THE ROLE OF CULTIVAR AND ROOTSTOCK IN SYLLEPTIC SHOOT FORMATION IN MAIDEN PEAR TREES

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A B S T R A C T

The natural growth habit of maiden trees of six pear cultivars grafted on either Quince MA (*Cydonia oblonga* Mill.) or 'Bartlett' seedling (*Pyrus communis* L.) rootstocks was examined over two growing seasons. The factor that most influenced sylleptic shoot formation was cultivar. 'Duchess' produced the most sylleptic shoots (3.09 shoots/tree/year), and 'Seckel' produced the least (0.02 shoots/tree/year). Cultivar, rootstock, and the interactions between them had no significant effect on tree height or diameter. With most of the cultivars studied, there was a significant positive correlation between total number of shoots and tree diameter, but not between total number of shoots and tree height.

Key words: lateral branching, quince rootstock, pear, syllepsis

INTRODUCTION

Vegetative growth and growth habit depend on the genetic constitution of the plant. Growth habit may also be affected by rootstock, environmental conditions, or growing methods (Howard et al., 1974; Kamboj and Quinlan, 1997; Tromp, 1996).

How rootstock controls scion growth is not fully understood. Hormones may be involved. Kamboj and Quinlan (1997) found a higher concentration of cytokinin in root exudate from vigorous rootstocks than from dwarf rootstocks. Abscisic acid and auxins may also affect the rootstock itself. The ratio of ABA:IAA was lower in vigorous rootstocks than in dwarf rootstocks. Maiden trees usually produce more lateral shoots when propagated on vigorous rootstocks, though this is not the case with some apple, sweet cherry and pear cultivars (Reznicek and Salas, 1998). A method of promoting lateral

growth in nursery trees by using chemicals that reduce apical dominance has been developed in Poland (Jankiewicz, 1960).

The degree to which non-genetic factors influence syllepsis is limited by the genetic make-up of the cultivar. Little has been published on natural branching habit in fruit trees, especially while they are still in the nursery, though some information can be found in publications on tree architecture, tree training, or improving the quality of maiden trees.

The aim of this study was to investigate natural sylleptic shoot formation in different combinations of pear cultivars and rootstocks commonly used in orchards in the northern United States.

MATERIAL AND METHODS

The experiments were carried out from 1994 to 1995 in a commercial nursery in western New York. From June to August, average air temperature was 21ºC, average soil temperature 22.7ºC, and average relative humidity was 79.7%. Trees were planted 120 x 30 cm apart and budded 5 cm above soil level using the T-budding technique. No treatments to enhance lateral branch formation were applied. The year after budding, six pear cultivars ('Anjou', 'Bartlett', 'Red Bartlett', 'Clapp's Favorite', 'Duchess' and 'Seckel') were grafted on Quince MA and 'Bartlett' seedling rootstocks. Trees were randomly selected from one or two adjacent rows of the same cultivar-rootstock combination. At the end of each growing season, tree height and tree diameter (15 cm above the bud union) were measured. Total lateral shoots were counted and classified as short shoots (< 30 cm) or long shoots (> 30 cm).

Data were subjected to analysis of variance, followed by Duncan's multiple range t-test at $P = 0.05$. For each cultivar, the significance of differences between rootstocks was evaluated by Student's t-test at $P = 0.05$ and $P = 0.01$ and was expressed as absolute values. Correlations between tree height, tree diameter, total shoot count and long shoot count were evaluated by Pearson's product moment correlation at $P = 0.05$.

RESULTS

The effect of cultivar, rootstock, and cultivar-rootstock combination on tree height, tree diameter and total shoot count is presented in Table 1.

Tree heights were lower in 1994 than in 1995. Tree diameters were about the same in both years, regardless of rootstock. Total shoot counts were higher in 1994 than in 1995 for all cultivar-rootstock combinations except 'Bartlett' on 'Bartlett' seedling rootstock (Tab. 1).

The effects of cultivar, rootstock, and cultivar-rootstock combination on tree height and tree diameter were much smaller than on total shoot count, and were often difficult to determine. In most cases, the data from 1994 were not consistent with the data from 1995. However, there was considerable cultivar-specific variation in total shoot count.

