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Selection of stone fruit rootstock for drought tolerance and amenability to clonal multiplication

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ABSTRACT

Heterogenous mass population of hybrid peach (raised by crossing commercial cultivars i.e. July Elberta, J H Hale, Kanto 5, Alton and Quetta with wild peach), wild peach and wild apricot were assessed for their nutrient uptake under low fertility conditions. The promising seedlings were evaluated for their propensity for clonal multiplication through cutting and stooling. Hybrid peach seedlings S-21, S-42, S-46, S-47, S-51 and S-52 performed better with respect to vegetative characters and proline content under lower irrigation regimes. Similarly wild peach seedlings S-26, S-27, S-47, S-48, S-55, S-56 and S-57, wild apricot seedlings S-44, S-45, S-46, S-47, S-52 and S-53 were better under low irrigation regimes. S-42 among hybrid peach seedlings, S-43 and S-47 from wild peach seedlings and S-47 among the wild apricot seedlings were promising with respect to their propensity for vegetative multiplication.

Keywords: Stone fruit rootstock, seedling rootstock selection, drought tolerance, rootstock selection, vegetative multiplication

INTRODUCTION

Stone fruits (Peach, Plum and Apricot) are mainly grown in the North-Western Indian States of Jammu and Kashmir (J&K), Himachal Pradesh (H.P.), Uttrakhand hills and to some extent in the North-Eastern Hills region. Major portion of the total stone fruits production in Himachal Pradesh is confined mainly to the mid hill region falling in the altitude range of 1000 – 1700 meters above mean sea level where the summer are moderately hot (31.8 to 34.8^{o}C) during May-June and winters are cold (2.4 to 3.7^{o}C) during December–January. The average annual rainfall ranges from 100-130 cm, 90% of which is limited to two months of the monsoon (July–August) and during the rest of the year plants remain under water stress. Most of the orchards are on sloppy land where irrigation is difficult to practice and due to scarcity of water and uneven distribution of rainfall throughout the growing season drought conditions are commonly prevalent, which results in poor fruit set, heavy fruit drop and sometimes even cause the death of the plants. Like majority of fruit crops, stone fruits are also multiplied clonally by grafting the scion cultivar on the desired rootstock and beneficial effects of rootstock on the grafted plant, including drought tolerance are well known among the fruit crops. Wild relatives of the stone fruits e.g. 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 in this region for ages. But the heterogeneity of the wild mass population remains the biggest problem in getting homogenous grafted plants. Thus in India the productivity of peach, plum and apricot is 8.10 tonnes/hac, 5.7 tonnes/hac and 4.17 tonnes/hac respectively which is considerably low as compared to other countries where these fruits are grown commercially. Non-availability of good clonal rootstocks suitable for the local climatic conditions for mid hills of Himachal Pradesh is one of the major reasons for the low productivity of these crops. Since there is huge variations available in form of wild peach (kateru), wild apricot (Chulli) and Behmi from which suitable clonal rootstock could be evolved which are suitable for the local climatic conditions and benefit the orcharding enterprise to a larger extent. Therefore the present investigations were carried out to select seedling from a hetrogenous mass of wild relatives which are efficient in nutrient uptake and are amenable for vegetative multiplication in the experimental block of Dr. Y. S. Parmar University of Horticulture and Forestry, Nauni, Solan, HP, so that subsequently they could be multiplied easily as rooting has always been a problem in the wild germplasm of the stone fruit plants.

MATERIALS AND METHOD

The experimental site falls under sub-temperate climatic region where the summer are moderately hot (31.8 to 34.8^{o}C) during May-June and winters are cold (2.4 to 3.7^{o}C) during December – January. The average annual rainfall ranges from 100-130 cm, major portion of which is confined mainly to two months of monsoon (July – August). Winter rains are usually of lighter intensity and of shorter durations. Thus most of the cultivation is rainfed and dependent upon the rainwater.

Plant material: Uniform and healthy one year old seedlings of wild peach, wild apricot and F1 peach hybrids raised by hybridizing commercial cultivars named July Elberta, J H Hale, Kanto 5, Alton and Quetta with wild peach were planted at a spacing of 32×25 cm.

