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Effect of Wild Apricot Root Stock on Graft Success, Growth and Foliage Characters of Different Varieties of *Prunus* spp.

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A B S T R A C T

The present study was conducted to examine the effect of wild apricot seedling rootstock on graft compatibility and growth characteristics of peach, nectarine, apricot and plum varieties. Stratified seedlings of wild apricot were raised in the nursery at a spacing of 15 x 10 cm apart. *Prunus* scion cultivars of peach (Redheaven, July Elberta and Red Globe), nectarine (Snow Queen, Red Gold and Silver King), plum (Santarosa, Frontier, and Red Beaut) and apricot (Halman, Kaisha and CITH Apricot-1) were tongue grafted on wild apricot seedling rootstock in the second fortnight of February. Maximum graft success was observed in apricot scion (96.30 %) followed by peach scion (87.96 %) and nectarine scion (82.97 %) with minimum stock/scion ratio was also observed with peach scion (1.08). Apricot scion (1.96 m) measured maximum plant height closely followed by nectarine scion (1.88 m)whereas maximum trunk girth was recorded in peach scion (41.13 mm) followed by apricot scion (39.58 mm).Maximum chlorophyll content was recorded in plum scion (29.36 mg/g) varieties followed by nectarine scion (26.58 mg/g) and peach scion (26.45 mg/g). Contrary to higher vigour recorded in apricot scions as compared to other scions of *Prunus* sp. maximum leaf area was recorded in nectarines followed by peach scion varieties. Comparative studies indicates that plant height, trunk girth, internodal length, leaf area, chlorophyll content and pruning weight differs in different *Prunus* scions varieties. With the present study, it is clear that apart from apricot varieties peach and nectarine varieties also perform well as compared to plum varieties when grafted on wild apricot seedlings.

Introduction

Stone fruits (Peach, Plum and Apricot) are mainly grown in the North-Western Indian States of Jammu and Kashmir, Himachal Pradesh, Uttarakhand and to some extent in the North-Eastern hills region. Like majority of fruit crops, stone fruits are also multiplied clonally by grafting the scion cultivar on the desired rootstock. The most important ability of the rootstock is its adaptability to variable environmental and geographical conditions and its compatibility with more number of fruit crops/species (Costa *et al.*, 1981). Wild relatives of the stone fruits eg. wild peach (Kateru), wild apricot (Chulli) and Behmi have remained the first choice as rootstock in case of stone fruits on commercial level and

have adapted for ages. Seedling rootstocks have been used by horticulturists for more than one millennia, but still we have little comprehension regarding their useful effects on the physiology, growth and cropping of fruit trees scions (Dolkar *et al.*, 2018).Rootstocks are an essential component in modern fruit production because of their capability of adapting a particular cultivar to diverse environmental conditions and cultural practices. Rootstocks with desirable properties are pre-requisite for optimization of yield and quality. Report and references of rootstock effect on fruit yield, fruit quality and resistance/tolerance against various biotic and abiotic factors are in plenty. India as a horticultural country is a typical example of seedling rootstocks because of low cost, ease of propagation, persistent use of seedling rootstocks over decades. Non-availability of suitable rootstocks for the local climatic conditions is still one of the major reasons for the low productivity of these crops (Sharma *et al.*, 2009).

Wild apricot (*Prunus armeniaca* L.) seeds and seeds of commercial cultivars are commonly used for propagating apricot and even other stone fruits. Seeds of wild apricot and other stone fruits are dormant when they are harvested and require 2-3 month stratification (Martinez and Dicenta 2001) for germination and also for normal seedling growth. Almost entire commercial plantation of stone fruits in the country is growing on seedling rootstocks (Nimbolkar *et al.*, 2016) and are easy and almost inexpensive to propagate and are probably still the most widely used methods and are free of those viruses that are not seed propagated (Mink, 1993).

