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Grafting Success and Early Performance of Asian Pears on *Pyrus calleryana* Rootstock

HLA AUNG AND FRANK B. MATTA[1]

Abstract

Grafting success of 14 Asian pear cultivars on *Pyrus calleryana* and early performance of these cultivars after 2 growing seasons are reported. Percentage survival was 100% for 'Chojuro,' 'Japanese Golden Russet,' 'Kikusui,' 'Seuri,' 'Shinseiho,' '20th Century,' 'Yakumo' and 'Tsu-Li.' 'Erishinge,' 'Hosui,' 'Seigyoku' and 'Pai-Li' had 75% survivals on *P. calleryana* rootstock 'Shinseiki' and 'Ya-Li' had poor survival attributed to poor grafts, since no incompatibility symptoms were observed. Very early budbreak was observed in 'Korean Giant,' 'Seuri,' 'Pai-Li' and 'Tsu-Li' followed by 'Hosui,' 'Japanese Golden Russet' and 'Kikusui.' 'Erishinge,' 'Seigyku,' 'Shinseiho' and '20th Century' were late blooming. 'Chojuro' was identified as a vigorous cultivar. Scion and rootstock caliper did not differ at the end of the second growing season. All trees of 'Chojuro' and 'Seigyoku' were infected with fire blight. 'Erishinge,' 'Kikusui' and 'Seuri' did not exhibit fire blight symptoms.

Introduction

Prior to orchard establishment, it is important to select the best scion/rootstock combination for tree longevity, maximum fruit quality and yield. In efforts to meet growers' demands for information on Asian pears, several studies have been reported in Washington (8, 9), California (6), and Oregon (2). Presently, no information on Asian pear cultivars and rootstocks exists in the southern United States, specifically, Mississippi. Tree mortality in a new planting of Asian pear cultivars was related to rootstock and scion (8). Low survival of budded trees suggest that compatibility of Asian pear on Provence quince *(Cydonia oblonga)* is low. *Pyrus calleryana* has been the most successful of the Asian pear rootstocks tested to date but is grown to a limited extent in the southern United States (10). This rootstock is also commonly used in China (11) and Australia (10). *P. calleryana* responds favorably to many scion cultivars and is superior in orchard performance to many other rootstocks (15). In addition, *P. calleryana* has been reported resistant to fire blight (5).

Fire blight *(Erwinia amylovora)* has limited European pear production in the southeastern United States (1). However, most Asian pears have been reported to be resistant or somewhat more resistant than European types (1).

The long-term objective of this experiment was to evaluate the overall performance of 14 Asian pear scion cultivars grafted on *P. calleryana*. Grafting success, tree growth, and fire blight resistance of these cultivars is reported in this paper.

Materials and Methods

One-year-old *P. calleryana* Pecene. seedling rootstocks were planted in 1987 on a 6.1 x 6.1 meter spacing at the Pontotoc-Flatwoods Research and Extension center (34°08'N and 89°00'W), Pontotoc, MS. On March 22, 1989 the three-year-old seedlings were grafted with 15 Asian pear scion cultivars (Table 1). Graftwood was collected from healthy four-year-old trees, wrapped in moist newspaper and stored in a refrigerator at 5C January 29, 1989. Five days prior to grafting the wood was reconditioned for five days at room temperature (24C).

The mean caliper of the rootstock at grafting was 1 m. Scion pieces were 16 cm long with six buds. The splice graft method was used for grafting and the mean height of the graft union was 16 cm above ground. On May 31, 1989, 27 days after grafting,

[1]Graduate student and Professor, respectively, Department of Horticulture, Mississippi State University, Mississippi State, MS 39762.

all newly forced shoots, except the strongest were removed from the scion. The remaining shoot was topped at 103 cm above ground 94 days after grafting to induce lateral branching. Plant survival was taken both years in September. Shoot length and diameter of the main shoot were measured every 10 days during the second growing season. Dates of 50% budbreak were recorded weekly beginning the first week of April, 1990. On August 14, 1990, primary, secondary and tertiary branches were counted to determine branch number and total branch length (sum of all branches). In addition, branching angle from vertical trunk of three main scaffold branches was taken. For each cultivar, thirty mature leaves per replicate were removed from current seasons growth on August 16, 1990 to determine leaf area and size using a LI-3000 portable area meter (Li-Cor, Inc., Lincoln, NE). Internode length was measured August 15, 1990 and consisted of measuring the first three basal internodes on three different randomly selected shoots per tree.