Number of treatments: 6,

Seedlings per treatment: 8

Treatments: 1) T1: No irrigation, 2) T2: Soil moisture raised to 25% of the field capacity once in a week, 3) T3: Soil moisture raised to 50% of the field capacity once in a week, 4) T4: Soil moisture raised to 75% of the field capacity once in a week, 5) T5: Soil moisture raised to field capacity once in a week, 6) T6: Soil saturated once in a week

The soil moisture was determined at 0-30cm depth by gravimetric method i.e. by drying the soil samples in aluminum boxes in the oven at 105^{O}C for 12 hours. Irrigation was applied at weekly intervals and amount of water to raise soil moisture to desired level was calculated as follows:

Deficit in moisture	×	Depth of soil to be irrigated	×	Bulk density of the soil

Depth of water to be applied (Xcm say) = 10

1cm of water/m^2 = 10 Liter

X cm of water/m^2 = X × 10 Liter

1.21 × 0.45 m^2 of water = X × 10 × 1.21 × 0.45 cm (Where 1.21 × 0.45 m^2 is the size of the bed)

Growth and vigour: The physical parameters e.g. plant height, plant spread, trunk cross-sectional area, internodal length, No. of side branches, No. of leaves per plant were measured using standard methods. Leaf area was measured on leaf area meter (Licor model 3100) and expressed as cm2/leaf. The technique used for the stomatal study was as described by Beakbane and Majumdar (1975). Chlorophyll content was measured using the method suggested by Hiscex and Isralistan (1979) using the following formula.

$$\text{Total Chlorophyll (mg/g)} = \frac{20.2\ A645 + 8.02\ A663}{a \times 1000 \times w} \times V$$

Where V = Volume of the extract made, a = Length of the light path in cell (usually 1 cm), w = Weight of the sample (gm), A645 = Absorbance at 645 nm wavelength, A663 = Absorbance at 663 nm wavelength. The results were expressed as chlorophyll content mg/gm fresh weight

Proline content: Proline content was determined according to the method suggested by Uma (2000) with the help of standard curve using the following formula:

$$\mu\text{g/gm of tissue} = \frac{\mu\text{g proline/ml} \times \text{ml toluene} \times 0.5\ \text{gm sample}}{115.5^*}$$

* molecular weight of proline.

