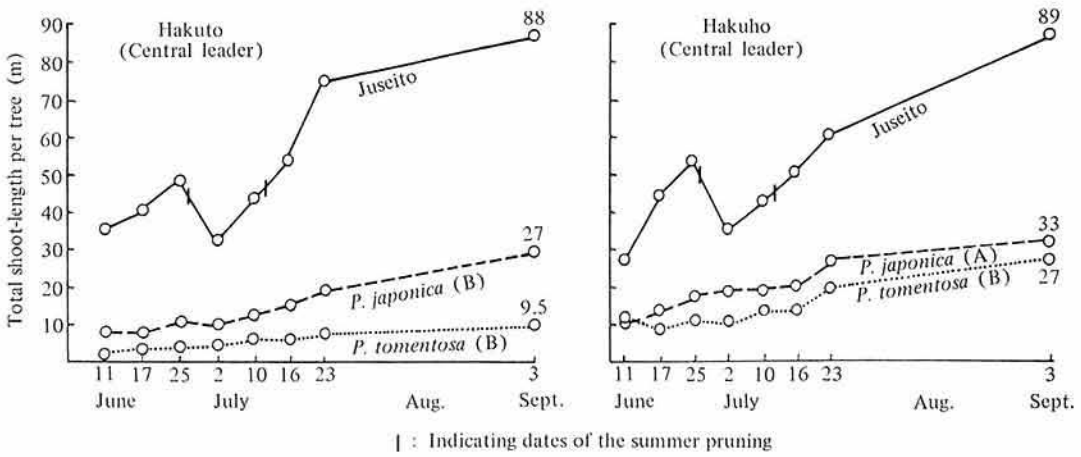


Fig. 2. Seasonal growth patterns of the shoots during the growing season in 1983

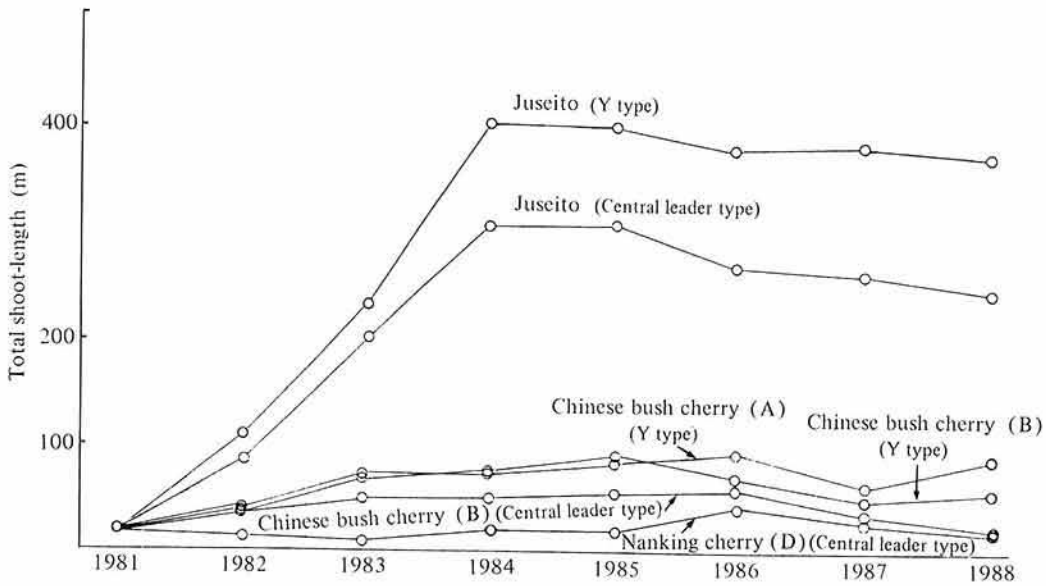


Fig. 3. Annual shoot growth of Hakuto peach trees grafted on *P. tomentosa*, *P. japonica* and Juseito (*P. persica*)

(2) Growth patterns of the shoots at the age of 8 years

Growth patterns of the grafted shoots of Hakuto and Hakuho are shown in Figs. 3 and 4. Young trees of these two peach varieties, grown in a nursery for the first two years, were transplanted in the field. At the transplanting time, their shoots were 10–25 m in total length, but in the following years great differences took place between the peach trees grafted on the dwarfing rootstocks and Juseito.

