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Fruit Varieties Journal 47(1):31-37 1993

A Sixteen-Year-Old Trial of Pear Cultivars on Quince A and C in Byelorussia

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Abstract

The performance of 3 cultivars of pear (*Pyrus communis* L.) on rootstocks of Quince A, C and pear seedlings was studied over a 16 year period in a trial planted at distances 5 x 3 m. Pear trees were trained as compact free standing hedgerow crowns. The planting was subjected to severely cold 3 winters during which the temperature reached -30 to -32°C. Tree survival was higher on the two quince rootstocks in comparison with pear seedling rootstock. The anchorage of trees on quince rootstocks did not prevent leaning of the trees but the trees did not appear to affect growth and tree fruiting. Rootstocks of Quince A and C increased an orchard yield by 8-14 and 14-27% respectively. Fruit quality did not differ greatly.

Introduction

Mature pear trees on pear seedling rootstocks in Byelorussia may reach a height of 7-9 m. Dwarfing rootstocks for pear have an advantage in that they allow high density plantings, increase yield, and reduce labor involved in picking. Early attempts to use quince as a pear rootstock in Central and Western regions of European territory of the U.S.S.R. was not always successful. When grafted on quince, pear trees were damaged by freezing temperatures of -30 to -32°C and low soil temperatures of -8 to -11°C in the nursery, or in young orchards (2, 4, 7, 12-14, 16). But the use of quince as a rootstock in Byelorussia has not been previously studied.

Materials and Methods

The trial was planted in spring 1975 in the Byelorussian Research Institute for Fruit Growing near Minsk (54° N.L., 28° E.L., rainfall 622mm, sunshine 1815 h). Quince rootstocks were grown by layering. Pear seedling (*P. communis* L.) served as a rootstock control. The wild pear trees growing here and there on the fields in the Western Byelorussia were the source of seeds for control. Three pear cultivars 'Byelorussian Late,' 'Beurre Loshitskaya,' and 'Beurre Slutskaya' were grafted using an interstem 30-40 cm long of pear cultivar 'Staras 31' *(P. communis)* developed by I. Staras, Institute of Horticulture in Lithuania. The same interstem was used to propa-

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gate the control. Besides 40 trees of cv. 'Staras 31' were formed on the interstem base after scions dying off because of winter injuries 1978-79 and 1979-80. Trees with one-year old scions, and without any visible symptoms of virus diseases, were planted at a spacing of 5 x 3 m (666 trees/ha). The experimental orchard was established in a completely randomized block design with 4 replicates of 4 to 5 trees in each plot. Tree crowns were trained as a hedgerow without any support, bending or angle planting bending. Dormant pruning only was carried out. Some trees on quince rootstocks leaned from severe winds and heavy rainfalls in the early years of the trial. If they did not obstruct the between-row spacing these trees remained lodging. The tree height was 3.0 m but the spread was 2.0-2.5 m depending on cultivar.

The pear orchard was planted on a level on sod-podzolic silty loam soil. The thickness of humus horizon was 25 cm and contained 1.5-2.0% of humus but there were sufficient amounts of nitrates and available forms of phosphorus and potassium. Minimal field capacity (FC) was near 22% of soil weight, air porosity at FC—more than 10% of soil volume. Soil management in orchard alleys was fallow with discing at a depth of 6-8 cm with herbicide strips within rows. The orchard was fertilized with 90 kg/ha of nitrogen, 90 kg/ha of potassium and 60 kg/ha of phosphorus annually.

Results

Winter hardiness. Three severe winters occurred during the course of the trial. In December 1978 minimum air temperature at 2 m over soil was -29°C, on the snow cover -35°C. In January 1980 air temperatures fell to -28°C, and in winter 1986-87, air temperatures fell to -32°C. The thickness of snow cover during these frosts varied strongly, but was never less than 10 cm. Soil temperature at a depth of 20 cm fell to -1.5°C. (Table 1).

After the 1978-79 and 1979-80 freezes, injury occurred to trunks and branches. Some trees were completely killed, whereas in other trees injury was only evident on the scion. Tree death occurred in the years immediately following the severe freezes and several years thereafter. Trees did not die from root injury. Nearly fifty percent

Table 1. Meteorological data of severe winters.