RESULTS AND DISCUSSION

Variations in growth parameters and proline content: Among hybrid peach seedlings (Table 1) plant height, spread, trunk cross sectional area internodal length, no. of shoots/seedling, no. of leaves/seedling, leaf area, stomatal density (per microscopic field), stomatal length, stomatal breadth, chlorophyll content and proline content ranged between 0.76-1.64m, 0.21-0.42m, 2.80-4.68cm^2, 1.64-3.02cm, 4-9, 503-822, 17.88-29.73cm^2, 15-24, 21.60-28.80µm, 7.20-10.80µm, 1.50-1.98mg/g and 503.00-1615µg/gm respectively. The respective coefficients of variation for the characters was recorded as 23.58, 15.63, 12.61, 21.76, 21.76, 22.86, 8.10, 17.80, 21.75, 9.77 and 5.40 and the respective mean values were 1.06, 0.32, 3.33, 2.16, 4.90, 22.95, 18.88, 22.95, 8.55, 1.74 and 1524.63 for the seedlings under treatment T1. In case of treatment T2, the coefficient of variation for the characters plant height, spread, trunk cross sectional area internodal length, no. of shoots/seedling, no. of leaves/seedling, leaf area, stomatal density (per microscopic field), stomatal length, stomatal breadth, chlorophyll content and proline content were 13.89, 15.63, 7.79, 20.59, 23.95, 7.79, 11.00, 10.49, 19.68, 7.34 and 6.58 and the respective mean values under same treatment observed were 1.08, 0.32, 4.11, 2.38, 5.22, 4.11, 20.00, 24.30, 9.45, 1.77, and 1320.63. The coefficients of variation under treatment T3 were 17.86, 13.33, 12.12, 15.93, 20.29, 13.21, 17.23, 11.62, 15.31, 8.75 and 14.40 for the characters plant height, spread, trunk cross sectional area internodal length, no. of shoots/seedling, no. of leaves/seedling, leaf area, stomatal density (per microscopic field), stomatal length, stomatal breadth, chlorophyll content and proline content respectively and the respective mean values for same characters recorded were 1.12, 0.30, 3.96, 2.26, 4.88, 23.39, 19.38, 23.40, 12.15, 1.75 and 1276.00. Similarly in case of treatment T4 the respective coefficients of variations recorded were 27.97, 29.63, 20.06, 16.06, 25.52, 11.70, 16.21, 7.42, 15.31, 16.37 and 8.82 and the respective mean values for same characters under treatment T4 were 1.18, 0.27, 3.24, 1.93, 3.88, 22.65, 18.63, 22.50, 12.15, 1.75 and 1120.88. In treatment T5, coefficient of variation for plant height, spread, trunk cross sectional area internodal length, no. of shoots/seedling, no. of leaves/seedling, leaf area, stomatal density (per microscopic field), stomatal length, stomatal breadth, chlorophyll content and proline content were 15.97, 16.13, 8.17, 15.60, 17.10, 16.49, 17.54, 7.80, 19.45, 7.95 and 8.26 respectively and the mean values for same characters were recorded as 1.19, 0.31, 4.04, 2.17, 5.38, 23.47, 19.50, 23.85, 9.45, 1.76 and 1001.75 respectively. The given in Table 2, shows that in wild peach seedlings grown under different irrigation levels, plant height, plant spread, trunk cross sectional area internodal length, no. of shoots/seedling, no. of leaves/seedling, leaf area, stomatal density (per microscopic field), stomatal length, stomatal breadth, chlorophyll content and proline content ranged between 0.81-1.39m, 0.30-0.80m, 2.80-4.59cm^2, 1.66-3.02cm, 475-822, 3-9, 19.11-29.73cm^2, 17-25, 21.60-28.80µm, 7.20-10.80µm, 1.65-2.12mg/gm and 503.00-1615µg/g respectively. Under treatment T1 for wild peach seedlings the coefficient of variation for plant height, spread, trunk cross sectional area internodal length, no. of shoots/seedling, no. of leaves/seedling, leaf area, stomatal density (per microscopic field), stomatal length, stomatal breadth, chlorophyll content and proline content were 16.35, 24.39, 15.57, 24.15, 20.94, 11.70, 10.61, 8.10, 21.33, 5.56 and 5.40 respectively and the mean values for same characters were recorded as 1.04, 0.41, 3.66, 2.36, 4.25, 22.65, 19.13, 22.95, 9.00, 1.80 and 1524.63 respectively. Similarly in case of treatment T2 the respective coefficients of variations recorded were 25.96, 30.23, 21.29, 8.53, 31.56, 16.16, 13.81, 8.10, 19.68, 8.74 and 5.40 and the respective mean values for same characters under treatment T2 were 1.04, 0.43, 3.57, 2.11, 4.88, 22.90, 19.25, 22.95, 9.45, 1.83 and 1317.36. The coefficients of variation under treatment T3 were 17.14, 15.56, 8.75, 8.43, 29.53, 13.21, 17.52, 8.10, 2.75, 5.78 and 14.40 for the characters plant height, spread, trunk cross sectional area internodal length, no. of shoots/seedling, no. of leaves/seedling, leaf area, stomatal density (per microscopic field), stomatal length, stomatal breadth, chlorophyll content and proline content respectively and the respective mean values for same characters recorded were 1.05, 0.45, 4.23, 2.37, 6.13, 32.39, 19.25, 22.95, 10.35, 1.73 and 1276.00. The respective coefficients of variation for the characters was recorded as 17.92, 13.73, 12.57, 12.39, 13.54, 16.56, 17.09, 7.80, 21.75, 10.50 and 8.82 and the respective mean values were 1.06, 0.51, 3.58, 2.26, 6.13, 23.40, 20.13, 23.85, 8.55, 1.81 and 1120.88 for the seedlings under treatment T4. 13.27, 15.09, 15.40, 13.30, 17.53, 9.89, 16.44, 11.24, 21.75, 9.78