Keeping in view the advantages of the seedling rootstocks of wild apricot the present study was conducted to determine the graft compatibility and growth of different cultivars of *Prunus* sp. on the wild apricot seedling rootstock.

Materials and Methods

The present investigations were carried out in the experimental field of KVK/ETC, Malangpora, Pulwama, SKUAST-Kashmir. Experimental farm is situated at an elevation of 1601 metres above mean sea level and lies between 33°North latitude and 74°East longitude. The KVK is located at 33° North and 74° East at an altitude of 1601 m amsl. The minimum and maximum temperatures of the station during summers range between 10 and 30°C and -4 and 10°C during winter under open conditions.

The soil of the location is silty clay loam neutral in reaction (pH 7.07) having organic carbon 10.02 g/ kg, available nitrogen 248.6 kg/ha, available phosphorous 14.7 kg/ ha and available potassium 250.3 kg/ha. The mean annual rainfall ranges from 500 to 850 mm, major portion of which is received during April-May month. Winter rains are usually of lighter intensity and of shorter durations.

Planting material and grafting procedure

Seedlings of wild apricot were raised from stratified seeds collected during the active growing season and stored before stratification. The seedlings were raised in the nursery at a spacing of 15 x 10 cm apart. *Prunus* scion cultivars (given below) were tongue grafted on wild apricot seedlings rootstock in the second fortnight of February.

Species name	Varieties
Peach	Redheaven, July Elberta and Red Globe
Nectarine	Snow Queen, Red Gold and Silver King
Plum	Santarosa, Frontier and Red Beaut
Apricot	Halman, Kaisha and CITH Apricot-1

Observations recorded and statistical analysis

Observations were recorded on various parameters viz. bud take success (%) which was recorded after two months of grafting in all the combinations, stock/scion ratio was calculated by dividing girth of stock with girth of scion at the end of the season. Growth parameters viz. plant height (m), trunk girth (cm), number of branches per plant, internodal length (cm) and pruning weight (g) and foliage characters (leaf bud burst time, leaf area (cm^2) were also recorded as per procedure. Stomatal density and size was calculated as described by Beakbane and Majumdar (1975). For the estimation of chlorophyll content (mg/g fresh weight of leaves) the leaf samples were prepared as per the method suggested by (Halfacre *et al.*, 1968) and according to the formula given by Hiscox and Israeeistam (1979). Time of leaf fall was calculated after completion of 75 per cent leaf fall. The experiment was replicated thrice and the data was analysed in RBD. Contrast methods were applied between rootstocks and between scion cultivars within each rootstock as suggested by Gomez and Gomez (1984).

Results and Discussion

Graft compatibility

Graft success of different stionic combination of *Prunus* sp. with wild apricot seedling rootstock is presented in Table 1. Significant differences were observed within varieties of different *Prunus* sp. and among various treatment combinations.

Maximum bud take among peach varieties grafted on wild apricot seedling rootstock was obtained in Redhaven (97.22 %) peach which was statistically higher than all other varieties, however statistically higher results was recorded for Snow Queen (91.66 %) nectarine as compared to other varieties. Kaisha cv. of apricot recorded cent per cent bud take which was statistically at par with CITH Apricot-1 (97.23 %). Among plum varieties Santarosa (72.67 %) recorded significant higher bud take as compared to Frontier (66.67 %) and Red Beaut (39.33 %). Among various scions used, apricot recorded an overall bud take per cent of 96.30 per cent followed by peach (87.96 %) and nectarine (82.97 %), respectively whereas lowest bud take was recorded in plum (59.56 %) being statistically different from other *Prunus* sp. These findings are in accordance with those of Nisar *et al.,* (2002) who also obtained 90.0 per cent bud take success in plum cultivars budded on peach rootstock. Ahmad *et al.,* (2012) recorded 85.0 per cent bud take success while budding Early Grande peach on seedling rootstock. Sharma and Kumar (2017) also recorded 95.83 per cent bud take success in nectarine than peaches (91.67 %) when grafted on Jaspi clonal rootstock. For stock/scion ratio for different cultivars used recorded observations as Red Globe (1.11), Redhaven (1.08) and July Elberta (1.06) for peach, Snow Queen (1.13), Silver King (1.12) and Red Gold (1.18) for nectarine, CITH Apricot-1 (1.18), Halman (1.14) and Kaisha (1.12) for apricot and Red Beaut (1.19), Santarosa (1.17) and Frontier (1.14) for plum varieties being statistically at par with each other. Overall stock/scion ratio of 1.17 in plum was statistically at par with apricot (1.15) and nectarine (1.14) however significantly differs in peaches (1.08). Wild apricot seedling rootstock tested for *Prunus* sp. varieties reported that bud take success was higher and significantly different in apricot from that other *Prunus* sp. in contrary to the reverse trend reported earlier by Grasselly and Saunier (1968). Among the different *Prunus* sp. bud take success was significantly different while stock/scion ratio was at par.

