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# INFLUENCE OF ROOTSTOCK AND INTER-STOCK COMBINATIONS ON PRE-BEARING BEHAVIOUR OF PEAR CV. PUNJAB BEAUTY

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## SUMMARY

**Effect of Shiara, Kainth large fruited, Kainth small fruited, Patharnakh cuttings and Sucker rootstocks along with inter-stock were evaluated for their effect on various vegetative characteristics of pear cv. Punjab Beauty. The overall minimum rootstock, inter-stock and scion girth was in Patharnakh cutting/ Patharnakh / Punjab Beauty treatment among the triple combinations, while Sucker/ Punjab Beauty recorded the lowest values both for rootstock and scion girth among double combinations. Combination of Patharnakh cutting/ Punjab Beauty recorded maximum plant height, plant spread and tree volume. Leaf size and number of stomata were maximum in Sucker/ Sucker/ Punjab Beauty combination. The combinations of Shiara/ Patharnakh/ Punjab Beauty; Shiara/ Punjab Beauty; Kainth large fruited/ Patharnakh/ Punjab Beauty; Kainth large fruited/ Punjab Beauty; Patharnakh cutting/ Patharnakh/ Punjab Beauty and Patharnakh cutting/ Punjab Beauty resulted into a smooth graft union. The results show great variability among different combinations. The combinations of Sucker/ Sucker/ Punjab Beauty and Sucker/ Punjab Beauty have produced dwarf plants. These combinations will be further critically examined for their flowering and fruiting behaviour.**

***Key words*: Compatibility, inter-stock, pear, rootstock, scion**

## INTRODUCTION

In Punjab, pear is commercially propagated on *Kainth* seedlings or on root suckers. The later has a serious problem of root suckering, while former is free from it, but imparts vigorous growth to the scion cultivar. Apart from these, pear plants are also propagated by cuttings, but field observations revealed that these plants are neither successful on sandy soils, where these show iron and zinc deficiency symptoms, nor on heavy soils where drainage is a problem (Sandhu and Singh 1987). Rootstocks and inter-stocks have a certain influence on the vigour, health and fruit bearing capacity of scion varieties grafted onto them. Several rootstocks are known to impart dwarfness and resistance against biotic and abiotic stresses. Punjab Beauty is a popular variety of pear in Punjab and attains height up to seven meters on *Kainth* rootstock and the trees become unmanageable. To restrict the growth particularly the tree height, need has been felt to try some other combinations of rootstocks and inter-stocks. So far the studies on use of inter- stocks to restrict the growth of scion cultivars of pear have not been conducted under Indian conditions. Keeping this in view, studies have been planned to investigate the influence of rootstocks and inter-stocks on pre- bearing behaviour of pear trees cv. Punjab Beauty.

## MATERIALS AND METHODS

The pear cv. Punjab Beauty was grafted onto various combinations of rootstocks and inter-stocks. The test plants were planted at the departmental orchard of Punjab

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Agricultural University, Ludhiana during 2002 and the studies were conducted during 2006 and 2007. All the plants received uniform cultural practices during the course of study. The combinations were $T_1$- Shiara/ Patharnakh/ Pumjab Beauty); $T_2$- (Shiara/ Sucker/ Punjab Beauty); $T_3$- (Shiara/ Punjab Beauty); $T_4$- (Kainth large fruited/ Patharnakh/ Punjab Beauty); $T_5$- (Kainth large fruited/ Sucker/ Punjab Beauty); $T_6$- (Kainth large fruited/ Punjab Beauty); $T_7$- (Kainth small fruited/ Patharnakh/ Punjab Beauty); $T_8$- (Kainth small fruited/ Sucker/ Punjab Beauty); $T_9$- (Kainth small fruited/ Punjab Beauty); $T_{10}$- (Patharnakh cutting/ Patharnakh/ Punjab Beauty); $T_{11}$- (Patharnakh cutting/ Sucker/ Punjab Beauty); $T_{12}$- (Patharnakh cutting/ Punjab Beauty); $T_{13}$- (Sucker/ Patharnakh/ Punjab Beauty); $T_{14}$- (Sucker/ Sucker/ Punjab Beauty); and $T_{15}$- (Sucker/ Punjab Beauty). The inter stock of 10 cm in length was used, and both scion and inter stock were tongue grafted on to the rootstock at a height of 15 cm from the ground level. The scion on the inter stock was tongue grafted on the proximal end. The experiment was laid out according to randomized block design.