and 6.06 were the respective coefficient of variation values recorded for plant height, spread, trunk cross sectional area, internodal length, no. of shoots/seedling, no. of leaves/seedling, leaf area, stomatal density (per microscopic field), stomatal length, stomatal breadth, chlorophyll content and proline content under treatment T5 and the respective mean values for same characters were 1.13, 0.53, 3.83, 2.33, 7.13, 24.46, 20.13, 23.85, 8.55, 1.84 and 991.38. Similarly in case of treatment T6 the respective coefficients of variations recorded were 13.16, 17.24, 8.13, 19.31, 20.94, 16.03, 14.78, 12.12, 21.75, 21.75 and 23.69 and the respective mean values for same characters under treatment T6 were 1.14, 0.58, 4.06, 2.33, 4.25, 25.01, 19.75, 24.75, 8.55, 8.55 and 710.50. The data given in Table 3 shows that the plant height, spread, trunk cross sectional area, internodal length, no. of shoots/seedling, no. of leaves/seedling, leaf area, stomatal density (per microscopic field), stomatal length, stomatal breadth, chlorophyll content and proline content for wild apricot seedlings varied between 0.79-1.47m, 0.42-0.59m, 1.96-3.66cm^2, 0.96-1.66cm, 452-845, 4-9, 14.48-25.69cm^2, 11-31, 18.00-25.20µm, 9.00-12.60µm, 1.42-2.02mg/gm and 850.00-2382.00µm/gm respectively. The respective coefficients of variation for the characters was recorded as 5.75, 13.73, 15.00, 11.21, 24.83, 15.69, 34.61, 8.89, 8.02, 10.71 and 3.96 and the respective mean values were 0.87, 0.51, 2.20, 1.07, 5.88, 16.89, 16.50, 20.03, 10.35, 1.68 and 2267.00 for the seedlings under treatment T1. In case of treatment T2, the coefficient of variation for the characters plant height, spread, trunk cross sectional area internodal length, no. of shoots/seedling, no. of leaves/seedling, leaf area, stomatal density (per microscopic field), stomatal length, stomatal breadth, chlorophyll content and proline content were 8.70, 13.79, 13.51, 20.34, 25.29, 16.91, 16.91, 6.54, 10.87, 12.21 and 3.30 and the respective mean values under same treatment observed were 0.92, 0.29, 2.59, 1.18, 6.13, 20.28, 20.63, 20.48, 10.58, 1.72 and 2095.75. The coefficients of variation under treatment T3 were 3.03, 15.00, 12.64, 9.60, 13.42, 18.47, 15.82, 8.07, 10.87, 5.65 and 1.53 for the characters plant height, spread, trunk cross sectional area internodal length, no. of shoots/seedling, no. of leaves/seedling, leaf area, stomatal density (per microscopic field), stomatal length, stomatal breadth, chlorophyll content and proline content respectively and the respective mean values for same characters recorded were 0.99, 0.32, 2.61, 1.25, 7.75, 20.30, 22.63, 20.70, 10.58, 1.77 and 1810.88. Similarly in case of treatment T4 the respective coefficients of variations recorded were 10.71, 11.11, 21.97, 20.31, 10.21, 16.59, 24.48, 51.11, 14.18, 8.43 and 5.37 and the respective mean values for same characters under treatment T4 were 1.06, 0.51, 3.58, 2.26, 6.13, 23.40, 20.13, 23.85, 8.55, 1.81 and 1120.88. In treatment T5, coefficient of variation for plant height, spread, trunk cross sectional area internodal length, no. of shoots/seedling, no. of leaves/seedling, leaf area, stomatal density (per microscopic field), stomatal length, stomatal breadth, chlorophyll content and proline content were 4.07, 11.36, 14.39, 12.32, 10.21, 14.98, 22.04, 8.15, 10.87, 8.89 and 5.58 respectively and the mean values for same characters were recorded as 1.23, 0.44, 2.71, 1.38, 8.13, 14.98, 22.04, 8.15, 1.80 and 1082.75 respectively. In case of treatment T6, the coefficient of variation for the characters plant height, spread, trunk cross sectional area internodal length, no. of shoots/seedling, no. of leaves/seedling, leaf area, stomatal density (per microscopic field), stomatal length, stomatal breadth, chlorophyll content and proline content were 5.84, 13.73, 5.96, 12.75, 6.24, 19.12, 7.88, 9.28, 16.82, 5.41 and 3.96 and the respective mean values under same treatment observed were 1.37, 0.51, 2.85, 1.49, 8.50, 21.44, 24.88, 20.70, 10.58, 1.85 and 899.13. Unal *et.al.* (1994) recorded 0.62 – 1.25 m plant height, 7.63 – 12.89 cm plant spread and 1-10 shoots per plant in one year old seedlings of nine almond cultivars. In the recent past many researchers (Licznar and Sausa, 2005, Carrera *et. al.* 2005 and Caruso, 2005) have found huge variations in the vigorousness of different fruit rootstocks. Kaundal and Bindra (1987) recorded 12.30-30.15 stomata per 0.04 mm^2 leaf area, 17.74 – 26.89µm long and 7.70 – 12.72µm wide stomata in 12 prunus rootstocks and cultivars.