Scion cultivars were evaluated for resistance to natural infection of fire blight. Fire blight severity was rated as 10 = severe (90-100% of tree infected) and 1 = none (no infection of tree). Trees showing any degree of fire blight were included in determining the percentage of trees with the disease.

A randomized complete block design was used for the 14 scion cultivars and each cultivar was replicated four times (single plant replicates). The general linear model (GLM) procedure was used for data analysis, percentage data was transformed and means were separated using Duncan's New Multiple Range Test (SAS, Inc., Cary, N.C.).

Results and Discussion

Total survival of grafted scions the second growing season was 83.3% (Table 1). One hundred percent survival was obtained with 'Chojuro,' 'Japanese Golden Russet,' 'Kikusui,' 'Seuri,' 'Shinseiho,' '20th Century,' 'Yakumo,' and 'Tsu-Li.' 'Erishinge,' 'Hosui,' 'Seigyoku' and 'Pai-Li' had 75% survival followed by, 'Korean Giant,' 'Shinseihi' and 'Ya-Li' with 50% survival. Survival of 'Korean Giant' and 'Pai-Li' would have been 100% but plants died because of mechanical injury. Scion wood of 'Shinseiho' and 'Ya-Li' was hard and difficult to cut to obtain an even surface for close contact with the rootstock cambium.

According to Tanaha (6), 'Chojuro' trees on *P. calleryana* had lower percentage survival than trees on *P. serotina, P. betulaefolia* or *P. bretschneideri.* In this experiment, 'Chojuro' grafts had 100 percent survival. Failure to form a successful graft union was observed in all dead scions except one of 'Erishinge' which died later. Incompatible symptoms such as yellowing of foliage, marked differences in growth rate or vigor of scion or rootstock, over growth above or below the graft union, and graft components breaking apart clearly at the graft union did not occur. Incompatibility among the species was not expected since Westwood (14) pointed out that there is good graft compatibility among *Pyrus* species.

Very early budbreak was observed in 'Korean Giant,' 'Seuri,' 'Pai-Li' and 'Tsu-Li' as indicated by date of 50% budbreak. 'Tsu-Li' had previously been reported as blooming early, 'Hosui' and 'Kikusui' bloomed latest and there was an inconsistent effect of rootstock on the time of bloom (7). Budbreak of 'Hosui,' 'Japanese Golden Russet' and 'Kikusui' was rated as early and occurred on March 25, 1990. 'Erishinge',' 'Seigyoku,' 'Shinseiho, and '20th Century' were rated as late and 50% budbreak occurred April 1. The very late cultivars, 'Chojuro' and 'Yakumo' had 50% budbreak on April 15 (Table 1). Results suggest that early budbreak cultivars have a lower chilling requirement as compared to later budbreak-

Table 1. Survival, date of budbreak, and fire blight assessment of scion cultivars on *P. calleryana* rootstock during the second season at the Pontotoc Ridge-Flatwoods Research and Extension Center.

Cultivar	Survival %	Date of 50% budbreak	Fire Blight Severity[y]	Trees with Fire Blight (%)
P. serotina				
Chojuro	100 a[x]	April 15	9.0 a	100 a
Erishinge	75 b	April 1	1.0 b	0 e
Hosui	75 b	March 25	4.2 b	50 c
Japanese Golden Russett	100 a	March 25	2.7 b	25 d
Kikusui	100 a	March 25	1.0 b	0 e
Korean Giant	50 c	March 11	3.6 b	25 d
Seigyoku	75 b	April 1	4.0 b	100 a
Seuri	100 a	March 11	1.0 b	0 e
Shinseiho	100 a	April 1	2.0 b	25 d
Twentieth Century	100 a	April 1	2.5 b	75 b
Yakumo	100 a	April 15	2.0 b	75 b
P. bretschneideri				
Pai-Li	75 b	March 11	1.7 b	25 d
Tsu-Li	100 a	March 11	3.5 b	50 c
Ya-Li	50 c	---	3.0 b	75 b
Mean	83.3		2.9	44.6