The data on the scion, rootstock and inter-stock girth was recorded with the help of measuring tape at the distance of 5 cm above and below the graft union. The plant height from the ground level to the top of the trees and plant spread both towards North-South and East-West was measured with the help of calibrated bamboo pole. Tree volume was calculated with the help of formula as suggested by Westwood (1978). The trees were cylindrical in shape and their volumes were calculated according to formula: $4/3\ \pi a^2 b$, where a = ½ the spread and b = ½ the height. Total numbers of branches on each tree were also counted. Four shoots, one each from the four sides of the tree were selected and tagged for recording periodical increase in shoot length at monthly interval. Shoot thickness was recorded with the help of Vernier's Caliper's. After collecting the leaves from the representative tree, were placed on the graph paper and the boundary line of the leaves was drawn for estimating leaf size/ area. The number of full, more than half squares were counted and two half squares were counted as one. Total number of counted squares gives the total leaf size. The petiole length was measured with the help of measuring scale.

Stomata counts were recorded from the mature leaves according to the methods described by Beakbane and Majumdar (1975). The samples of the leaves were collected during August- September in the bright sunny period. To get the impression of stomata as waterproof the adhesive *Quick fix*™ was spread on the dorsal surface of the leaf as a thin film. The leaves were then placed in paper bags and brought to laboratory. The dried film bearing the impression of cuticle was gently removed and placed on a glass slide and held in position by a cover slip. The slide was examined under light microscope. The stomatal density was recorded at 10 x 40 magnification field. On each leaf film, three microscopic fields were examined and average was worked out.

## RESULTS AND DISCUSSION

The rootstock and/ or inter-stock, and in particular their union with the scion, bring about their effects upon the scion by influencing the endogenous hormones, water and mineral elements within the plant. The data on stock, inter-stock and scion girth showed variation in different treatments. The maximum stock girth was recorded in $T_7$ which was significantly better than $T_3$, $T_4$, $T_{10}$, $T_{11}$, $T_{14}$ and $T_{15}$ treatments, but statistically at par with rest of the treatments (Fig. 1). The minimum stock girth was noted in $T_{15}$ treatment. The triple combination of Shiara/ Sucker/ Punjab Beauty produced maximum inter-stock

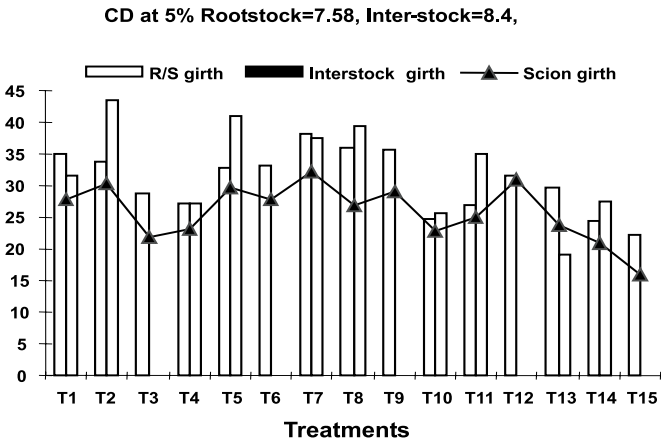


**Fig. 1. Effect of rootstocks and inter-stocks on stock, inter-stock and scion girth (Details of treatments given in the text) $T_1$-$T_{15}$ as in Table 1.**

girth, followed by a combination of Kainth large fruited/ Sucker/ Punjab Beauty. However, when Sucker was used as rootstock and Patharnakh as inter-stock for Punjab Beauty cultivar, inter-stock girth was recorded to be lowest. No inter-stock was used in treatments $T_3$, $T_6$, $T_9$, $T_{12}$ and $T_{15}$. The scion of Punjab Beauty attained maximum girth in $T_7$ and $T_{12}$ treatments. It was significantly higher than $T_3$, $T_4$, $T_{10}$, $T_{11}$, $T_{14}$ and $T_{15}$ treatments. However, the minimum scion girth was observed in $T_{15}$.

The overall lesser rootstock, inter-stock and scion girth was recorded in $T_{10}$ treatment among the triple combinations. However, among the double combinations, the treatment $T_{15}$ recorded the lowest values both for rootstock and scion girth. In earlier studies too, the stock influenced the trunk girth. Quince BA-29 rootstock produced highest trunk girth of Beurre Hardy scion as compared to some other rootstocks (Carrera 1989). The four pear cultivars viz. Smith, LeConte, Kieffer and Baggugosha attained better scion girth on Kainth than on Patharnakh rootstock (Bajwa *et al.* 1974). Sharma *et al* (1988) also reported that the stock and scion girth of Patharnakh and Baggugosha were maximum on D-4 (strain of Kainth) rootstock as compared to Quince A and pear sucker rootstock.