Similarly Guirguis and Khalil (1995) observed 14.30–28.32 µm long and 5.67–11.00µm wide stomata/cm^2 of leaf surface in sweet almond, bitter almond, Nemagaurd peach, Okinawa peach, Flordaguard peach, Florda 9/3 peach, local apricot, and Myrobalan B. Leaf chlorophyll content have also been reported to be affected by various factors in fruit crops and can differ between species and within species and is also affected by the type of rootstock used (Fayeket *et. al.* 2004 and Sotiropoulos, 2008). Mishra (1997) recorded 2.70 – 3.45 mg/gm and 1.86 – 4.74 mg/gm chlorophyll content before and after harvest respectively in peach cultivar July Elberta under different planting systems. Jha (1996) also recorded 1.86 – 4.74 mg/gm chlorophyll content in peach cultivar July Elberta. Higher chlorophyll content has been correlated with vigorousness many times. The differences in the growth behavior of different seedlings under low soil moisture may be due to the fact that some of them can maintain higher stomatal resistance which reduces the transpiration and thus helps in water conservation (Giulivo *et.al.* 1985 and Mannini and Gallina, 1999). Increased chlorophyll content under higher moisture levels may be due to increased uptake by the irrigated plants and it is well known that magnesium is an important constituent of chlorophyll. Another reason for chlorophyll content under irrigated condition might be the greater synthesis and translocation of assimilates and water might check the degradation of chlorophyll in the leaves. Water stress suppresses the photosynthesis by reducing the leaf area, closing of stomata and by checking the activity of the dehydrated chloroplast. Proline accumulation increased markedly with the decrease in soil moisture and is considered as an osmo-protectant compound in plant cells. Under the present investigations the seedlings grown under low moisture levels had lower vigor as compared to those under higher moisture levels, but some seedlings showed promise with respect to growth characters and drought tolerance under low soil moisture. Najafian (2008) also reported increased leaf praline content accumulation in two bitter almond rootstocks under stressed conditions. On the basis of growth, vigor and proline content seedlings S-12, S26, S-27, S-42, S-45, S-48, S-51, S-52 and S-57 from hybrid peach, seedlings S-15, S-23, S-27, S-28, S-43, S-46, S-47, S-53, S-54, S-56 and S-57 from wild peach and seedlings S-27, S-28, S-44, S-47, S-48, S-51, S-53 and S-55 form wild apricot showed performance better than the average performance under T5.

Amenability to vegetative propagation: The hardwood cutting from better performing seedlings, selected from different irrigation levels were treated with 2500 ppm IBA. All the cuttings sprouted but they did not root at all and died by the end of June. Stooling was done by applying 2500 ppm IBA paste in lanoline on the circular cut of the mother stock. Observations for rooting were taken by the end of the season. It is evident from the data shown in Table 4 that percent rooting in the selected seedlings of hybrid peach ranged between 0.00% in S-12, S-45 and S-57 to 66.67% in S-42. Percent rooting in S-26 and S-48 was 33.33% and S-27, S-51 and S-52 had 25.00% rooting. Number of roots ranged from 2 in S-26, S-42 to 4.00 in S-48. Highest average root length was 10.0 cm in S-26, S-42, S-48 and S-51 followed by 7.5 cm in S-27 and S-52. In wild peach seedlings rooting percentage ranged from 0.00% in S-27, S-28, S-54, S-56 and S-57 to 50.00% in S-43 and S-47. S-23 and S-46 had 33.33% rooting and S-15 and S-53 had 25.00% rooting. Number of roots varied between 2 in S-23 and S-46 to S-46 and S-47, whereas in S-15, S-43 and S-53 had average root length of 10.00 cm. Wild apricot had 0.00% rooting in S-27, S-48, S-53 and S-54, 25.00% in S-44 and S-51 and 33.33% in S-47. Number of roots varied between 1 in S-47 to 2 in S-44 and S-51. Maximum average root length of 15.00cm was observed in S-44 followed by 12.5cm in S-47 and 10.00cm in S-51. Yadav (1988) recorded 0.00% rooting in July Elberta and J.H. Hale peaches when treated with IBA @2000 ppm. Rooting performance of the promising seedlings when studied in stooling, showed success. Among the hybrid peach seedlings grown under different irrigation regimes, S-42 had maximum rooting percentage (66.67%)

but had only two roots per stool which was minimum with average root length of 10.00cm. Other seedlings had less than 40.00% rooting. Among wild peach seedlings grown under different nutrient levels only one seedling S-48 had 60.00% rooting, 8 roots per shoot and 20.00cm average root length. Among wild peach seedlings S-43 and S-47 showed maximum rooting of 50.00%. Seedlings S-47 had 4 roots per stool with 7.5cm average root length and S-43 had 3 roots per stool with 10.00cm average root length. . Dwivedi (1973) recorded 9.00-46.00% rooting in eight plum rootstocks having 1.40-3.07 roots and 0.80-6.75 cm roots per sucker. Mishra *et.al.* (1980) also observed 20.20-51.00% rooting in Prunus rootstock Behmi. On average the rooting percentage varied from 25.00-33.33% with 2 roots per stool among the seedlings grown under different irrigation levels.

