

## Research Article

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# Influence of different scion-rootstock combination of pear on grafting success and vegetative growth under nursery conditions

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## ABSTRACT

A field study was carried out at the Experimental Farm of Division of Fruit Science, SKUAST-Kashmir, Shalimar Campus, Srinagar (Jammu and Kashmir) in 2019 to find out the best rootstock-scion combinations among different pear cultivars and rootstocks. As there is problem of uneven and weak growth of rootstock under different rootstock-scion combinations and to find best combination, four scion cultivars (Carmen, Abate Fetel, William Bartlett, and Chinese Sandy Pear) were bench grafted on five rootstocks (Quince C, BA-29, Quince seedling, Kainth seedling, and Pear suckers) during mid-March and these grafted plants were transplanted in the nursery. The earliest bud burst (14th April) was recorded in Chinese Sandy Pear/Quince and the highest grafting success (96.67 %) was recorded in Carmen/Quince C, Abate Fetel/Quince C, Chinese Sandy Pear/Quince C, Abate Fetel/BA-29 and Chinese Sandy Pear/Quince. The highest stock girth (34.29 mm) was measured in Chinese Sandy Pear/Quince whereas the highest scion girth (38.51 mm) was measured in William Bartlett/Kainth. The highest and lowest stock-scion ratio was recorded in William Bartlett/Quince and Abate Fetel/Quince C, respectively. Maximum plant height (132.15 cm) and the number of branches per plant (3.55) was recorded in Chinese Sandy Pear/Pear sucker whereas minimum plant height (98.16 cm) and the number of branches per plant (1.88) was recorded in Carmen/Quince and Carmen/BA-29, respectively. The minimum and maximum internodal length was recorded in Carmen/Quince (1.58 cm) and William Bartlett/Pear sucker (2.31 cm). The maximum growth and proportion of saleable plants was obtained in William Bartlett/Quince (86.33 %). From the present study, it is concluded that the pear scion cultivars grafted on Quince C and Quince rootstocks had moderate to high levels of compatibility and hence are best suitable for the propagation of pear.

**Keywords:** Growth, nursery, pear, rootstocks, scion, vegetative, grafting

## INTRODUCTION

Rootstock plays an important role in deciding the success or failure of an orcharding enterprise. The selection and use of suitable rootstock help not only in improving fruit crop productivity and quality but also in extending fruit cultivation under marginal lands. The rootstock has a pronounced effect on growth, vigor, longevity, productivity, fruit quality, and nutrient uptake of the composite plant in fruit trees. In order to establish new orchards, using suitable and compatible rootstock is an important task. [1] Fruit tree characteristics such as vegetative and reproductive growth characteristics [2] and water potential within the tree trunk [3] are influenced by the rootstock.

Amongst the detectable temperate fruits, the pear is next only to the apple in importance, acreage, production, and varietal diversity in the world. [4] In India, the pear occupies the third

place among temperate fruits both in area and production and with the introduction of improved pear cultivars in the later part of the 19th century, the cultivation got momentum due to the success of various cultivars in the different parts of the country. Because of its hardy nature and tolerance to a wide range of soil, it needs less care and can be grown under different agro-climatic conditions. It is successfully grown in both temperate and sub-tropical regions of Jammu and Kashmir, Himachal Pradesh, Uttarakhand, and some other parts of the country. Pear can tolerate as low as -26°C during the dormant period and as high as 45°C growing period. However, the productivity of pears in India is considerably low due to a lack of quality planting material which is directly correlated with the rootstock. Recently two colored pear varieties (Carmen and Abate Fetel raised on Quince C rootstock) have been introduced from Italy by the Division of Fruit Science, SKUAST-Kashmir, Shalimar and these varieties started bearing after the second year of planting having medium to large-sized fruits with yellow and red peel and aromatic juicy. However, the main disadvantage of both the scion-rootstock combinations was that the rootstock girth is quite weak in comparison to scion girth even at 3-5 years of age thus the plants require staking so an urgent need was felt to find

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suitable rootstock for these cultivars. As the rootstock effect on the performance of scion cultivars has been studied and demonstrated in many of the fruit crops, but no such studies have been carried out in pears, under Kashmir conditions. Thus, the present study was conducted to find a suitable rootstock-scion combination of pears under nursery conditions.