The data in Fig. 2 reveal that the plant height varied significantly under different treatments. The plant height was noted to be lowest in $T_{14}$. The plants of $T_{12}$ attained

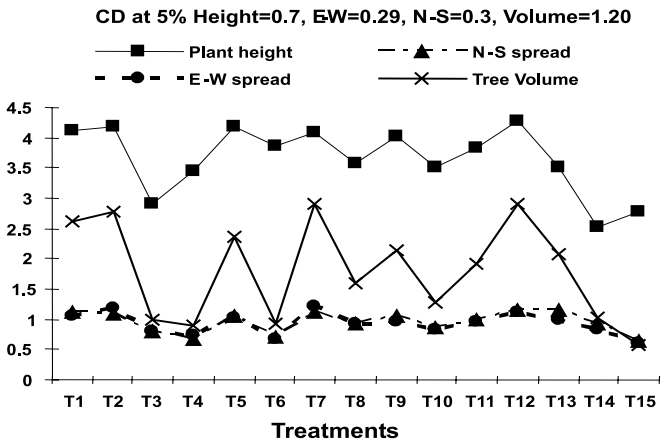


**Fig. 2. Effect of rootstocks and interstocks on plant height, plant spread and tee volume (Details of treatments given in the text) $T_1$-$T_{15}$ as in Table 1.**

significantly more plant height as compared to $T_3$, $T_4$, $T_8$, $T_{10}$, $T_{13}$, $T_{14}$ and $T_{15}$ treatments. The variation in plant height might be due to genetically controlled behaviour of the rootstocks or inter stocks which influenced the vigour of scion cultivars grafted on them. This is evidently clear from the correlation (Table 3) worked out for different characters. A very week correlation was found between plant heights and inters stock girth. However, the correlation was highly significant between plant height, and rootstock and scion girth. In Punjab, Sharma *et al* (1988) reported that tree height of Patharnakh and Baggugosha was higher on D-4 rootstock as compared to Quince A and pear sucker rootstocks. The plants of Punjab Beauty cultivar attained lowest spread when grafted onto Sucker rootstock ($T_{15}$). The plants of treatment $T_7$ showed significantly higher plant spread than $T_3$, $T_4$, $T_6$ and $T_{15}$ treatments. The spread of pear trees was also significantly greater on Kainth than on Patharnakh. The observations of Westwood *et al* (1963) showed that the pear trees were smaller in size on *Pyrus pyrifolia* than on other rootstocks. Similarly, plant spread of Patharnakh and Baggugosha was more on D-4 rootstock as compared to Quince A and pear rootstock (Sharma *et al.* 1988). The data on tree volume shows significant differences and there are large, medium and small sized trees among various rootstock and inter-stock interactions under the study. The trees of $T_7$ and $T_{15}$ treatments produced highest and lowest tree volume, where *Kainth* and Suckers were used as rootstocks, respectively. Similarly, four cultivated cultivars (Patharnakh, Baggugosha, LeConte and Smith) attained greater height on *Kainth* as compared to Patharnakh suckers rootstock (Bajwa *et al.* 1974).

Periodical increase in shoot length from April to November is presented in Table 1. During April, the shoot length was noted maximum in $T_5$ which was significantly higher than $T_3$, $T_4$, $T_8$, $T_{11}$ and $T_{15}$ treatments. However, it was statistically at par with rest of the treatments. The treatment $T_{10}$ produced minimum shoot length. The periodic increase in shoot length from April to August was also highest in $T_5$ and lowest in $T_{10}$ treatments. After August no further increase in shoot length was observed. The variation in shoot length might be due to various factors such as climate, soil, and nature