CONCLUSIONS

Hybrid peach seedlings S-21, S-42, S-46, S-47, S-51 and S-52 performed better with respect to vegetative characters and proline content under lower irrigation regimes. Similarly wild peach seedlings S-26, S-27, S-47, S-48, S-55, S-56 and S-57, wild apricot seedlings S-44, S-45, S-46, S-47, S-52 and S-53 were better under low irrigation regimes.

S-42 among hybrid peach seedlings, S-43 and S-47 from wild peach seedlings and S-47 among the wild apricot seedlings were promising with respect to their propensity for vegetative multiplication.

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Table 1. Variation in growth parameters and proline content of hybrid peach seedlings

Parameters		**Treatment**					
		T1	T2	T3	T4	T5	T6
Plant height (m)	Range Mean CV SE	0.76-1.39 1.06 23.58 0.17	0.81-1.35 1.08 13.89 0.10	0.76-1.34 1.12 17.86 0.14	0.81-1.39 1.18 27.97 0.23	1.01-1.51 1.19 15.97 0.13	0.81-1.64 1.28 20.31 0.18
Plant spread (m)	Range Mean CV SE	0.21-0.38 0.32 15.63 0.03	0.21-0.38 0.32 15.63 0.03	0.25-0.35 0.30 13.33 0.03	0.28-0.42 0.27 29.63 0.06	0.22-0.35 0.31 16.13 0.03	0.29-0.40 0.36 11.11 0.03
Trunk cross sectional area (cm^2)	Range Mean CV SE	2.80-4.19 3.33 12.61 0.29	3.61-4.53 4.11 7.79 0.22	3.20-4.54 3.96 12.12 0.33	2.49-4.24 3.24 20.06 0.45	3.72-4.59 4.04 8.17 0.23	3.59-4.68 4.20 9.76 0.28
Internodal length (cm)	Range Mean CV SE	1.64-2.77 2.16 21.76 0.33	1.81-3.02 2.38 20.59 0.34	1.92-2.97 2.26 15.93 0.25	1.34-2.24 1.93 16.06 0.21	1.74-2.75 2.17 15.60 0.24	2.07-3.02 2.46 13.41 0.23
Number of shoots	Range Mean CV SE	4-6 4.90 22.86 0.78	3-7 5.22 23.95 0.87	3-6 4.88 20.29 0.69	3-6 3.88 25.52 0.69	4-7 5.38 17.10 0.64	5-9 7.13 19.53 0.87
Leaf area (cm^2)	Range Mean CV SE	17.88- 25.20 22.95 8.10 1.29	18.80- 25.56 4.11 7.79 0.22	19.27- 28.55 23.39 13.21 2.14	19.11- 26.12 22.65 11.70 1.84	18.96- 29.73 23.47 16.49 2.68	18.30- 29.55 25.00 16.04 2.78
Stomatal density	Range Mean CV SE	15.00- 25.00 18.88 17.80 2.33	17.00- 24.00 20.00 11.00 1.52	14.00- 25.00 19.38 17.23 2.31	14.00- 23.00 18.63 16.21 2.09	15.00- 24.00 19.50 17.54 2.37	18.00- 23.00 20.75 9.54 1.37
Stomatal length (µm)	Range Mean CV SE	21.60- 25.20 22.95 8.10 1.29	21.60- 28.80 24.30 10.49 1.77	21.60- 28.80 23.40 11.62 1.88	21.60- 25.20 22.50 7.42 1.16	21.60- 25.20 23.85 7.80 1.29	21.60- 28.80 25.20 10.79 1.88
Stomatal breadth (µm)	Range Mean CV SE	7.20-10.80 8.55 21.75 1.29	7.20-10.80 9.45 19.68 1.29	7.20- 14.40 12.15 15.31 1.29	7.20- 14.40 12.15 15.31 1.29	7.20-10.80 9.45 19.45 1.29	7.20- 10.80 9.90 16.87 1.88
Chlorophyll content (mg/g)	Range Mean CV SE	1.50-2.00 1.74 9.77 0.12	1.56-1.98 1.77 7.34 1.09	1.52-1.95 1.75 8.75 0.10	1.54-1.98 1.75 16.37 0.10	1.51-1.92 1.76 7.95 0.10	1.65-1.92 1.79 5.03 0.06
Proline content (µg/gm)	Range Mean CV SE	1407-1615 1524.63 5.40 57.03	1189-1421 1320.63 6.58 60.23	1007- 1575 1276.00 14.40 127.29	948-1260 1120.88 8.82 68.47	899-1155 1001.75 8.26 57.31	503-936 716.59 23.69 168.34

Table 2. Variation in growth parameters and proline content of wild peach seedlings