(3) Effect of rootstocks on the shoot growth at 8 years old

The shoot growth of Hakuto and Hakuho at the age of 8 years after being grafted on the dwarfing rootstocks and Juseito is shown in Table 3.

Branch length except shoot: Total length of the branches of Hakuto grafted on Juseito and Chinese bush cherry trained in a central leader type, and Juseito, Chinese bush cherry (A) and (B) trained in a Y type was 56, 37, 65, 70 and 62 m, respectively. In Hakuho,

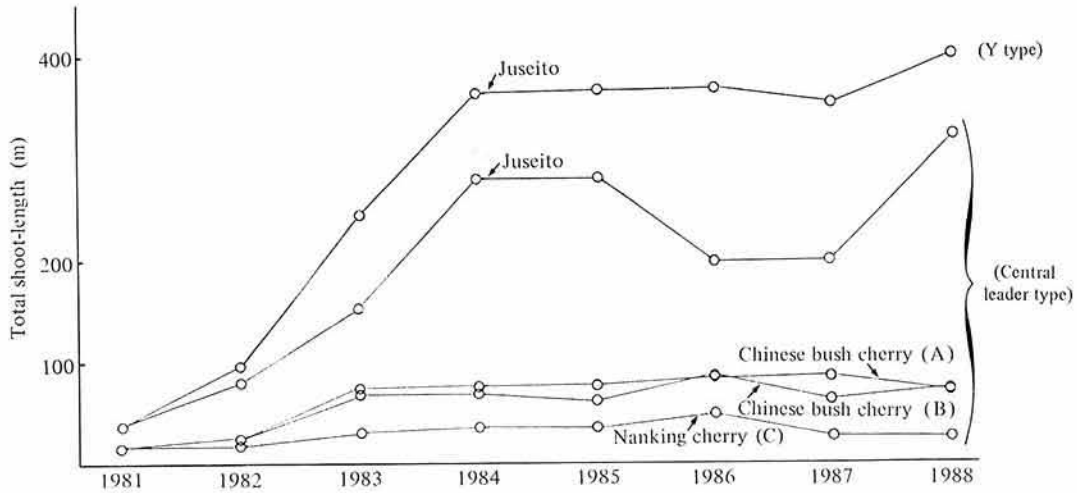


Fig. 4. Annual shoot growth of Hakuho peach trees grafted on *P. tomentosa*, *P. japonica* and Juseito (*P. persica*)

Table 3. Shoot growth of peach trees grafted on the different rootstocks at the age of 8 years, Hakuho and Hakuto

Cultivar of peach	Rootstock	Training type	Length of elder branches*	Shoot growth		
				Number of shoot	Total length	Average
			cm		cm	cm
Hakuho	*P. tomentosa* (C)	Central leader	3,501	483	2,592	5.3
	P. japonica (A)	Central leader	4,374	725	7,243	10.0
	P. japonica (B)	Central leader	4,716	706	7,648	10.8
	Juseito	Central leader	5,495	1,220	32,454	26.6
	Juseito	Y type	5,988	1,435	40,896	28.5
Hakuto	*P. tomentosa* (D)	Central leader	1,984	217	2,572	11.9
	P. japonica (B)	Central leader	3,777	481	2,640	5.5
	P. japonica (A)	Y type	7,422	885	8,332	9.4
	P. japonica (B)	Y type	6,191	942	5,620	6.0
	Juseito	Central leader	5,580	835	24,514	29.4
	Juseito	Y type	5,877	1,211	38,026	31.4

* Total length of the existing branches, excluding new shoots.

the branch length grafted on Juseito, Chinese bush cherry (A), (B) and Nanking cherry (A) was 55, 44, 47 and 35 m, respectively.