	December			January			February		
	Ten-day period								
	I	II	III	I	II	III	I	II	III
Winter 1978-79									
Minimum air temperature[x]	-14.3	-22.3	-29.2	-22.0	-15.1	-20.2	-15.3	-25.4	-20.6
Soil temperature[xx]	0.5	0.3	0.0	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
Snow cover[xxx]	none	7	13	21	31	35	41	43	42
Winter 1979-80									
Minimum air temperature	-6.5	-18.3	-10.0	-17.4	-19.2	-27.1	-13.3	-25.1	-15.3
Soil temperature	3.0	0.8	-0.2	-0.2	-0.5	-0.8	-0.3	-0.3	-0.3
Snow cover	none	3	2	11	13	30	25	33	32
Winter 1986-87									
Minimum air temperature	-8.1	-10.3	-25.3	-32.0	-30.5	-29.7	-16.7	-8.4	-20.3
Soil temperature	2.7	0.6	0.2	-1.2	-1.5	-0.6	-0.7	-0.2	-0.2
Snow cover	none	4	12	16	23	26	30	30	31

[x]At 2 m over a soil, °C.
[xx]At a depth of 20 cm, °C.
[xxx]Thickness, cm.

Table 2. Winter survival of pear on various rootstocks during 15 years and the cross trunk section area at the age of 4 and 15 years.

Rootstock	Killed and damaged, %[x]				Cross trunk section area, cm²	
	completely killed	scion only killed	interstem and scion killed	total	4-year old tree	15-year old tree
			Cv. 'Byelorussian Late'			
Pear seedling	14	12	5	31	21a	117a[xx]
Quince A	17	9	none	26	28b	153b
Quince C	14	2	none	16	29b	155b
LSD_{05}					2.8	11.5
			Cv. 'Beurre Lishitskaya'			
Pear seedling	25	none	4	29	14a	177a
Quince A	18	6	none	24	23b	190a
Quince C	20	none	none	20	26c	185a
LSD_{05}					2.0	$F_f < F_t$[xxx]
			Cv. 'Beurre Slutskaya'			
Pear seedling	37	30	10	77	10a	112a
Quince A	27	18	3	48	16b	146b
Quince C	31	4	none	35	16b	163c
LSD_{05}					1.1	13.9

[x]Percent of trees planted primary.
[xx]The means within columns of different cultivars followed by unlike letters are significantly different by Student's test at the 5% level.
[xxx]Fisher's criterion.

of all trees of 'Beurre Slutskaya' and twenty-five percent of all trees of 'Byelorussian Late' and 'Beurre Loshitskaya' on Quince A were killed (Table 2). The winter survival of pear trees on rootstock of Quince C was better than on Quince A.

After the winter of 1986-87, spur and flower bud injury was prevalent. No root damage was present. The tree death was not observed.

Survival of pear trees on quince rootstocks was higher than on pear seedlings. Survival of 'Byelorussian Late' and 'Beurre Slutskaya' was two times greater on Quince C rootstock than in the control. All scions survived better on Quince A rootstock than on pear seedlings (Table 2).

Tree growth. The mean length of a shoot and the number of shoots per tree on quince rootstocks in the first years after planting were significantly more than in the control (Fig. 1). The mean total shoot length of all three cultivars on Quince A and C rootstocks exceeded the control by 42 and 39%, 40 and 34%, 32 and 39%, 31 and 34% during the first, second, third and fourth season, respectively.

The increase of cross trunk section area on Quince A during the first 4 years was by 46% and on Quince C by 64% greater than on the pear rootstock (Fig. 2). When trees began to bear fruit, their growth on quince rootstocks slowed as compared to the control, but not all cultivars did the same. For example, the increase of cross trunk sections of cv. 'Byelorussian Late' on quince rootstocks for 10 years (age 5 to 15) was at 1/5 less than on pear seedlings. The difference in tree growth of this cultivar on Quince A and C was not significant. The increase of cross trunk section of cv. 'Beurre Loshitskaya' during 10 years did not differ significantly for all rootstocks, but cv. 'Beurre Slutskaya' on quince rootstock continued to grow