Parameters		**Treatment**					
		T1	T2	T3	T4	T5	T6
Plant height (m)	Range Mean CV SE	0.81-1.26 1.04 16.35 0.12	0.55-1.31 1.04 25.96 0.19	0.73-1.31 1.05 17.14 0.12	0.88-1.39 1.06 17.92 0.13	0.96-1.34 1.13 13.27 0.10	0.91-1.34 1.14 13.16 0.10
Plant spread (m)	Range Mean CV SE	0.30-0.61 0.41 24.39 0.07	0.29-0.61 0.43 30.23 0.09	0.35-0.57 0.45 15.56 0.05	0.42-0.60 0.51 13.73 0.05	0.43-0.65 0.53 15.09 0.06	0.45-0.80 0.58 17.24 0.07
Trunk cross sectional area (cm^2)	Range Mean CV SE	2.80-4.54 3.66 15.57 0.39	2.72-4.59 3.57 21.29 0.53	3.61-4.68 4.23 8.75 0.26	3.07-4.34 3.58 12.57 0.31	2.87-4.59 3.83 15.40 0.41	3.59-4.46 4.06 8.13 0.23
Internodal length (cm)	Range Mean CV SE	1.66-3.15 2.36 24.15 0.39	1.81-2.34 2.11 8.53 0.12	2.04-2.65 2.37 8.43 0.14	1.81-2.67 2.26 12.39 0.19	1.76-2.82 2.33 13.30 0.21	1.74-3.02 2.33 19.31 0.31
Number of shoots	Range Mean CV SE	3-5 4.25 20.94 0.62	3-6 4.88 31.56 1.07	3-9 6.13 29.53 1.25	5-7 6.13 13.54 0.57	5-9 7.13 17.53 0.87	3-5 4.25 20.94 0.62
Leaf area (cm^2)	Range Mean CV SE	19.11- 26.12 22.65 11.70 1.84	18.80- 25.50 22.90 16.16 2.56	19.27- 28.55 32.39 13.21 2.14	18.96- 29.73 23.40 16.56 2.68	20.51- 26.79 24.46 9.89 1.68	18.30- 29.55 25.01 16.03 2.78
Stomatal density	Range Mean CV SE	17-22 19.13 10.61 1.41	15-23 19.25 13.81 1.84	15-23 19.25 17.52 2.33	14-25 20.13 17.09 2.38	15-25 20.13 16.44 2.29	15-25 19.75 14.78 2.02
Stomatal length (µm)	Range Mean CV SE	21.60- 25.20 22.95 8.10 1.29	21.60- 25.20 22.95 8.10 1.29	21.60- 25.20 22.95 8.10 1.29	21.60- 25.20 23.85 7.80 1.29	21.60- 28.80 23.85 11.24 1.86	21.60- 28.50 24.75 12.12 2.08
Stomatal breadth (µm)	Range Mean CV SE	7.20-10.80 9.00 21.33 1.33	7.20-10.80 9.45 19.68 1.29	7.20- 14.40 10.35 2.75 2.08	7.20- 10.80 8.55 21.75 1.29	7.20-10.80 8.55 21.75 1.29	7.20- 10.80 8.55 21.75 1.29
Chlorophyll content (mg/g)	Range Mean CV SE	1.65-1.96 1.80 5.56 0.07	1.64-2.06 1.83 8.74 0.11	1.58-1.92 1.73 5.78 0.07	1.58-2.12 1.81 10.50 0.13	1.60-2.12 1.84 9.78 0.12	1.52-2.08 8.55 21.75 1.29
Proline content (µg/gm)	Range Mean CV SE	1407-1615 1524.63 5.40 57.05	1189-1400 1317.36 5.40 57.03	1007- 1575 1276 14.40 127.29	948-1260 1120.88 8.82 68.47	900-1045 991.38 6.06 41.60	503-936 710.50 23.69 116.59

Table 3. Variation in growth parameters and proline content of wild apricot seedlings