Although it is a general opinion that overgrowth of scion indicates graft incompatibility but in several cases it has been seen that such graft unions showed no signs of incompatibility later on (Westwood, 1978). The level of bud take success obtained in the present studies or in other words survival rate of different scion cultivars of *Prunus* sp. on seedling rootstock of wild apricot coupled with stock/scion ratio around 1.0 in most cases indicates moderate to high levels of graft compatibility with respective scion cultivars.

Growth characters

Data on different growth and foliage characters of different *Prunus* scion varieties on wild apricot seedling rootstock is presented in Table 1. Significant differences for plant height were observed among different *Prunus* varieties. Among peach cultivars Redhaven (2.17 m) measured maximum plant height followed by July Elberta (1.82 m) and Red Globe (1.44 m) which were statistically differ from each other whereas among nectarine varieties maximum plant height was recorded in Silver King (2.15 m) which was statistically at par with Snow Queen (1.89 m). Halman (2.34 m) apricot measured maximum plant height which was statistically higher than Kaisha (1.91 m) and CITH Apricot-1 (1.62 m) however plum cultivar differs statistically from each other for plant height i.e. Red Beaut (1.69 m), Santarosa (1.56 m) and Frontier (1.33 m). Overall among *Prunus* sp. maximum plant height was recorded in apricot (1.96 m) followed by nectarine (1.88 m) and peach (1.81 m) which were statistically significant with each other however minimum plant height was recorded in plum (1.52 m). Sharma and Kumar (2016) reported maximum annual growth of peach scion cultivars than plum scion cultivars on Julior clonal rootstocks.

All the grafted peach varieties were statistically differs from each other for trunk girth, number of branches per plant and internodal length, whereas nectarine cultivar Snow Queen (40.10 mm) was statistically at par with Silver King (37.08 mm) and Silver King was statistically at par with Red Gold (36.02 mm). Nectarine varieties were statistically different from each other for number of branches per plant and internodal length. Among apricot cultivars, Halman (43.11 mm) was statistically at par with CITH Apricot-1 (39.53 mm) for trunk girth and CITH Apricot-1 was statistically at par with Kaisha (36.10 mm) whereas all the apricot varieties were statistically differs from each other for number of branches per plant and intermodal length.

Similar trend for trunk girth, number of branches per plant and internodal length was recorded among plum cultivars. Overall, peach (41.13 mm), apricot (39.58 mm) and nectarine (37.73 mm) varieties were statistically differs from each other for trunk girth and significantly higher from each other for plum (28.81 mm), however for number of branches per plant, apricot (16.15) recorded maximum values which was statistically higher from plum (12.66), peach (12.27) and nectarine (11.45). Internodal length of peach (3.38 cm) and nectarine (3.23 cm) were statistically at par from each other and significantly higher from plum (2.58 cm) and apricot (1.71 cm). Sitarek and Jakubowski (2006) also reported similar results for plant height, trunk girth and number of branches while grafted apricot cultivars on five different rootstocks.