## MATERIALS AND METHODS

The present investigation was carried out at the Experimental Farm of the Division of Fruit Science, SKUAST-Kashmir, Shalimar Campus, Srinagar (Jammu and Kashmir) during the year 2019. The maximum and minimum temperature during the experimental period ranged between 18.1-32.0oC and 4.42-17.7oC with a mean relative humidity of 43.90 percent. The experiment was laid out with four scion cultivars viz. Carmen, Abate Fetel, William Bartlett, and Chinese Sandy Pear grafted on five rootstocks viz. Quince C, BA-29, Quince seedlings, Kainth seedlings, and Pear suckers formed twenty combinations with three replications. Bench grafting (cleft grafting) was performed on the second week of March and grafted material was transplanted in the nursery beds at a spacing of 30 x 30 cm. All the cultural practices were performed uniformly viz. irrigation, weeding, hoeing, and fertilization.

### Observations recorded:

Observations were recorded on five randomly selected grafted plants. The time of leaf bud burst was recorded when over 50 percent of the terminal buds had swollen and bud scales had split exposing the green of the leaves inside. Graft take success was recorded two months after grafting in each treatment and calculated as per the following formula

% Graft success	=	Total graft survival	x	100
		-----		
		Total grafted plants		

Stock and scion girth was measured at 5 cm below and above the graft union, respectively with the help of Vernier Caliper at the end of the growing season, averaged and expressed in centimeters (cm). The stock-scion ratio was calculated by dividing stock girth by scion girth. The number of branches per plant and number of leaves per plant was counted, averaged, and expressed in numbers. The internodal length was measured with the help of the measuring scale between two internodes, averaged, and expressed in cm. After the cessation of growth in the end of November, the final height of plants was measured with the help of a measuring scale from the base of the ground to the terminal bud of the main axis and expressed in cm and the plants that have attained a height of 90 cm or more were considered as saleable plants. Time of leaf fall was recorded when more than 75 percent of the leaf fall was completed. Data generated from these investigations were appropriately computed, tabulated, and statistically analyzed as per the procedure given by Snedecor and Cochran. [5] The level of significance was tested for the different variables at 5 percent level of significance.

## RESULTS AND DISCUSSION

Persual data presented in Fig 1 indicates that the bud burst was from 14th April to 20th April among various rootstock-scion combinations. Among all the rootstock scion combinations, the