[x]Mean separation within columns by Duncan's Multiple Range Test at p = 0.05.
[y]Fire blight severity was rated as; 10 = severe (90-100% of tree infected) and 1 = none (no infection of tree).

ing cultivars. '20th Century' has been reported to have a much longer chilling requirement than many *P. communis* cultivars. Ferree, et al. (4) concluded that plants that broke dormancy late in the spring, had a longer chilling requirement and avoided frost damage to flower buds. Therefore, in areas where late spring freezes exist, early blooming, low chill pears should be avoided.

All trees of 'Chojuro' and 'Seigyoku' had fire blight and fire blight severity was rated as 9 and 4, respectively. 'Erishinge,' 'Kikusui' and 'Seuri' did not exhibit fire blight symptoms. The percentage of fire blighted trees ranged between 20 and 100 depending on cultivar. Overall fire blight severity and trees with fire blight was 21.2 and 44.6 percent, respectively (Table 1).

Shoot length among cultivars did not differ at the end of the second growing season (Table 2). The number of branches was highest in 'Yakumo' as compared to 'Seigyoku,' 'Shinseiho,' 'Tsu-Li,' '20th Century' and 'Seuri.' Thibault, et al. (12) reported that '20th Century' produced numerous shoots and that 'Chojuro' had good branching. Branch number of 'Chojuro,' 'Hosui,' 'Korean Giant,' 'Pai-Li,' 'Kikusui,' 'Erishinge,' 'Japanese Golden Russet,' did not differ. Total shoot length of 'Chojuro' was greater than all cultivars except 'Hosui,' 'Korean Giant,' 'Yakumo,' and 'Pai-Li' (Table 2).

The small leaf sizes were observed in 'Yakumo,' 'Chojuro' and 'Pai-Li' (Table 2). The leaves of 'Seuri,' 'Seigyoku,' and 'Japanese Golden Russet' were larger than those of 'Erishinge,' while the remainder did not differ from each other.

'Chojuro' and 'Yakumo' had the shortest internodes with 2.8 and 2.7

Table 3. Trunk diameter of *P. calleryana* rootstock and Asian pear scions at the end of the first and second growing season at the Pontotoc Ridge-Flatwoods Research and Extension Center.

Cultivar	First Growing Season	Second Growing Season
	Trunk Diameter (cm)	
	Scion/Rootstock	Scion/Rootstock
P. serotina		
Chojuro	1.5/1.7[x]	2.6/2.8
Erishinge	1.3/2.1	2.1/2.9
Hosui	1.2/1.9	2.4/3.2
Japanese Golden Russett	1.3/1.8	1.9/2.8
Kikusui	1.2/2.0	2.1/2.9
Korean Giant	1.1/1.9	2.3/3.3
Seigyoku	1.2/1.8	1.9/2.8
Seuri	1.3/2.1	2.3/3.2
Shinseiho	1.1/1.7	1.6/2.4
Twentieth Century	1.2/1.6	2.1/2.7
Yakumo	1.5/1.8	2.5/2.8
P. bretschneideri		
Pai-Li	1.4/2.1	2.0/2.9
Tsu-Li	1.1/1.7	1.8/2.6
C.V. (%)	15.9/19.1	19.4/17.6

[x]Mean separation within columns by Duncan's Multiple Range Test, p = 0.05, indicated no difference in rootstock and scion at grafting or after grafting.

vars did not differ after grafting the first year (data not shown). During the second growing season, vigorous cultivars were identified in terms of number of branches and total branch length. Caliper of scion and rootstock did not differ at the end of the second growing seasons. In addition, leaf characteristics and internode length varied, depending on cultivar. Fire blight resistance among cultivars was documented.