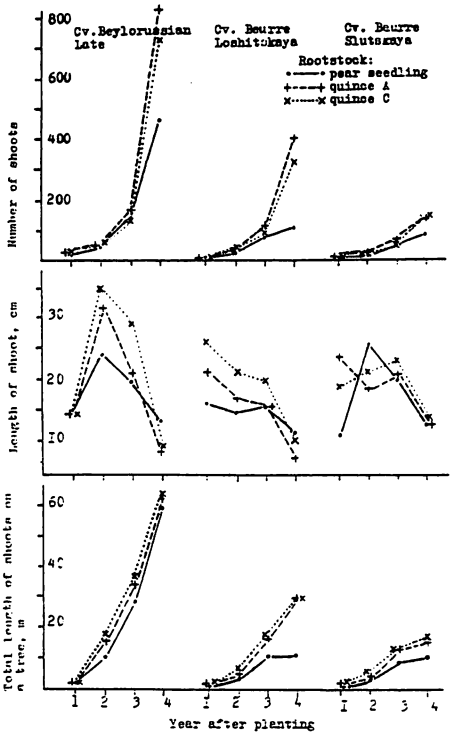

Figure 1. Age dynamics of number of shoots, mean length of shoot and total length of shoots per a pear tree on different rootstocks.

more strongly than on pear seedlings. Rootstock Quince C in comparison with Quince A was more vigorous for this cultivar (Fig. 2).

As a result of scion injury in winters 1978-79 and 1979-80 the aerial parts of some pear trees recovered from interstem (cv. 'Staras 31'). 15-old trees of this cultivar on Quince A had cross trunk section area 118 cm,^{2} but on pear seedlings—183 cm^2 (level of significant difference = 25.6 cm^2).

The uniformity of tree size was good on all rootstocks, because of annual pruning for height restriction. The cross trunk section area of pear trees on quince rootstocks had middle coefficient of variation (V) = 14-17% (Table 2). The trunk thickness of cv. 'Beurre Loshitskaya,' 'Beurre Slutskaya' and 'Staras 31' on pear seedlings varied more greatly (V = 28-41%) in comparison with trees grafted on quince rootstocks.

Anchorage. Trees on quince leaned after heavy rains and high winds (Fig. 3). But the leaning trees developed a vertical canopy after several years and growth and fruit yield did not appear to be greatly affected.

Suckers. One of the advantages of quince rootstock was an absence of root suckers that developed on the roots and crown. Some trees on pear rootstock had few root suckers that required removal.

Yield. Flowering of trees on pear and quince rootstocks began in the fourth year. But frost injury eliminated most of the fruit in the 3 to 4 years irrespective of a rootstock.

Yield of pear cv. 'Byelorussian Late' on rootstocks of Quince A and Quince C averaged 8-14% higher than on pear seedling during 6-year period 1986-91 (Table 3). 'Beurre Loshitskaya' on quince rootstocks A and C exceeded the seedling rootstock by 12 and 27% respectively. Taking into account the greater tree loss on pear seedlings after winter injury, the actual yields of 2 cultivars on Quince A and C rootstocks were 12-20 and 38-41% higher as compared with the control. The actual orchard crop on quince rootstocks for 6 years averaged 16-19 t/ha for 'Byelorussian Late' and 13-15 t/ha for cv. 'Beurre Loshitskaya.' Actual yield on pear rootstock was 2-5 t/ha lower for this period.

Yield efficiency of cv. 'Byelorussian Late' on quince rootstocks A and C exceeded the control by 25 and 30%, respectively (Table 3). This index for cv. 'Beurre Loshitskaya' on Quince C was 21% higher than on pear seedlings, but did not differ from control significantly on Quince A rootstock.

Maximum crop reached 30-40 t/ha in 1990. Rootstocks were not to affect biennial bearing of all tested cultivars.