Among four cultivars of peach budded on two peach rootstocks Florida King have maximum values for most of the growth and foliage characters (Zeb *et al.*, 2002) however, maximum growth and maximum foliage was observed in plum cultivar when grafted on

peach rootstock (Nisar *et al.,* 2002). The trends in annual extension growth of scion cultivars on different rootstocks reveals that the effect of rootstock is of little significance, rather it is more due to the inherent growth potential of the scion cultivar. However, as per Renaud and Salesses (1994) the effect of rootstock on scion is different according to variety.

Red Globe (684.80 g/plant) and July Elberta (707.20 g/plant) peach were statistically at par with each other for pruning weight however both the peach varieties were significantly different from Redhaven (782.50 g/plant) whereas Halman (809.20 g/plant) apricot recorded maximum pruning weight which was statistically at par with Kaisha (761.60 g/plant) and Kaisha apricot was statistically at par with CITH Apricot-1 (708.00 g/plant). All the nectarine varieties viz. Silver King (766.00 g/plant), Snow Queen (732.40 g/plant), Red Gold (664.40 g/plant) and plum varieties viz. Santarosa (544.20 g/plant), Red Beaut (426.50 g/plant), Frontier (339.00 g/plant) were significantly differs from each other for pruning weight.

No differences was noticed within varieties of different *Prunus* sp. for time of leaf bud burst and time of leaf fall, however among *Prunus* sp., apricot (2nd week of March) was found to be early in leaf bud burst followed by peach (3rd week of March), nectarine (3rd week of March) and plum (4th week of March) whereas early leaf fall was recorded was recorded in peach (1st week of November) and nectarine (1st week of November) followed by plum (2nd week of November) and apricot (3rd week of November).

Foliage character

Leaf area was significantly higher in Silver King (28.82 cm^2) nectarine than in Snow Queen (25.92 cm^2) whereas Snow Queen was significantly higher than Red Gold (22.81 cm^2) for leaf area. Redhaven (24.38 cm^2) peach was statistically at par July Elberta (22.84 cm^2) and July Elberta with Red Globe (21.32 cm^2) for leaf area. Similar trend for leaf area was recorded among apricot varieties i.e. Kaisha (23.22 cm^2), Halman (21.92 cm^2) and CITH Apricot-1 (20.14 cm^2). Among plum cultivars, Red Beaut (16.44 cm^2) was statistically at par with Santarosa (15.90 cm^2) while Santarosa was statistically at par with Frontier (13.39 cm^2). Overall leaf area of nectarine (25.85 cm^2), peach (23.12 cm^2), apricot (21.52 cm^2) and plum (15.24 cm^2) was statistically higher from each other. Maximum chlorophyll content was recorded in Santarosa (30.01 mg/g) which was statistically at par with Red Beaut (29.30 mg/g) and Frontier (28.78 mg/g) whereas Redhaven (27.12 mg/g) peach was statistically at par with both peach varieties i.e. Red Globe (26.30 mg/g) and July Elberta (25.94 mg/g). Among nectarine varieties Silver King (27.09 mg/g) recorded maximum chlorophyll content which was statistically at par with Snow Queen (26.73 mg/g) and Red Gold (25.92 mg/g), however CITH Apricot-1 (23.15 mg/g) was statistically at par with Halman (22.69 mg/g) and Kaisha (21.97 mg/g). Overall, plum (29.36 mg/g) registered maximum values for chlorophyll content which was significantly higher than nectarine (26.58 mg/g), peach (26.45 mg/g) and apricot (22.60 mg/g).

As regards foliage characteristics viz., leaf area and chlorophyll content plums and apricots as scions were at par on Myrocal except lower stomatal density recorded in plums than in apricot on Myrocal. Higher stomatal density and increased accumulation of chlorophyll content in the leaves of scion cultivars are generally correlated with rootstock effect (Miller, 1977; Makariev *et al.,* 1986).