**Table 1.** Effect of rootstocks and interstocks on the periodical increase in shoot length.

| Treatment | Periodical increase in shoot length (m) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **April** | **May** | **June** | **July** | **August** | **Sept.** | **Oct.** | **Nov.** |
| $T_1$ | 1.83 | 1.92 | 2.11 | 2.15 | 2.18 | 2.18 | 2.18 | 2.18 |
| $T_2$ | 1.52 | 1.54 | 1.81 | 1.86 | 1.92 | 1.92 | 1.92 | 1.92 |
| $T_3$ | 1.13 | 1.17 | 1.31 | 1.34 | 1.38 | 1.38 | 1.38 | 1.38 |
| $T_4$ | 1.17 | 1.35 | 1.38 | 1.42 | 1.51 | 1.51 | 1.51 | 1.51 |
| $T_5$ | 2.02 | 2.10 | 2.24 | 2.29 | 2.39 | 2.39 | 2.39 | 2.39 |
| $T_6$ | 1.64 | 1.71 | 1.84 | 1.85 | 1.94 | 1.94 | 1.94 | 1.94 |
| $T_7$ | 1.75 | 1.87 | 2.07 | 2.13 | 2.19 | 2.19 | 2.19 | 2.19 |
| $T_8$ | 1.24 | 1.41 | 1.48 | 1.51 | 1.53 | 1.53 | 1.53 | 1.53 |
| $T_9$ | 1.72 | 1.81 | 1.97 | 2.01 | 2.05 | 2.05 | 2.05 | 2.05 |
| $T_{10}$ | 0.77 | 0.82 | 0.92 | 0.96 | 0.98 | 0.98 | 0.98 | 0.98 |
| $T_{11}$ | 1.13 | 1.28 | 1.38 | 1.41 | 1.51 | 1.51 | 1.51 | 1.51 |
| $T_{12}$ | 1.53 | 1.63 | 1.79 | 1.90 | 1.93 | 1.93 | 1.93 | 1.93 |
| $T_{13}$ | 1.26 | 1.37 | 1.52 | 1.61 | 1.65 | 1.65 | 1.65 | 1.65 |
| $T_{14}$ | 1.28 | 1.35 | 1.37 | 1.41 | 1.46 | 1.46 | 1.46 | 1.46 |
| $T_{15}$ | 1.17 | 1.21 | 1.24 | 1.25 | 1.28 | 1.28 | 1.28 | 1.28 |
| **C.D. (P=0.05)** | **0.65** | **0.66** | **0.75** | **0.76** | **0.80** | **0.80** | **0.80** | **0.80** |

The details of treatment are given in materials and methods

of rootstock and inter stock used. In general, the scion cultivar Punjab Beauty attained more plant growth when inter stock was not used. Both plant spread and tree volume showed better relationship with rootstock girth as compared to inter stock girth (Table 3). Cultivars Duchess produced the highest number of sylleptic shoots, where cultivar Seckel produced the least (Jacyna 2004). Hirst and Ferree (1995) reported that shoot length was also affected by rootstock and it was positively related to trunk cross sectional area but the slope of regression of line decreases as trees get matured.

The production of root suckers under the tree canopy is always considered a undesirable character. The rootstock/ inter-stock scion combination which produces less or low number of root suckers considered better provided other yield and quality characteristics are good. The $T_{13}$ treatment produced more number of suckers as compared to $T_{14}$ and $T_{15}$ treatments wherein root suckers were used as rootstock. However, except these three treatments others did not produce any sucker. Earlier, Kosina (2005) also reported that OH x F rootstocks produced low amount of suckers. Trees on BA-29 produced few suckers and both OH x F 87 and BA-29 appears to be most suitable for three cultivars (Red Bartlett, Conference and Alexander Lucas). The production of branches by a particular combination decides the vigour of the tree and ultimately the fruit yield. The highest number of branches was borne by $T_9$ treatment. The lowest numbers of branches were, however, observed in $T_{14}$ and $T_{15}$ treatments. The rootstocks have significant effects on the degree of scion branching, the individual length of shoots and the angle of branching as all these influence tree habit (Warner 1991). Apple rootstock B 118 influences greatly the scion cultivar for producing numerous numbers of branches (Kviklys 2004). Although, there was some variation in the average shoot thickness of different treatments, but the differences were non- significant. The variation in shoot thickness of various treatments might

**Table 2.** Effect of rootstocks and interstocks on the sucker emergence, shoot thickness, leaf size, petiole length and number of stomata.

| Treatment | Number of suckers plant$^{-1}$ | Number of branches plant$^{-1}$ | Shoot thickness (cm) | Leaf size (cm$^2$) | Petiole length (cm) | Number of stomata (10x40 microscopic field) |
|---|---|---|---|---|---|---|
| T1 | - | 7.33 | 1.77 | 25.00 | 3.80 | 13.50 |
| T2 | - | 4.67 | 1.65 | 24.78 | 3.64 | 12.42 |
| T3 | - | 4.67 | 1.22 | 20.67 | 3.39 | 13.50 |
| T4 | - | 4.00 | 1.33 | 26.56 | 3.92 | 13.25 |
| T5 | - | 6.67 | 2.02 | 22.89 | 3.90 | 12.75 |
| T6 | - | 6.00 | 1.67 | 22.89 | 3.86 | 11.75 |
| T7 | - | 6.67 | 1.97 | 26.89 | 3.76 | 13.00 |
| T8 | - | 5.00 | 1.34 | 26.89 | 4.04 | 11.75 |
| T9 | - | 7.00 | 1.63 | 21.78 | 3.63 | 13.42 |
| T10 | - | 3.67 | 1.04 | 20.56 | 3.59 | 12.50 |
| T11 | - | 5.33 | 1.29 | 21.89 | 3.80 | 12.42 |
| T12 | - | 3.67 | 1.58 | 25.55 | 4.00 | 13.33 |
| T13 | 6.33 | 5.67 | 1.06 | 23.11 | 3.59 | 12.41 |
| T14 | 3.67 | 3.33 | 1.24 | 27.11 | 3.50 | 13.67 |
| T15 | 3.00 | 3.67 | 0.93 | 19.56 | 3.33 | 11.58 |
| **C.D. (P=0.05)** | **—** | **2.54** | **NS** | **NS** | **NS** | **NS** |