It is too early to recommend certain cultivars because yield and fruit quality have not been determined. However, these initial findings are important in that they identify which Asian pear cultivars survive successfully on *P. calleryana*. Cultivar vegetative characteristics important to plant establishment and orchard maintenance were identified. Also, differing levels of natural fire blight infection were observed and will continue to be evaluated. For maximum benefit to fruit growers evaluation of these cultivars should be considered a long-term project.

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Table 2. Number of branches, total branch length, average shoot length, leaf area and internode length of various Asian pear cultivars at the end of the second growing season (1990) at the Pontotoc Ridge-Flatwoods Research and Extension Center.

Cultivar	Shoots (#)[z]	Total Shoot length (m)	Average Shoot length (cm)	Leaf Area (cm^2)	Internode Length (cm)
P. serotina					
Chojuro	19.5ab[x]	9.4a	86.7a	19.8d	2.8e
Erishinge	12.0ab	3.4bc	86.7a	40.7b	3.8cd
Hosui	16.7ab	7.4ab	108.0a	48.7ab	4.6a
Japanese Golden Russett	11.3ab	4.3bc	91.5a	50.8a	4.7a
Kikusui	13.5ab	3.9bc	84.4a	48.8ab	3.7d
Korean Giant	14.0ab	6.4abc	66.8a	45.0ab	4.6a
Seigyoku	7.7b	2.4c	76.8a	52.3a	4.1a-d
Seuri	8.0b	4.6bc	70.8a	53.1a	3.9b-d
Shinseiho	5.0b	2.3bc	67.6a	47.6ab	3.9b-d
Twentieth Century	9.0b	3.6bc	72.3a	46.5ab	3.8cd
Yakumo	22.8a	7.6ab	102.5a	19.5d	2.73e
P. bretschneideri					
Pai-Li	3.7ab	6.3abc	96.0a	28.9c	3.6d
Tsu-Li	8.8b	3.4bc	72.5a	45.1ab	3.8cd
C.V. (%)	57.5	50.6	26.5	25.2	11.6

[z]Total # of primary, secondary, and tertiary branches.
[y]Total length of primary, secondary and tertiary branches.
[x]Mean separation within columns by Duncan's Multiple Range Test, p = 0.05.

cm, respectively (Table 2). 'Hosui' and 'Korean Giant' had the largest internodes of 4.6 cm each. Internode length of the remaining cultivars ranged between 3.6-4.1 cm. Crane and Lewis (1941) found that leaf and shoot character were each under the control of a different gene. Ferree and Barden (3) reported that leaves of two apple strains did not differ in size on seedling or M.7A rootstocks. However, leaves of some cultivars on MM.106 rootstock were larger than other cultivars.

Differences in rootstock and scion trunk diameter at grafting or after grafting were not evident during the first or second growing season (Table 3). Hodgson (7) reported that if a strong growing scion cultivar is grafted on a weak growing rootstock, the growth of the rootstock will be stimulated, becoming larger than if left ungrafted. Conversely, if a weak growing scion cultivar is grafted on a vigorous rootstock, the growth of the rootstock will be lessened than if left ungrafted. *P. calleryana* has been recognized to induce scion vigor (10) and to produce intermediate size trees compared to larger sized trees on *P. betulaefolia* and smaller size trees on *P. communis* (13).

This experiment indicated that most Asian pear cultivars had high survival on *calleryana* rootstock with the exception of 'Shinseiki' and 'Ya-Li.' The inability of 'Shinseiki' and 'Ya-Li' to survive may have been due to poor graft union due to difficult to cut hard wood, since no incompatibility symptoms were observed. Early and late budbreaking cultivars were identified. Very late and late budbreaking cultivars such as 'Yakumo' and 'Chojuro,' '20th Century,' 'Erishinge,' 'Shinseiho,' and 'Seigyoku' can be planted in the places where early spring frost injury is possible. Shoot length among culti-