Number of shoots: In Hakuto, the numbers of the shoots per peach tree grafted on Chinese bush cherry (B) trained in a central leader type, Chinese bush cherry (A) and (B) trained in a Y type were 57, 73 and 78% as compared with the shoots grafted on Juseito trained in each type, respectively. The number of shoots in Hakuho was the same with Hakuto.

Length of shoots: Total length of the shoots of Hakuto trained in a central leader type and a Y type grafted on Juseito was 245 and 380 m, respectively. Relative shoot length of the peach trees grafted on Chinese bush cherry (B), trained in a central leader type and a Y type, and Chinese bush cherry (A) rootstock in a Y type, and Nanking cherry (B) in a central leader type was 11, 15, 22 and 10% of the trees of Juseito rootstocks, respectively. The relative shoot length of Hakuho grafted on Nanking cherry (C), Chinese bush cherry (A) and (B) was 8, 22 and 24% of Juseito rootstock, respectively, under a central leader type training.

The average of shoot length of Hakuto and Hakuho grafted on Chinese bush cherry and Nanking cherry rootstocks were approximately one-third as much as that of the same varieties grafted on Juseito, which was 30 cm in shoot length.

(4) Effect of the training systems on shoot growth

The shoots of Hakuto trained in the Y type grafted on Juseito and Chinese bush cherry (B) both grew more vigorously than those in the central leader type. The major difference between the two types was seen not in the average shoot length but in the shoot number. This result suggests that the training system of Y type provide more shoots than the central leader type does.

3) Effect of rootstocks on the internode length and the flower buds

Internode length of the shoots was measured as an index of the repletion of shoot growth, which is shown in Table 4. The internodes in Hakuto, grafted on Juseito trained in the central leader type, grew in a spindly form with a largest main shoot, while the peach trees grafted on Nanking cherry (D) was the shortest in their internode length. The peach trees grafted on Juseito and Chinese bush cherry were equal in their average internode length.

As indicated in Fig. 5, a close relationship is seen between the internode length and the

Table 4. Flower bud formation and internode length of the peach shoots grafted on the different rootstocks, Hakuho and Hakuto

Cultivar	Rootstock	Training type	Percentage of flower buds*		Internode length
			1982 (first season in orchard)	1983 (second season in orchard)	
			%	%	cm
Hakuho	*P. tomentosa* (C)	Central leader	60.1	56.9	1.04
	P. japonica (A)	Central leader	63.9	55.9	1.29
	P. japonica (B)	Central leader	58.8	50.1	1.49
	Juseito	Central leader	38.9	58.6	1.87
	Juseito	Y type	46.0	53.0	1.72
Hakuto	*P. tomentosa* (D)	Central leader	67.7	63.6	1.21
	P. japonica (B)	Central leader	60.9	59.2	1.59
	P. japonica (A)	Y type	58.6	64.1	1.73
	P. japonica (B)	Y type	53.3	54.6	1.54
	Juseito	Central leader	34.0	54.9	2.31
	Juseito	Y type	35.5	55.6	1.88

* Indicating relative numbers of the flower buds out of the total bearing of buds.

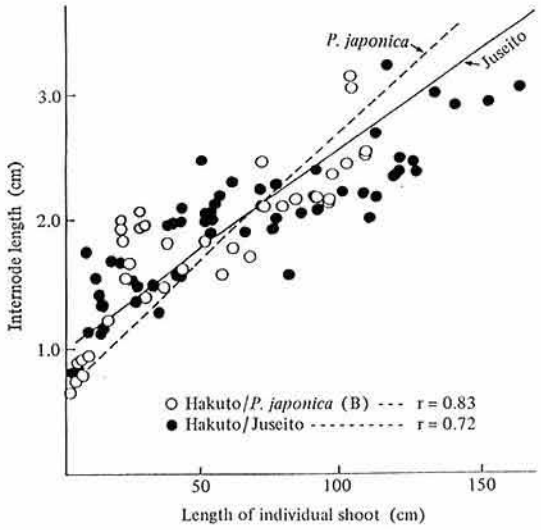


Fig. 5. Relationship between the internode and the shoot growth of peach trees grafted on *Prunus japonica* (B) and Juseito

shoot length. It is recognized that the internode length of shoot is a useful index of repletion of the shoot growth.