earliest bud burst was observed on the 14th and 15th of April in a rootstock-scion combination of Chinese Sandy Pear/Quince followed by Carmen/Quince C, Williams Bartlett/Quince C, Chinese Sandy Pear/Quince C, Chinese Sandy Pear/BA-29, Williams Bartlett/Quince, Carmen/Kainth and Carmen/Pear suckers which achieved bud burst on 15th and 16th April. Five combinations viz. Abate Fetel/Quince C, Abate Fetel/BA-29, Carmen/Quince, Abate Fetel/Kainth and Chinese Sandy Pear/Kainth attained bud burst on 16th and 17th April whereas four combinations i.e. Carmen/BA-29, Williams Bartlett/BA-29, Williams Bartlett/Kainth, and Abate Fetel/Pear seedlings recorded bud burst on 17th and 18th April. The most delayed bud burst was observed in the combination of Abate Fetel/Quince (19th and 20th April). An early bud burst is beneficial as the vegetative growth will start sooner and is an indication of the more vigor of the plant. Present results are in accordance with the earlier results on walnut [6] and apple. [7] Graft success, scion girth, stock girth, and the stock-scion ratio of different sonic combinations of pear varieties and rootstocks were presented in Table 1 and Fig 2. Data presented in Table 1 revealed that scion cultivars had a non-significant influence on grafting success however rootstock significantly influenced grafting success. Rootstock-scion combinations of Carmen/Quince C, Abate Fetel/Quince C, Chinese Sandy Pear/Quince C, Abate Fetel/BA-29, and Chinese Sandy Pear/Quince had the highest (96.67 %) grafting success which was statistically higher among all the other rootstock-scion combinations closely followed by Carmen/BA-29, Carmen/Quince, Abate Fetel/Quince, Williams Bartlett/Quince C, Williams Bartlett/Quince and Chinese Sandy Pear/BA-29 with the grafting success of 93.33 percent. The lowest grafting success among the different combinations was recorded in Chinese Sandy Pear/Kainth (80.00 %). The grafting success was clearly influenced by rootstocks and the highest grafting success was obtained in Quince C rootstock with all the graft combinations closely followed by Quince however least grafting success was recorded with the pear suckers. Thus it is clear from the present study that rootstocks more significantly influenced the grafting success than the scion cultivars. Similar results were earlier reported in apple and stone fruits. [8] [9] [10] Significant results were recorded for scion, rootstock, and rootstock-scion combinations with respect to scion girth and stock girth (Table 1). Maximum scion girth was recorded in the combination of Carmen/Quince (6.18 cm) which was statistically at par with Abate Fetel/Quince (6.02 cm), Abate Fetel/BA-29 (6.02 cm), and Chinese Sandy Pear/Quince (5.99 cm). Minimum scion girth was recorded in the combination of Chinese Sandy Pear/Pear sucker (4.59 cm) which was statistically at par with William Bartlett/Pear sucker (4.77 cm). A higher scion girth is deleterious as it causes an increased load on the rootstock and causes the failure of the graft, however, a lower scion girth is also harmful as it causes self-incompatibility in the future. Maximum scion girth in pear cultivars grafted on Kainth followed by Quince was also reported earlier. [11] William Bartlett grafted on Quince recorded maximum stock girth (6.20 cm) which was statistically at par with Abate Fetel/Quince (6.14 cm) and Carmen/Quince (6.05) whereas minimum stock girth was recorded in all the scion cultivars having graft combinations with Quince C rootstock i.e. Carmen/Quince C (3.68 cm), Abate Fetel/Quince C (3.72 cm),

William Bartlett/Quince C (3.83 cm) and Chinese Sandy Pear/Quince C (3.75 cm). Rootstock diameter should always be within the range of 6-15 mm [12] which increased regularly with the uptake of nutrients. Present findings on rootstock girth are in accordance with earlier works [13], [14] and [15] while the researchers working on pear rootstock-scion combinations. The stock-scion ratio was significantly influenced by scion cultivars and rootstocks (Fig. 2). Rootstock-scion combination of William Bartlett/Quince had a higher stock-scion ratio (1.12) which was statistically at par with Abate Fetel/Quince (1.02) however least stock-scion ratio was observed in the rootstock-scion combination of Abate Fetel/Quince C (0.74) which was statistically at par with all the other combinations with Quince C. In general, overgrowth of scion indicates graft incompatibility but in most of cases, it has been observed that such graft union showed no signs of incompatibility later on. Similar results have been reported by earlier researchers while working on different scion combinations of pear at the nursery stage. [13] [15]

