Himachal Journal of Agricultural Research 35 (2):188-194, 2009

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

Nirmal Sharma and S. D. Sharma
Department of Fruit Breeding and Genetic Resources
Dr Y. S. Parmar University of Horticulture and Forestry, Nauni, Solan-176 062, India.

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.

Key words: Stone fruit rootstock, seedling rootstock, drought tolerance, rootstock selection, clonal 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.), Uttranchal 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°C) during May-June and winters are cold (2.4 to 3.7°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 draught 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/ha, 5.7 tonnes/ha and 4.17 tonnes/ha, 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 heterogeneous 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.

Material and Methods

The experimental site falls under sub-temperate climatic region where the summer are moderately hot (31.8 to 34.8°C) during May-June and winters are cold (2.4 to 3.7°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°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:

$$\text{Depth of water to be applied (X cm say)} = \frac{\text{Deficit in moisture} \times \text{Depth of soil to be irrigated} \times \text{Bulk density of the soil}}{10}$$

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 (g), 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:

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

* molecular weight of proline.

Results and Discussion

Variations in growth parameters and proline content: The data given in Table 1 reveals that among the hybrid peach seedlings 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, 2.49-4.68cm^2, 1.34-3.02cm, 3-9, 503-822, 17.88-29.73cm^2, 15-25, 21.60-28.80µm, 7.20-14.40µm, 1.50-1.98mg/g and 503.00-1615µg/g, respectively. 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, 0.29-0.80m, 2.72-4.68cm^2, 1.66-3.02cm, 3-9, 409-822, 18.30-29.73cm^2, 14-25, 21.60-28.80µm, 7.20-14.80µm, 1.52-2.12mg/g and 503.00-1615µg/g respectively (Table 2). 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 (Table 3) varied between 0.79-1.47 m, 0.25-0.59 m, 1.96-3.66 cm^2, 0.88-1.66 cm, 4-9, 452-845, 14.04-25.70 cm^2, 11-31, 18.00-25.20 µm, 9.00-12.60 µm, 1.42-2.04mg/ g and 850.00 -2382.00 µm/ g respectively. 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. 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. Mishra (1997) recorded 2.70 – 3.45 mg/gm and 1.86 – 4.74 mg/g 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.