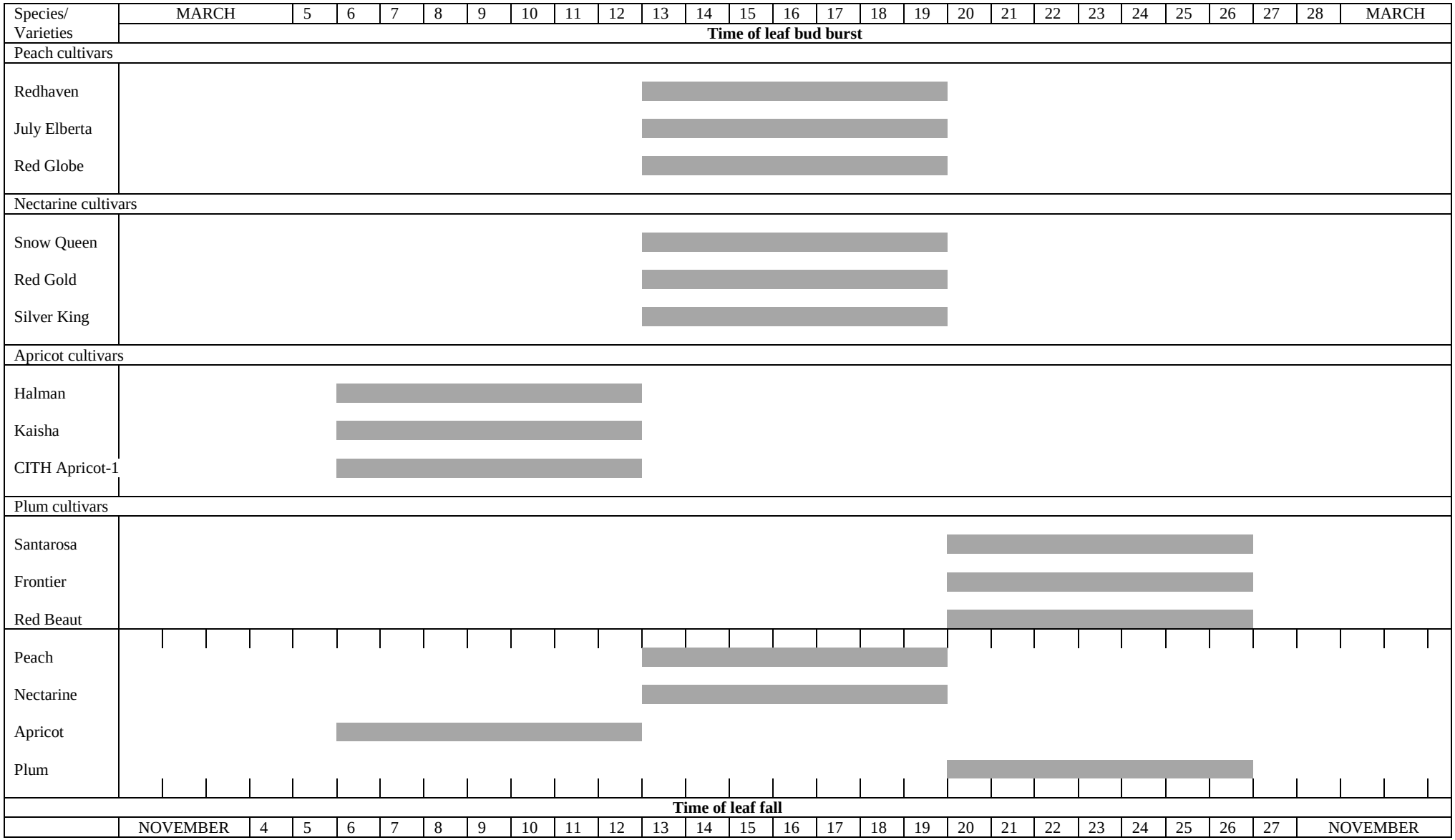
Table.1 Graft success and growth parameters of different *Prunus* species scion cultivars on wild apricot seedling rootstocks