T a b l e 1 . Cultivar-specific and rootstock-specific effects on tree height, tree diameter and total shoot count in maiden pear trees

Characteristic	Cultivar	Rootstock				Two-year cultivar-specific average	Significance of differences between the rootstocks [absolute values]	
		Quince MA		'Bartlett' seedling				
		1994	1995	1994	1995		1994	1995
Tree height [cm]	'Anjou'	144 abc	181 bc	140 ab	213 de	170	n.s.	**
	'Bartlett'	151 abcd	193 bcde	158 bcd	219 ef	180	n.s.	**
	'Clapp's Favorite'	129 a	169 ab	121 a	203 cde	156	n.s.	**
	'Duchess'	125 a	164 ab	139 ab	244 f	168	n.s.	**
	'Red Bartlett'	173 d	194 bcde	166 cd	242 f	194	n.s.	**
	'Seckel'	126 a	150 a	126 a	189 bcd	148	n.s.	**
	Mean	141	175	142	218		for 1994: LSD 0.05 = 27.5	
	Two-year rootstock-specific mean	158		180			LSD 0.01 = 36.1	
							for 1995: LSD 0.05 = 10.5	
							LSD 0.01 = 13.7	
Tree dia-meter [cm]	'Anjou'	1.51 d	1.25 ab	1.43 cd	1.45 f	1.41	n.s.	**
	'Bartlett'	1.27 a	1.28 abc	1.34 ab	1.34 bcde	1.31	n.s.	n.s.
	'Clapp's Favorite'	1.32 ab	1.30 abcd	1.20 a	1.36 cdef	1.30	**	n.s.
	'Duchess'	1.50 d	1.47 def	1.43 cd	1.68 g	1.52	n.s.	**
	'Red Bartlett'	1.46 d	1.23 c	1.37 bc	1.43 ef	1.37	**	**
	'Seckel'	1.27 a	1.29 abc	1.28 ab	1.40 ef	1.31	n.s.	**
	Mean	1.39	1.30	1.34	1.44		for 1994: LSD 0.05 = 0.08	
	Two-year rootstock-specific mean	1.35		1.39			LSD 0.01 = 0.11	
							for 1995: LSD 0.05 = 0.09	
							LSD 0.01 = 0.12	
Total shoot count	'Anjou'	2.13 cd	0.06 a	0.63 ab	0.23 a	0.76	**	n.s.
	'Bartlett'	0.80 ab	0.67 abc	0.93 ab	2.61 d	1.25	n.s.	**
	'Clapp's Favorite'	0.70 ab	0.00 a	1.57 c	0.56 a	0.71	n.s.	n.s.
	'Duchess'	7.80 f	1.58 bc	2.24 d	0.76 cd	3.09	**	n.s.
	'Red Bartlett'	3.53 e	0.06 a	1.13 bc	0.44 a	1.29	**	n.s.
	'Seckel'	0.03 a	0.06 a	0.00 a	0.00 a	0.02	n.s.	n.s.
	Mean	2.50	0.41	1.08	0.76		for 1994: LSD 0.05 = 0.92	
	Two-year rootstock-specific mean	1.46		0.93			LSD 0.01 = 1.21	
							for 1995: LSD 0.05 = 0.91	
							LSD 0.01 = 1.19	

*Means followed by the same letter are not significantly different at P = 0.05. Comparisons are valid within two columns of the same characteristic for the same year

Table 2. Correlations between tree height, tree diameter, total shoot count, and long shoot count in maiden pear trees on Quince MA and 'Bartlett' seedling rootstocks

Cultivar	Rootstock	Correlation coefficients							
		tree height and tree diameter		tree height and total shoot count		tree diameter and total shoot count		total shoot count and long shoot count	
		1994	1995	1994	1995	1994	1995	1994	1995
'Anjou'	Quince MA	0.68	0.69	0.52	n.s.	0.77	n.s.	0.95	1.00
	'Bartlett' seedling	n.s.	0.76	n.s.	n.s.	0.46	0.71	0.97	0.95
'Bartlett'	Quince MA	0.76	0.91	n.s.	n.s.	0.71	0.48	0.95	0.83
	'Bartlett' seedling	0.80	0.78	0.47	0.70	0.44	0.86	0.96	0.87
'Red Bartlett'	Quince MA	0.69	0.68	0.47	n.s.	0.60	n.s.	0.78	1.00
	'Bartlett' seedling	0.84	0.81	0.38	n.s.	0.63	n.s.	0.95	0.73
'Clapp's Favorite'	Quince MA	0.45	0.62	n.s.	n	0.47	n	0.92	n
	'Bartlett' seedling	0.69	0.59	n	n.s.	n	0.40	n	1.00
'Duchess'	Quince MA	n.s.	0.63	n.s.	n.s.	0.54	n.s.	0.56	0.51
	'Bartlett' seedling	0.74	0.68	n.s.	n.s.	n.s.	0.53	0.90	0.77
,Seckel'	Quince MA	0.72	0.69	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
	'Bartlett' seedling	0.67	0.83	n	n	n	n	n	n

All correlation coefficients are significant at P = 0.05 unless otherwise marked (n.s.) n = no data

The cultivar-specific average of tree heights for both rootstocks ranged from 148 cm for 'Seckel' to 194 cm for 'Red Bartlett'. The rootstock-specific average of tree heights for all cultivars was 158 cm for Quince MA rootstock, and 194 cm for 'Bartlett' seedling rootstock.

The cultivar-specific average of tree diameters for both rootstocks ranged from 1.30 cm for 'Clapp's Favorite' to 1.52 cm for 'Duchess'. The rootstock-specific average of tree diameters for all cultivars was 1.35 cm for Quince MA rootstock, and 1.39 cm for 'Bartlett' seedling rootstock.