Significant influence of scion and rootstock was observed for plant height and the number of branches per plant among all the rootstock-scion combinations of pear; however, the interaction between scion/rootstock had a significant influence only on plant height (Table 2). Among different graft combinations, Chinese Sandy Pear/Pear suckers exhibited higher plant height (132.15 cm) which was statistically at par with William Bartlett/Pear suckers (130.65 cm) followed by William Bartlett/Kainth (127.31 cm). Carmen/Quince graft combination recorded the least plant height (98.16 cm) which was statistically at par with Abate Fetel/Quince C (99.30 cm), Abate Fetel/Quince (100.52 cm), Abate Fetel/BA-29 (100.92 cm), William Bartlett/Quince C (101.14 cm) and Carmen/Quince C (101.34 cm). Variable influence of rootstocks on scion vigor has also been reported by researchers. [1] [11] Chinese Sandy Pear/Pear suckers (3.55) had a maximum number of branches per plant followed by Chinese Sandy Pear/Quince C (3.47) and William Bartlett/Pear suckers (3.42). A minimum number of branches per plant among different scion-rootstock combinations was observed in Carmen/BA-29 combination (1.88). A variable number of branches depends on the transportation of cytokinin as this hormone is transported from roots and produced at shoot nodes and acts as bud growth promoter tends to stimulate cell division and growth activity in those newly formed lateral buds. [16] The present findings are in accordance with earlier findings. [17]

Data on the internodal length of pear shoots with different scion and rootstock combinations revealed that the scion cultivars had a non-significant influence on internodal length whereas rootstocks and interaction between scion/rootstock significantly affected internodal length. Graft combination of William Bartlett/Pear suckers had a maximum internodal length (2.31 cm) which was statistically at with Chinese Sandy Pear/Pear suckers (2.09 cm), William Bartlett/Kainth (2.05 cm), Carmen/Kainth (1.98 cm) and Abate Fetel/Pear suckers (1.97 cm). The minimum internodal length was recorded in a graft combination of Carmen/Quince C (1.58 cm). Reduced internodal length favors dwarfism and similar reports in the previous studies have been given in pear [11], in *Prunus* spp. [18] and in peach and nectarine [10].

The effect of different graft combinations using scion and rootstock of pear on the time of leaf fall is presented in Fig 1. Leaf fall started from the third week (15th to 18th) of November in a

scion-rootstock combination of Abate Fetel/Quince C, Abate Fetel/BA-29 and Abate Fetel/Quince followed by Carmen/Quince C, Chinese Sandy Pear/Quince C, Chinese Sandy Pear/BA-29, Carmen/Quince and Carmen/Quince (from 16th to 19th November). Delayed leaf fall was observed in the scion/rootstock combination of William Bartlett/Pear seedlings (26th to 28th November). All the graft combinations of William Bartlett with different rootstocks had leaf fall in the fourth week of November. Leaf fall of all the graft combinations in Kainth and Pear suckers rootstocks was in the fourth week of November except Carmen. In the earlier studies in *Prunus* spp. [18] and in peach and nectarine [10] researchers also reported leaf fall in the third and fourth week of November after the cessation of the plant growth.

Scion and rootstock-scion combinations had non-significant and rootstock had a significant influence on the proportion of saleable plants (Fig. 3). Maximum saleable plants were obtained in the scion/rootstock combination of William Bartlett/Quince (86.33%) combination followed by Carmen/Quince C (82.33 %) and William Bartlett/ Quince C (81.67 %). A minimum percentage of saleable plants was obtained in Carmen/Pear suckers (70.33 %) combination. When a grafted or budded pear plant attains a height of three feet (90 cm), then it is considered saleable.

## CONCLUSION

From the present studies, it can be inferred that graft success, vegetative characteristics, and proportion of saleable pear plants were influenced by the rootstocks. The level of bud take success and saleable plants of different scion cultivars grafted on Quince seedlings and Quince C had moderate to high levels of compatibility. All the scion cultivars on Quince seedlings and Quince C were observed more suitable for the propagation of pear. However, among the two rootstocks, Quince seedlings hold promise as future rootstocks for different pear cultivars due to limited availability and higher cost of Quince C rootstocks.

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## Conflict of interest

The authors declare no conflict of interest.