As for the effects of rootstocks on the formulation of flower buds of the peach trees, comparisons among rootstocks were made in 1982 and 1983 (Table 4). In 1982, there was a great variation in percentages of flower buds among rootstocks. More flower buds of Hakuto were produced on the trees grafted on dwarfing rootstocks than on Juseito. The percentages of flower buds of the peach trees grafted on the dwarfing rootstocks were more than 50% of the entire buds, while those grafted on Juseito were less than 50%. In 1983, flower buds of peach trees grafted on rootstocks were all over 50% and no significant difference in the flower bud formulation was seen among rootstocks and training types.

4) Effects of rootstocks for fruit ripening, yield and quality

The effects of rootstocks and training systems on the fruit ripening, yield and quality are presented in Table 5.

The date of harvest: The harvesting time is shown by the dates when half of the fruits were harvested (M50). The harvesting time of Hakuto grafted on Juseito was October 31, 1988, while those on Chinese bush cherry (A) and (B) were October 23 and 20, 1988, respectively, which were at least 7 days earlier than the case in Juseito. The fruits of Hakuto grafted on Nanking cherry were harvested on October 18, 1988. The same magnitude of early maturing of fruits was found in Hakuho, with an exception in the trees grafted on Chinese bush cherry (A), which resulted in the same or only a few days earlier maturing dates than the Juseito

Table 5. Harvesting dates and yields of the peach fruits on the 8-year old trees grafted on the different rootstocks and grown under two types of training

Cultivar	Rootstock	Training type	Date of harvest* (M50)	Yield	Fruit size	Soluble solid content
				t/ha	g	%
Hakuho	*P. tomentosa* (C)	Central leader	18 July	21.5	164	11.6
	P. japonica (A)	Central leader	28 July	29.2	180	12.5
	P. japonica (B)	Central leader	22 July	29.8	150	12.2
	Juseito	Central leader	28 July	16.9	182	10.5
	Juseito	Y type	28 July	10.2	176	10.4
Hakuto	*P. tomentosa* (D)	Central leader	16 Aug.	4.9	180	12.9
	P. japonica (B)	Central leader	21 Aug.	25.6	231	13.1
	P. japonica (A)	Y type	23 Aug.	41.5	273	12.9
	P. japonica (B)	Y type	19 Aug.	25.0	258	13.7
	Juseito	Central leader	31 Aug.	6.6	240	11.2
	Juseito	Y type	31 Aug.	5.5	245	11.0

* Year: 1988.

rootstock. No significant difference in fruit ripening of peach was seen between the training systems under this study.

Yield: The yield of Hakuto grafted on the Juseito rootstocks, grown in the central leader type, was very low, or only 6.6 t/ha. The yield of peach grafted on Nanking cherry was also extremely low, being less than 1 t/ha. The yield of peach grafted on the Chinese bush cherry (B) under the central leader system was 25 t/ha. The yield of Hakuto under the Y type of Juseito rootstocks was less than 10 t/ha, while the yield of the trees grafted on the Chinese bush cherry (A) and (B) rootstocks were 40 and 25 t/ha, respectively. The yield of Hakuho on the rootstocks of Juseito, Nanking cherry (C), Chinese bush cherry (A) and (B) were 17, 20, 30 and 30 t/ha, respectively.

Fruit size: Fruit sizes in Hakuto grafted on Chinese bush cherry (A), Chinese bush cherry (B), Juseito and Nanking cherry (D) rootstocks were smaller in this order. Fruit sizes in Hakuho were smaller in the order of Juseito/Chinese bush cherry (A), Nanking cherry (C) and Chinese bush cherry (B) rootstocks. Larger fruit size of peach was harvested from the trees trained in the Y type than from those trees trained in the central leader type.

Soluble solid of the fruits: Soluble solid percentage in the fruits was higher in the trees grafted on dwarfing rootstocks than those in the Juseito rootstocks in both Hakuto and Hakuho.

From the above-stated results, it is concluded that the Chinese bush cherry (A) and (B) and the Nanking cherry (C) would be suitable rootstocks for dwarfing peach trees.

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