The cultivar-specific average of total shoot counts for both rootstocks ranged from 0.02 shoots/tree for 'Seckel' to 3.09 shoots/tree for 'Duchess'. The rootstock-specific average of total shoot counts for all cultivars was 1.46 shoots/tree for Quince MA rootstock, and 0.93 shoots/tree for 'Bartlett' seedling

rootstock (Tab.1). In most cultivar-rootstock combinations, cultivar and rootstock did not significantly affect ratios of short to long shoots (data not shown).

The correlation between tree height and tree diameter was significant at P = 0.05 for all cultivar-rootstock combinations except 'Anjou' on 'Bartlett' seedling rootstock, and 'Duchess' on Quince MA in 1994. The correlation between total shoot count and long shoot count was also strong for all cultivar-rootstock com-binations except for 'Duchess' on Quince MA rootstock in 1995. The correlation between tree height and total shoot count is also moderately strong. The correlation between tree diameter and total shoot count is very weak (Tab. 2).

DISCUSSION

The main factor determining branching is genetics (Quinlan and Tobutt, 1990). This study demonstrates that, with pear trees, choice of cultivar had a much greater effect on branching than did choice of rootstock, though less so than in other fruit species (Czynczyk, cited by Lipecki, 1994). Air temperature, soil temperature and relative humidity also play a role in sylleptic branch formation (Tromp, 1996). At the experimental site, the weather in both years was not very different. The differences between 1994 and 1995 are thus probably due to factors other than the weather. Soil quality probably played a role because the trees were grown in the nursery using field rotation. Genetic factors involved in the propagation of 'Bartlett' seedling rootstock probably also played a role (Czynczyk, 1998). Of the cultivars examined, 'Duchess' produced by far the most sylleptic shoots, and 'Seckel' by far the least, which confirms earlier findings (Jacyna, 1996).

Rootstock may influence branching by affecting scion vigor (Kamboj et al., 1997). Trees grafted on vigorous rootstocks usually branch more profusely than trees grafted on dwarf and semi-dwarf rootstocks. However, in this study, branching was better with dwarf Quince MA rootstock than on standard 'Bartlett' seedling rootstock, probably because maiden pear trees have a limited branching capacity in comparison to trees of other fruit species, such as apples or sour cherries. The fact that the rootstocks were grown in a hot and humid climate may also have had some effect on branch formation.

The effects of cultivar, rootstock, and cultivar-rootstock combination on tree height and tree diameter were much smaller than on total shoot count. The moderately strong correlation between tree diameter and total shoot count is particularly significant for sylleptic branch formation. There was a high correlation between trunk cross-sectional area and total shoot count in pear trees (Ostrowska and Chełpiński, 1997) and apple trees (Lipecki and Janisz, 1999). The results of this study confirm those of Kowalik (2001) and Łanczont (2004), who found that, in the pear cultivars 'Lucas', 'Concorde'

and 'Conference', there is a high correlation between tree diameter and total shoot count, but not between tree height and total shoot count. This suggests that tree diameter may be a useful indicator of the quality of maiden trees. (Kowalik, 2001; Lipecki and Janisz, 1999; Łanczont, 2004; Ostrowska and Chełpiński, 1997).

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ROLA ODMIANY I PODKŁADKI WE WZROŚCIE SYLEPTYCZNYM OKULANTÓW GRUSZ

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S T R E S Z C Z E N I E

W ciągu dwóch lat badano tworzenie się naturalnych rozgałęzień syleptycznych okulantów grusz odmian ‘Bera Anjou’, ‘Bonkreta Williamsa’, ‘Czerwona Bonkreta Williamsa’, ‘Faworytka’, ‘Duchess’ i ‘Seckel’ na podkładkach pigwy MA i siewki odmiany ‘Bonkreta Williamsa’. Ocena wzrostu okulantów za pomocą liczby pędów syleptycznych (LPS) wskazuje, ze naturalne zdolności do tworzenia tych pędów są cechą odmianową; w tym wypadku typ zastosowanej podkładki odgrywa marginalną rolę. Największymi zdolnościami do tworzenia pędów syleptycznych charakteryzowała się odmiana ‘Duchess’, zaś najmnieszymi odmiana ‘Seckel’ tworząc odpowiednio 3,09 i 0,02 pędy/drzewko/rok. Pozostałe odmiany tworzyły od 0,71 do 1,29 pędów/drzewko/rok. Odmiana, podkładka bądź ich interakcja w niewielkim stopniu wpływały na wysokość (WD) i średnicę (SD) drzew. W okresie badań stwierdzono istotność korelacji w 65 i 30% porównań odpowiednio dla SD *x* LPS i WD *x* LPS.

Słowa kluczowe: grusza, pędy syleptyczne, pigwa, podkładka, syllepsis