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	0.76-1.39	0.81-1.35	0.76-1.34	0.81-1.39	1.01-1.51	0.81-1.64
	Mean	1.06	1.08	1.12	1.18	1.19	1.28
	CV	23.58	13.89	17.86	27.97	15.97	20.31
	SE	0.17	0.10	0.14	0.23	0.13	0.18
Plant spread (m)	Range	0.21-0.38	0.21-0.38	0.25-0.35	0.28-0.42	0.22-0.35	0.29-0.40
	Mean	0.32	0.32	0.30	0.27	0.31	0.36
	CV	15.63	15.63	13.33	29.63	16.13	11.11
	SE	0.03	0.03	0.03	0.06	0.03	0.03
Trunk cross sectional area (cm^2)	Range	2.80-4.19	3.61-4.53	3.20-4.54	2.49-4.24	3.72-4.59	3.59-4.68
	Mean	3.33	4.11	3.96	3.24	4.04	4.20
	CV	12.61	7.79	12.12	20.06	8.17	9.76
	SE	0.29	0.22	0.33	0.45	0.23	0.28
Internodal length (cm)	Range	1.64-2.77	1.81-3.02	1.92-2.97	1.34-2.24	1.74-2.75	2.07-3.02
	Mean	2.16	2.38	2.26	1.93	2.17	2.46
	CV	21.76	20.59	15.93	16.06	15.60	13.41
	SE	0.33	0.34	0.25	0.21	0.24	0.23
Number of shoots per seedlings	Range	4-6	3-7	3-6	3-6	4-7	5-9
	Mean	4.90	5.22	4.88	3.88	5.38	7.13
	CV	22.86	23.95	20.29	25.52	17.10	19.53
	SE	0.78	0.87	0.69	0.69	0.64	0.87
No. of leaves per seedlings	Range	503-618	572-798	460-725	409-822	488-746	636-774
	Mean	545.75	696.38	553.38	543.64	634.88	701.88
	CV	7.57	10.95	17.46	29.67	14.12	6.78
	SE	28.60	52.81	66.93	111.69	62.10	32.95
Leaf area (cm^2)	Range	17.88-	18.80-	19.27-	19.11-	18.96-	18.30-29.55
	Mean	25.20	25.56	28.55	26.12	29.73	25.00
	CV	22.95	4.11	23.39	22.65	23.47	16.04
	SE	8.10	7.79	13.21	11.70	16.49	2.78
		1.29	0.22	2.14	1.84	2.68	
Stomatal density	Range	15.00-	17.00-	14.00-	14.00-	15.00-	18.00-23.00
	Mean	25.00	24.00	25.00	23.00	24.00	20.75
	CV	18.88	20.00	19.38	18.63	19.50	9.54
	SE	17.80	11.00	17.23	16.21	17.54	1.37
		2.33	1.52	2.31	2.09	2.37	
Stomatal length (µm)	Range	21.60-	21.60-	21.60-	21.60-	21.60-	21.60-28.80
	Mean	25.20	28.80	28.80	25.20	25.20	25.20
	CV	22.95	24.30	23.40	22.50	23.85	10.79
	SE	8.10	10.49	11.62	7.42	7.80	1.88
		1.29	1.77	1.88	1.16	1.29	
Stomatal breadth (µm)	Range	7.20-10.80	7.20-10.80	7.20-14.40	7.20-14.40	7.20-10.80	7.20-10.80
	Mean	8.55	9.45	12.15	12.15	9.45	9.90
	CV	21.75	19.68	15.31	15.31	19.45	16.87
	SE	1.29	1.29	1.29	1.29	1.29	1.88
Chlorophyll content (mg/g)	Range	1.50-2.00	1.56-1.98	1.52-1.95	1.54-1.98	1.51-1.92	1.65-1.92
	Mean	1.74	1.77	1.75	1.75	1.76	1.79
	CV	9.77	7.34	8.75	16.37	7.95	5.03
	SE	0.12	1.09	0.10	0.10	0.10	0.06
Proline content (µg/g)	Range	1407-1615	1189-1421	1007-1575	948-1260	899-1155	503-936
	Mean	1524.63	1320.63	1276.00	1120.88	1001.75	716.59
	CV	5.40	6.58	14.40	8.82	8.26	23.69
	SE	57.03	60.23	127.29	68.47	57.31	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	0.81-1.26	0.55-1.31	0.73-1.31	0.88-1.39	0.96-1.34	0.91-1.34
	Mean	1.04	1.04	1.05	1.06	1.13	1.14
	CV	16.35	25.96	17.14	17.92	13.27	13.16
	SE	0.12	0.19	0.12	0.13	0.10	0.10
Plant spread (m)	Range	0.30-0.61	0.29-0.61	0.35-0.57	0.42-0.60	0.43-0.65	0.45-0.80
	Mean	0.41	0.43	0.45	0.51	0.53	0.58
	CV	24.39	30.23	15.56	13.73	15.09	17.24
	SE	0.07	0.09	0.05	0.05	0.06	0.07
Trunk cross sectional area (cm^2)	Range	2.80-4.54	2.72-4.59	3.61-4.68	3.07-4.34	2.87-4.59	3.59-4.46
	Mean	3.66	3.57	4.23	3.58	3.83	4.06
	CV	15.57	21.29	8.75	12.57	15.40	8.13
	SE	0.39	0.53	0.26	0.31	0.41	0.23
Internodal length (cm)	Range	1.66-3.15	1.81-2.34	2.04-2.65	1.81-2.67	1.76-2.82	1.74-3.02
	Mean	2.36	2.11	2.37	2.26	2.33	2.33
	CV	24.15	8.53	8.43	12.39	13.30	19.31
	SE	0.39	0.12	0.14	0.19	0.21	0.31
Number of shoots per seedlings	Range	3-5	3-6	3-9	5-7	5-9	3-5
	Mean	4.25	4.88	6.13	6.13	7.13	4.25
	CV	20.94	31.56	29.53	13.54	17.53	20.94
	SE	0.62	1.07	1.25	0.57	0.87	0.62
No. of leaves per seedlings	Range	475-672	460-725	436-768	409-822	488-746	636-774
	Mean	550.75	544.38	604.25	635.75	643.25	693.50
	CV	11.84	15.15	21.67	26.06	14.96	6.70
	SE	45.16	57.14	90.69	114.73	66.67	32.19
Leaf area (cm^2)	Range	19.11-	18.80-	19.27-	18.96-	20.51-	18.30-29.55
	Mean	26.12	25.50	28.55	29.73	26.79	25.01
	CV	22.65	22.90	32.39	23.40	24.46	16.03
	SE	11.70	16.16	13.21	16.56	9.89	2.78
		1.84	2.56	2.14	2.68	1.68	
Stomatal density	Range	17-22	15-23	15-23	14-25	15-25	15-25
	Mean	19.13	19.25	19.25	20.13	20.13	19.75
	CV	10.61	13.81	17.52	17.09	16.44	14.78
	SE	1.41	1.84	2.33	2.38	2.29	2.02
Stomatal length (µm)	Range	21.60-	21.60-	21.60-	21.60-	21.60-	21.60-28.50
	Mean	25.20	25.20	25.20	25.20	28.80	24.75
	CV	22.95	22.95	22.95	23.85	23.85	12.12
	SE	8.10	8.10	8.10	7.80	11.24	2.08
		1.29	1.29	1.29	1.29	1.86	
Stomatal breadth (µm)	Range	7.20-10.80	7.20-10.80	7.20-14.40	7.20-10.80	7.20-10.80	7.20-10.80
	Mean	9.00	9.45	10.35	8.55	8.55	8.55
	CV	21.33	19.68	2.75	21.75	21.75	21.75
	SE	1.33	1.29	2.08	1.29	1.29	1.29
Chlorophyll content (mg/g)	Range	1.65-1.96	1.64-2.06	1.58-1.92	1.58-2.12	1.60-2.12	1.52-2.08
	Mean	1.80	1.83	1.73	1.81	1.84	8.55
	CV	5.56	8.74	5.78	10.50	9.78	21.75
	SE	0.07	0.11	0.07	0.13	0.12	1.29
Proline content (µg/g)	Range	1407-1615	1189-1400	1007-1575	948-1260	900-1045	503-936
	Mean	1524.63	1317.36	1276	1120.88	991.38	710.50
	CV	5.40	5.40	14.40	8.82	6.06	23.69
	SE	57.05	57.03	127.29	68.47	41.60	116.59