## Author contribution

**J P Rathore, Amit Kumar:** Data curation, Investigation; Writing – original draft.

**Amit Kumar, M K Sharma:** Formal analysis; Project administration; Methodology.

**A.S Sundouri, F A Khan:** Conceptualization; Supervision.

**Anil Sharma:** Visualization.

## Ethical guidelines

Ethics approval was not required for this research work.

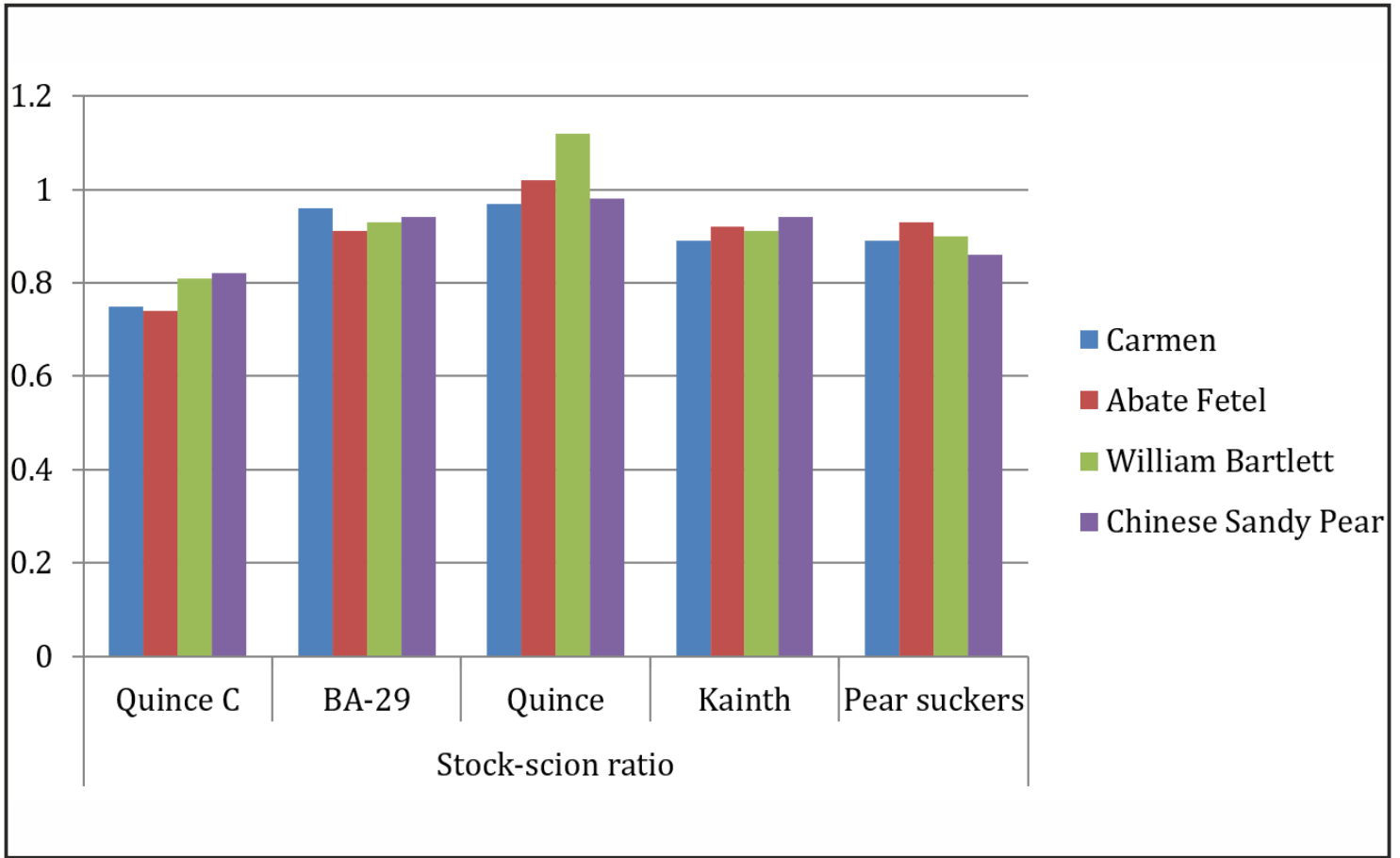


Figure 2. Effect of different rootstock-scion combinations of pear on stock-scion ratio