Parameters		**Treatment**					
		T1	T2	T3	T4	T5	T6
Plant height (m)	Range Mean CV SE	0.79-0.94 0.87 5.75 0.03	0.80-1.04 0.92 8.70 0.06	0.96-1.03 0.99 3.03 0.02	1.00-1.35 1.12 10.71 0.08	1.16-1.32 1.23 4.07 0.03	1.22-1.47 1.37 5.84 0.08
Plant spread (m)	Range Mean CV SE	0.42-0.59 0.51 13.73 0.05	0.25-0.35 0.29 13.79 0.03	0.28-0.36 0.32 15.00 0.02	0.31-0.42 0.36 11.11 0.03	0.38-0.52 0.44 11.36 0.03	0.42-0.59 0.51 13.73 0.05
Trunk cross sectional area (cm^2)	Range Mean CV SE	1.96-2.99 2.20 15.00 0.23	2.09-2.99 2.59 13.51 0.24	2.14-3.06 2,61 12.64 0.23	1.99-3.66 2.64 21.97 0.40	2.14-3.14 2.71 14.39 0.27	2.65-3.08 2.85 5.96 0.12
Internodal length (cm)	Range Mean CV SE	0.96-1.31 1.07 11.21 0.08	0.88-1.54 1.18 20.34 0.82	1.08-1.39 1.25 9.60 0.08	0.98-1.56 1.28 20.31 0.18	1.06-1.59 1.38 12.32 0.12	1.06-1.66 1.49 12.75 0.14
Number of shoots	Range Mean CV SE	4-8 5.88 24.83 1.01	5.00-9.00 6.13 25.29 1.07	6.00-9.00 7.75 13.42 0.72	7.00-9.00 8.13 10.21 0.57	7.00-9.00 8.13 10.21 0.57	8.00-9.00 8.50 6.24 0.37
Leaf area (cm^2)	Range Mean CV SE	14.48- 22.92 16.89 15.69 1.84	14.69- 24.40 20.28 16.91 2.38	15.22- 25.70 20.30 18.47 2.60	15.33- 24.30 20.92 16.59 2.40	16.08- 25.05 21.30 14.98 2.21	14.04- 25.69 21.44 19.12 2.84
Stomatal density	Range Mean CV SE	11-26 16.50 34.61 3.95	13.00- 25.00 20.63 16.91 2.38	16.00- 25.00 22.63 15.82 2.48	13-30 23.00 24.48 3.90	15.00- 31.00 24.50 22.04 3.74	21-28 24.88 7.88 1.36
Stomatal length (µm)	Range Mean CV SE	18.00- 23.40 20.03 8.89 1.23	18.00- 21.60 20.48 6.54 0.93	18.00- 23.40 20.70 8.07 1.16	18.00- 23.40 20.70 51.11 7.33	19.80- 25.20 21.83 8.15 1.23	18.00- 23.40 20.70 9.28 1.33
Stomatal breadth (µm)	Range Mean CV SE	9.00-10.80 10.35 8.02 0.57	9.00-12.60 10.58 10.87 0.80	9.00- 12.60 10.58 10.87 0.80	9.00- 12.60 10.58 14.18 1.04	9.00-12.60 10.58 10.87 0.80	9.00- 12.60 10.58 16.82 1.23
Chlorophyll content (mg/g)	Range Mean CV SE	1.42-1.92 1.68 10.71 0.12	1.45-2.00 1.72 12.21 0.15	1.60-1.91 1.77 5.65 0.76	1.58-2.01 1.78 8.43 0.10	1.58-2.02 1.80 8.89 0.11	1.75-1.04 1.85 5.41 0.07
Proline content (µg/gm)	Range Mean CV SE	2071-2382 2267 3.96 72.53	2005-2188 2095.75 3.30 47.93	1771- 1856 1810.88 1.53 19.14	1242- 1475 1357.63 5.37 50.48	990-1172 1082.75 5.58 41.85	850-956 899.13 3.96 24.68

Table 4. Rooting performance (in stooling) of promising seedlings grown under different irrigation regimes

Hybrid peach				**Wild peach**				**Wild apricot**			
Seedling	Rooting (%)	No. of roots	Root length (cm)	Seedling	Rooting (%)	No. of roots	Root length (cm)	Seedling	Rooting (%)	No. of roots	Root length (cm)
S-12	0.00	-	-	S-15	25.00	3	10.00	S-27	0.00	-	-
S-26	33.33	2	10.00	S-23	33.33	2	12.50	S-28	0.00	-	-
S-27	25.00	3	7.50	S-27	0.00	-	-	S-44	25.00	2	15.00
S-42	66.67	2	10.00	S-28	0.00	-	-	S-47	33.33	1	12.50
S-45	0.00	-	-	S-43	50.00	3	10.00	S-48	0.00	-	-
S-48	33.33	4	10.00	S-46	33.33	2	7.50	S-51	25.00	2	10.00
S-51	25.00	3	10.00	S-47	50.00	4	7.50	S-53	0.00	-	-
S-52	25.00	3	7.50	S-53	25.00	3	10.00	S-55	0.00	-	-
S-57	0.00	-	-	S-54	0.00	-	-				
				S-56	0.00	-	-				