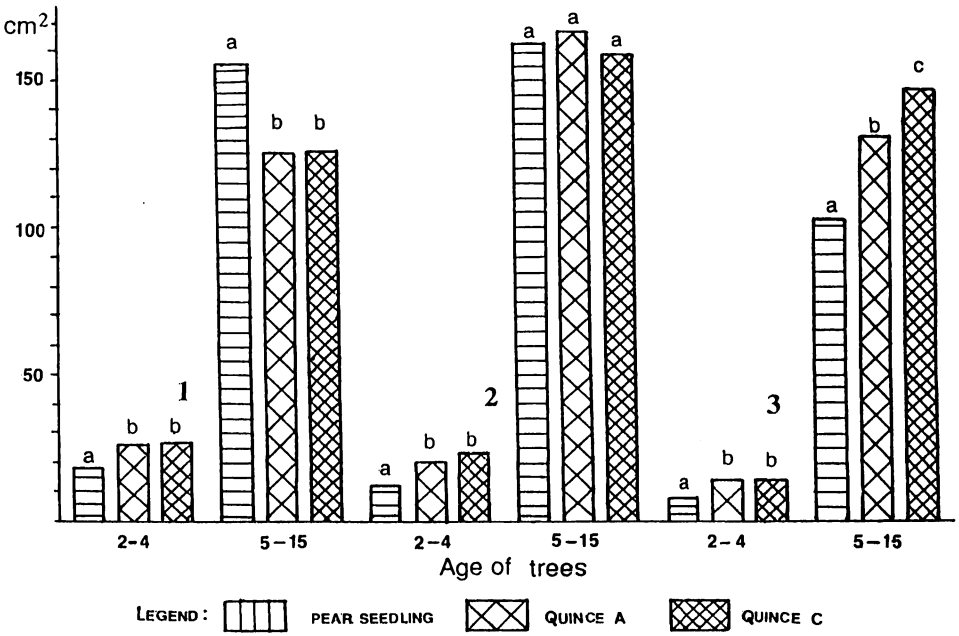

Figure 2. Increase of cross trunk section area of trees on different rootstocks at the age of 2-4 and 5-15 years: 1 — cv. 'Byelorussian Late'; 2 — cv. 'Beurre Loshitskaya'; 3 — cv. 'Beurre Slutskaya'; a, b, c — indexes of significant difference (see note to the Table 2).

Fruit size and quality. The size of pear fruit of cv. 'Byelorussian Late' on Quince A was 10% larger than in pear seedlings (Table 3). The difference in fruit size of this cultivar on Quince C and in the control was not significant. Fruit weight of the rest of the cultivars did not differ in connection with rootstocks.

Keeping quality of fruit. cv. 'Byelorussian Late' during 6 months of cold storage was identical for all rootstocks. In taste trials in March fruit of this cultivar on Quince A rootstock had a mean subjective quality score of 4.3 point (maximum = 5.0); on the Quince C score was 4.2; and on pear seedling was 3.9. The differences were due to flesh texture, flavor and taste. There were no noticeable differences in damage of fruit from *Monilia*, pear scab and other diseases.

Discussion

This trial confirmed a thesis of A.P. Margolin (10) that a snow cover of 10-15 cm enables the survival of quince root system in most winter conditions in this region. Limitations of pear culture on quince rootstock are conditioned first of all by the danger of winter-killing of roots due to lack of snow cover (1, 3, 5, 7-9, 15-18). In our trial, trees on Quince A and C withstood minimal temperatures of -30, -32°C in combination with good snow cover as well as pear seedlings. Low soil temperatures resulting from lack of snow cover limits the region in which quince rootstocks can be used. In southern Ontario, Canada, quince rootstock for pears withstood -26°C (15). In the southern Ukraine the air temperatures of -30, -32°C were critical if snow was absent (7). Similar

Table 3. Yield, yield efficiency and fruit weight of pear on different rootstocks.