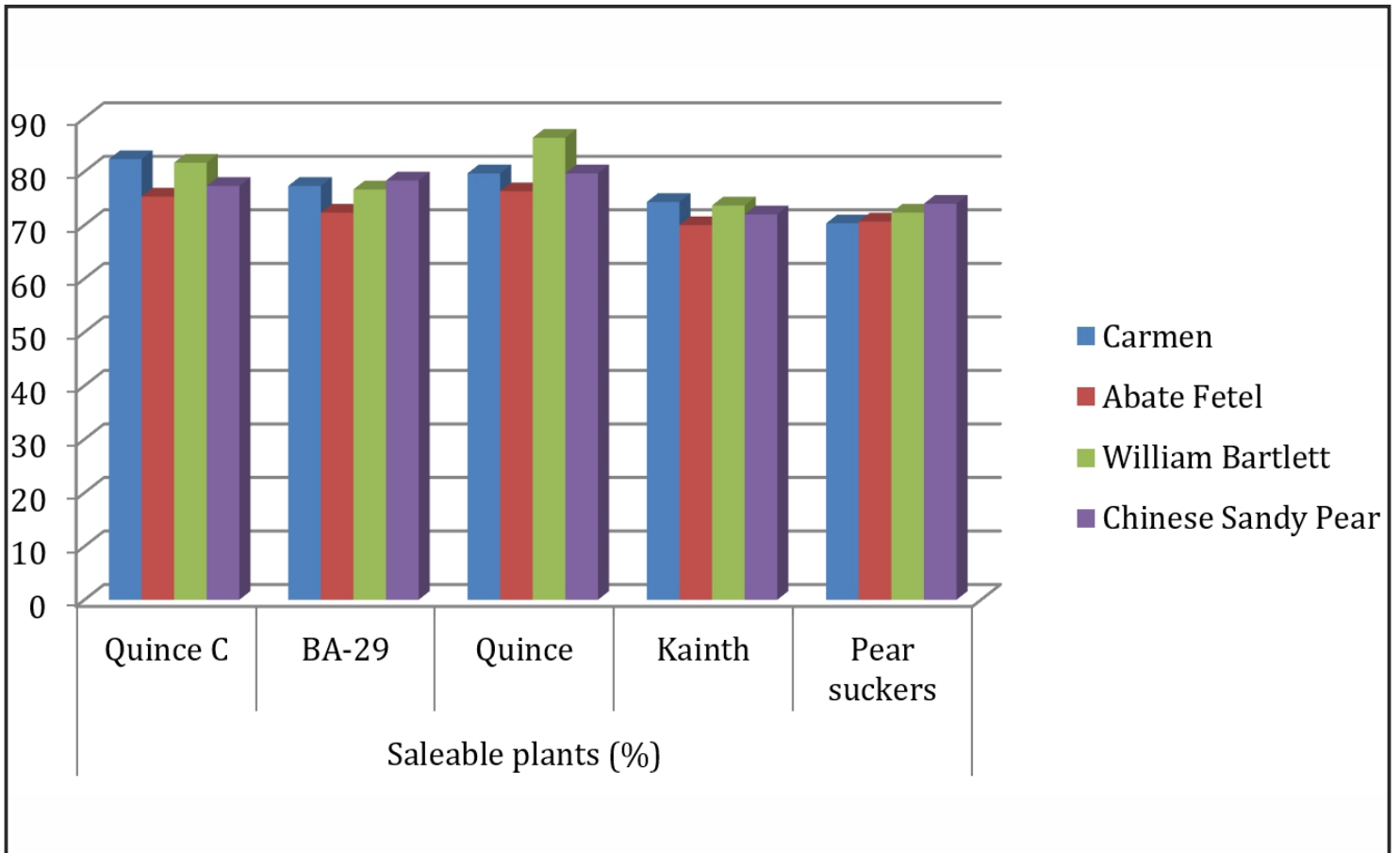


Figure 3. Effect of different rootstock-scion combinations of pear on proportion of saleable plants