The details of treatment are given in materials and methods

**Table 3.** Relationship between some vegetative characters like rootstock girth, inter stock girth, scion girth, plant height, plant spread (mean of north-south and east-west directions), and tree volume of different rootstock-inter stock- scion combinations.

| Treatment | Rootstock girth | Inter stock girth | Scion girth | Plant height | Plant spread | Tree volume |
|---|---|---|---|---|---|---|
| Rootstock girth | 1.0 | | | | | |
| Inter stock girth | 0.367 | 1.0 | | | | |
| Scion girth | 0.973** | 0.325 | 1.0 | | | |
| Plant height | 0.950** | 0.321 | 0.978** | 1.0 | | |
| Plant spread | 0.915** | 0.427 | 0.902** | 0.854** | 1.0 | |
| Tree volume | 0.914** | 0.546* | 0.895** | 0.849** | 0.975** | 1.0 |

*, ** Significant at 5% and 1%, respectively.

**Plate 1. Showing smooth graft union (Combination of Shiara/ Patharnakh/ Punjab Beauty)**

**Plate 2. Showing inter stock bigger than rootstock and scion (Combination of Shiara/ Sucker/ Punjab Beauty)**

not be due to the rootstock and inter-stock effects but might be due to soil or other factors. In contrast to the above results, Stachowiak and Swierczynski (2004) reported that P-2 have higher effect on the thickness of the shoot than on M-9.

The leaf size was recorded maximum in $T_{14}$ and minimum in $T_{15}$ treatment combinations. However, the difference between different combinations was non-significant. Similarly, Rottgerman *et al* (1994) observed that rootstock did not influence the leaf area/ spur but average leaf size was influenced by only vigorous rootstocks for Macspur. The petiole length was highest in $T_8$, followed by $T_{12}$, $T_4$ and $T_5$ treatments. The petiole length under different treatments varies from 3.33 to 4.04 cm. Although, there exist some variation in the average petiole length of various treatments, but the differences were non- significant. Such differences were also recorded in pear cultivars under sub- mountainous *Tarai* region where Gola- a low chill pear cultivar produced longest petiole length as compared to other cultivars (Bist *et al.* 2003). The maximum number of stomata under the leaves was recorded in $T_{14}$, followed by $T_1$ and $T_3$ treatments. Minimum number of stomatal count was found in $T_{15}$ treatment. The remaining treatments had intermediate number of stomata. A statistical analysis of the data on stomata number showed that the differences were non- significant. Similarly, the findings of Pathak *et al* (1976) also revealed that the M 25 rootstock of apple produced maximum number of stomata in scion cultivar, whereas M 9 produced the least number of stomata.

Ultimately, it is the compatibility of rootstock/ inter-stock with scion which decides the longevity of tree and its yield potential. Smooth union is always desirable. On physical examination of different combinations, it was observed that $T_1$, $T_3$, $T_4$, $T_6$, $T_9$, $T_{10}$ and $T_{12}$ resulted in to very smooth union. The inter-stock was bigger than rootstock and scion in $T_2$, $T_5$, $T_8$, $T_{11}$ and $T_{14}$ combinations. However, in some cases rootstock and scion was bigger than scion and rootstock, respectively. Possible cause of outgrowth of one of the component could be starch blockage, above or below union and phloem degeneration. Other physiological aspect of outgrowth of rootstock or inter-stock or scion may be due to the behavior of root system, behaviour of scion, response of cultivar and the role of phenolics (Robitaille and Carlson 1970). The difficulties of successful stock – scion interactions may not be due to specific combinations, but rather due to the compound genetic system being exposed to different environmental conditions (Westwood 1970).

From above findings, it is evident that there exists great variability among different stionic combinations with respect to growth characters. The treatments of $T_7$, $T_9$ and $T_1$ have shown vigorous growth, while $T_{15}$ and $T_{14}$

have produced dwarfed plants. These combinations will be further critically examined for their flowering and fruiting behaviour.

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