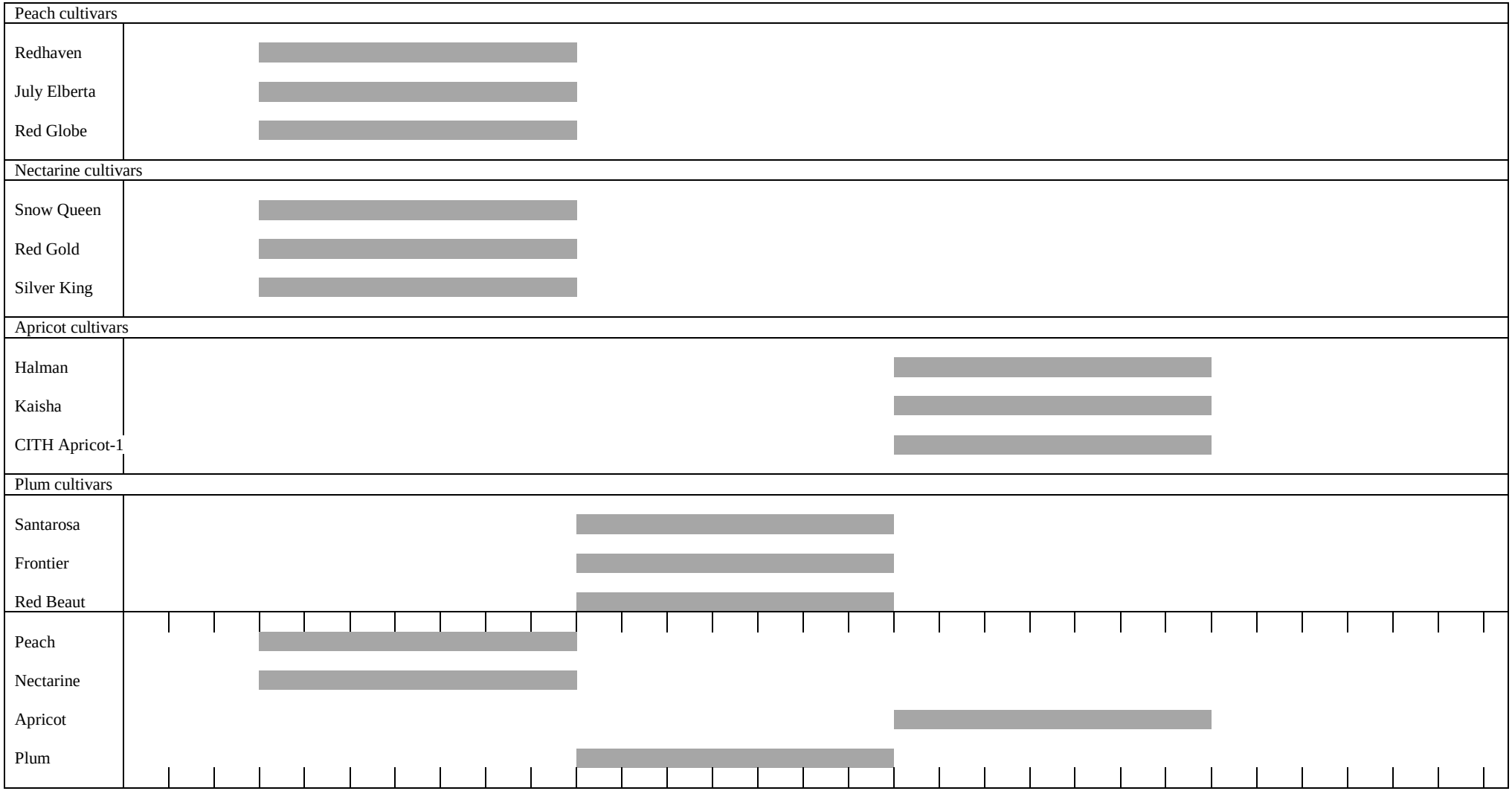
Species/ Cultivars	Graft Success		Plant height (m)	Trunk girth (mm)	No. of branches/plant	Internodal length (cm)	Pruning weight (g/plant)
	Bud take (%)	Stock/scion ratio					
Peach cultivars							
Redhaven	97.22	1.08	2.17	44.22	8.32	3.16	782.50
July Elberta	75.00	1.06	1.82	38.17	12.36	3.58	707.20
Red Globe	91.67	1.11	1.44	41.00	16.14	3.39	684.80
$CD_{0.05}$	**4.57**	**0.04**	**0.30**	**2.92**	**1.12**	**0.09**	**66.06**
Nectarine cultivars							
Snow Queen	91.66	1.13	1.89	40.10	14.12	3.44	732.40
Red Gold	82.24	1.12	1.60	36.02	9.22	3.23	664.40
Silver King	75.00	1.18	2.15	37.08	11.02	3.02	766.00
$CD_{0.05}$	**5.21**	**0.07**	**0.29**	**3.09**	**1.56**	**0.19**	**32.25**
Apricot cultivars							
Halman	91.67	1.14	2.34	43.11	12.39	1.92	809.20
Kaisha	100.00	1.12	1.91	36.10	19.44	1.48	761.60
CITH Apricot-1	97.23	1.18	1.62	39.53	16.62	1.72	708.00
$CD_{0.05}$	**3.39**	**0.05**	**0.22**	**3.67**	**2.19**	**0.18**	**55.62**
Plum cultivars							
Santarosa	72.67	1.17	1.56	31.12	12.72	2.84	544.20
Frontier	66.67	1.14	1.33	26.88	10.84	2.32	339.00
Red Beaut	39.33	1.19	1.69	28.42	14.42	2.57	426.50
$CD_{0.05}$	**5.23**	**0.03**	**0.18**	**3.03**	**1.66**	**0.23**	**79.23**
Peach	87.96	1.08	1.81	41.13	12.27	3.38	724.83
Nectarine	82.97	1.14	1.88	37.73	11.45	3.23	720.93
Apricot	96.30	1.15	1.96	39.58	16.15	1.71	759.60
Plum	59.56	1.17	1.52	28.81	12.66	2.58	436.56
$CD_{0.05}$	**4.28**	**0.04**	**0.20**	**2.41**	**1.82**	**0.34**	**42.12**