**Table 1. Effect of different rootstock-scion combinations of pear on grafting success, scion girth and stock girth**

Rootstock \ Scion		Grafting success (%)				
		Quince C	BA-29	Quince	Kainth	Pear suckers
Carmen		96.67	93.33	93.33	86.67	83.38
Abate Fetel		96.67	96.67	93.33	86.67	83.33
William Bartlett		93.33	90.00	93.33	90.00	83.33
Chinese Sandy Pear		96.67	93.33	96.67	80.00	83.33
CD <sub>0.05</sub>						
Scion				NS		
Rootstock				1.47		
Scion/Rootstock				2.93		

Rootstock \ Scion		Scion girth (cm)				
		Quince C	BA-29	Quince	Kainth	Pear suckers
Carmen		5.97	5.93	6.18	5.23	4.89
Abate Fetel		5.71	6.02	6.02	5.11	5.03
William Bartlett		5.94	5.59	5.55	5.33	4.77
Chinese Sandy Pear		5.66	5.22	5.99	5.35	4.59
CD <sub>0.05</sub>						
Scion				0.13		
Rootstock				0.15		
Scion/Rootstock				0.21		

Rootstock \ Scion		Stock girth (cm)				
		Quince C	BA-29	Quince	Kainth	Pear suckers
Carmen		3.68	5.71	6.05	5.28	4.64
Abate Fetel		3.72	5.21	6.14	5.55	4.76
William Bartlett		3.83	5.54	6.20	5.08	4.80
Chinese Sandy Pear		3.75	5.33	5.86	5.23	4.59
CD <sub>0.05</sub>						
Scion				0.09		
Rootstock				0.10		
Scion/Rootstock				0.19		

Table 2. Effect of different rootstock-scion combinations of pear on vegetative characters

Rootstock		Plant height (cm)				
		Quince C	BA-29	Quince	Kainth	Pear suckers
Scion						
Carmen		101.34	103.70	98.16	110.84	119.81
Abate Fetel		99.30	100.92	100.52	116.90	120.13
William Bartlett		101.14	107.34	103.08	127.31	130.65
Chinese Sandy Pear		104.61	111.44	107.22	120.46	132.15
CD <sub>0.05</sub>						
	Scion			1.89		
	Rootstock			2.12		
	Scion/Rootstock			4.24		

Rootstock		Number of branches per plant				
		Quince C	BA-29	Quince	Kainth	Pear suckers
Scion						
Carmen		2.11	1.88	2.26	2.88	2.55
Abate Fetel		2.77	2.89	2.16	2.91	2.97
William Bartlett		3.22	3.44	3.02	3.28	3.42
Chinese Sandy Pear		3.47	3.22	2.87	3.16	3.55
CD <sub>0.05</sub>						
	Scion			0.36		
	Rootstock			0.14		
	Scion/Rootstock			NS		

Rootstock		Internodal length				
		Quince C	BA-29	Quince	Kainth	Pear suckers
Scion						
Carmen		1.58	1.76	1.65	1.98	1.95
Abate Fetel		1.63	1.80	1.70	1.89	1.97
William Bartlett		1.74	1.87	1.75	2.05	2.31
Chinese Sandy Pear		1.80	1.79	1.81	1.91	2.09
CD <sub>0.05</sub>						
	Scion			NS		
	Rootstock			0.17		
	Scion/Rootstock			0.34		

**Figure 1. Effect of different rootstock-scion combinations of pear on date of bud burst (April) and time of leaf fall (November)**



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