Rootstock	Annual yield from year 12 to 17, kg/tree						Mean yield for year 12 to 17				
							Mean annual yield, kg/tree	Projected annual yield, t/ha		Yield efficiency, kg/cm²[x]	Fruit weight, g[xx]
	12	13	14	15	16	17		at 100% tree density in orchard	at real tree density in orchard		
					Cv. 'Byelorussian Late'						
Pear seedling	35a[xxx]	7a	24a	28a	57a	21a	29.3a	19.5a	13.5	0.166a	115
Quin;ce A	19b	10ab	27a	41b	63a	28a	31.8ab	21.2ab	15.7	0.208b	124
Quince C	15b	13b	31a	50b	61a	31a	33.5b	22.3b	18.7	0.216b	117
LSD_{05}	6.1	4.0	12.4	9.6	6.2	11.1	2.9	1.9		0.030	
					Cv. 'Beurre Loshitskaya'						
Pear seedling	33a	3a	16a	26a	43a	15a	22.6a	15.1a	10.8	0.128a	96
Quince A	39ab	3a	16a	30a	45ab	24b	25.7b	17.1b	13.0	0.135ab	100
Quince C	44b	3a	20a	30a	50c	24b	28.7c	19.1c	15.3	0.155b	99
LSD_{05}	6.6		7.1	16.8	3.4	4.4	0.9	0.6		0.027	

[x]Yield efficiency =mean yield for year 12 to 17/cross trunk section area at the age of 15 years (see Table 2).
[xx]Mean during 3 years.
[xxx]See note to the Table 2.

observations were made in the Northern Ukraine and the Northern Caucasus (10, 13, 16).

Some researchers noted (3, 6) intensive growth of shoots and a trunk of pear trees grafted on quince rootstock, particularly on Quince C in young orchards and a sharp decrease of growth at the beginning of fruiting. Such observations were confirmed in this trial. But growth of trees on Quince A and C did not differ in this study. Experience in Western Europe and North America indicates that pear *(P. communis)* seedling rootstock result in trees which are larger than those on both Quince A and C. In discussion trial this observation was confirmed for cv. 'Byelorussian Late' and 'Staras 31'. But cross truck section area of cv. 'Beurre Loshitskaya' was equal in all treatments. The trunk thickness of cv. 'Beurre Slutskaya' on pear seedlings was less in comparison with quince rootstocks. A key for understanding of different cultivar behavior on pear and quince rootstocks in situated in further investigations.

A positive effect of Quince C on yield of pear orchard in comparison with Quince A deserves special regional attention so far as a contrary opinion about peculiarities of these quince forms as rootstocks existed in many countries and regions (5, 8, 16).

Probably a deficiency of summer heat became the reason for insignificant difference between fruit quality on different rootstocks.

Summary

Snow cover is usually adequate in Byelorussia and winter hardiness of pear trees in this region is dependent on scion hardiness. This study reported

a positive effect of the rootstocks, Quince A and C on survival of 3 pear cultivars, 'Byelorussian Late,' 'Beurre Loshitskaya,' and 'Beurre Slutskaya.' When there is enough snow cover, winter hardiness of pear trees on quince rootstocks may be even increased in comparison with pear rootstock. Insufficient anchorage of Quince A and C cannot be an obstacle for commercial culture as leaning trees can recover their vertical orientation.

Quince rootstock A and C increased yield of two pear cultivars by 10 and 20%, respectively. As a result of better survival of trees during severe winters, the yield of trees on Quince A were 6-20% higher than on pear seedlings, whereas that on Quince C was 38-41% higher.

Acknowledgements

Young trees were grown in nursery by Dr. N. M. Zdorovtsov. Dr. A. F. Radyuk took part in planting and growing the orchard during the first 3 years of this trial.

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Wilder Medal Nominations

The Wilder Medal Committee of the American Pomological Society (APS) invites nominations for the 1992 Wilder Silver Medal Award.

The Wilder Medal is presented to individuals or organizations that have rendered outstanding service to horticulture in the area of pomology. Special consideration is given to work relating to the origination and introduction of meritorious fruit cultivars. Individuals associated with either commercial concerns or professional organizations may be considered if their introductions are superior and have been widely planted.

Significant contributions to the science and practice of pomology other than through fruit breeding will also be considered. Such contributions may relate to any important area of fruit production, such as rootstock development and evaluation, anatomical and morphological studies, or notable publications in any of the above subjects.

For nomination guidelines, contact Dennis J. Werner, Department of Horticultural Science, Box 7609, North Carolina State Univ., Raleigh, NC 27695-7609; phone 919/515-3166. Nominations must be submitted by **1 April 1993.**