Table.2 Foliage characters, time of bud burst and leaf fall of different *Prunus* species scion cultivars on wild apricot seedling rootstocks

Species/ Varieties	Leaf area (cm^2)	Stomatal density (per microscopic field)	Stomata size (µm)		Chlorophyll content (mg/g)
			length	breadth	
Peach cultivars					
Redhaven	24.38	24.87	24.90	16.80	27.12
July Elberta	22.84	24.03	24.16	17.13	25.94
Red Globe	21.32	25.98	25.84	17.36	26.30
$CD_{0.05}$	1.80	0.76	0.72	0.68	1.24
Nectarine cultivars					
Snow Queen	25.92	26.82	25.40	16.92	26.73
Red Gold	22.81	27.90	26.32	17.12	25.92
Silver King	28.82	28.76	24.16	16.60	27.09
$CD_{0.05}$	2.62	0.80	0.86	0.60	1.30
Apricot cultivars					
Halman	21.92	36.11	26.02	16.92	22.69
Kaisha	23.22	38.29	27.19	16.64	21.97
CITH Apricot-1	20.14	37.30	28.60	17.33	23.15
$CD_{0.05}$	2.08	0.90	1.02	0.72	1.23
Plum cultivars					
Santarosa	15.90	34.33	27.83	16.77	30.01
Frontier	13.39	32.10	26.17	17.23	28.78
Red Beaut	16.44	33.20	27.01	17.13	29.30
$CD_{0.05}$	1.44	1.07	0.53	0.52	1.34
Peach	23.12	24.89	24.97	17.10	26.45
Nectarine	25.85	28.16	25.29	16.91	26.58
Apricot	21.52	37.24	27.27	16.96	22.60
Plum	15.24	33.21	27.00	17.04	29.36
$CD_{0.05}$	1.42	1.21	0.78	0.22	1.52

Fig.1 Graphical representation of time of leaf bud burst and time of leaf fall




Peach cultivars
Redhaven
July Elberta
Red Globe
Nectarine cultivars
Snow Queen
Red Gold
Silver King
Apricot cultivars
Halman
Kaisha
CITH Apricot-1
Plum cultivars
Santarosa
Frontier
Red Beaut
Peach
Nectarine
Apricot
Plum

Stomatal characters

Maximum stomatal density among peach varieties in Red Globe (25.98 per microscopic field) was significantly different from Redhaven (24.87 per microscopic field) and July Elberta (24.03 per microscopic field) whereas among nectarine varieties maximum stomatal density in Silver King (28.76 per microscopic field) was significantly differs from Red Gold (27.90 per microscopic field) and Snow Queen (26.82 per microscopic field). All the apricot i.e. Kaisha (38.29 per microscopic field), CITH Apricot-1 (37.30 per microscopic field) and Halman (36.11 per microscopic field) were significantly differs from each other for stomatal density. Similar trend was recorded among plum varieties for stomatal density. Overall, all the *Prunus* sp. i.e. apricot (37.24 per microscopic field), plum (33.51 per microscopic field), nectarine (28.16 per microscopic field) and peach (24.89 per microscopic field) differs significantly from each other for stomatal density.

All the peach varieties [Red Golbe (25.84 µm), Redhaven (24.90 µm) and July Elberta (24.16 µm)], nectarine varieties [Red Gold (26.32 µm), Snow Queen (25.40 µm) and Silver King (24.16 µm)], apricot varieties [CITH Apricot-1 (28.60 µm), Kaisha (27.19 µm) and Halman (26.02 µm)] and plum varieties [Santarosa (27.83 µm), Red Beaut (27.01 µm) and Frontier (26.17 µm)] were significantly differs from each other for stomatal length. Overall, maximum stomatal length was recorded in apricot (27.27 µm) which was statistically at par with plum (27.00 µm) whereas nectarine (25.29 µm) and peach (24.97 µm) were statistically at par with each other. Red Globe (17.36 µm) peach was statistically at par with July Elberta (17.13 µm) and Redhaven (16.80 µm) for stomatal breadth whereas Red Gold (17.12 µm) nectarine was statistically at par with Snow Queen (16.92 µm) and Silver King (16.60 µm). Among apricot varieties, CITH Apricot-1 (17.33 µm) was statistically at par with Halman (16.92 µm) and Kaisha (16.64 µm), however Frontier (17.23 µm) was statistically at par with Red Beaut (17.13 µm) and Santarosa (16.77 µm). Overall all the *Prunus* sp. were statistically at par with each other for stomatal breadth. Sharma *et al.*, (2009) also reported similar results with respect to stomatal density (13.30 µm), stomatal length (19.80 µm) and stomatal breadth (9.0-12.60 µm).Among peach, nectarine, plum and apricot cultivars grafted on different clonal rootstock similar results was reported by Sharma and Kumar (2016) and Sharma and Kumar (2017).

On the whole, it appears that irrespective of the trends in growth and vigour of apricot cultivars grafted on wild apricot seedlings reflects significant effect of rootstock, positive results were also observed with nectarine cultivars. The trends in growth of scion cultivars except plum on wild apricot rootstocks reveals that the effect of rootstock is of little significance, rather it is more due to the inherent growth potential of the scion cultivar.

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