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). 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 vigour as compared to those under higher moisture levels, but some seedlings showed promise with respect to growth characters and draught tolerance under low soil moisture. On the basis of growth, vigour 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.

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	0.79-0.94	0.80-1.04	0.96-1.03	1.00-1.35	1.16-1.32	1.22-1.47
	Mean	0.87	0.92	0.99	1.12	1.23	1.37
	CV	5.75	8.70	3.03	10.71	4.07	5.84
	SE	0.03	0.06	0.02	0.08	0.03	0.08
Plant spread (m)	Range	0.42-0.59	0.25-0.35	0.28-0.36	0.31-0.42	0.38-0.52	0.42-0.59
	Mean	0.51	0.29	0.32	0.36	0.44	0.51
	CV	13.73	13.79	15.00	11.11	11.36	13.73
	SE	0.05	0.03	0.02	0.03	0.03	0.05
Trunk cross sectional area (cm^2)	Range	1.96-2.99	2.09-2.99	2.14-3.06	1.99-3.66	2.14-3.14	2.65-3.08
	Mean	2.20	2.59	2,61	2.64	2.71	2.85
	CV	15.00	13.51	12.64	21.97	14.39	5.96
	SE	0.23	0.24	0.23	0.40	0.27	0.12
Internodal length (cm)	Range	0.96-1.31	0.88-1.54	1.08-1.39	0.98-1.56	1.06-1.59	1.06-1.66
	Mean	1.07	1.18	1.25	1.28	1.38	1.49
	CV	11.21	20.34	9.60	20.31	12.32	12.75
	SE	0.08	0.82	0.08	0.18	0.12	0.14
Number of shoots per seedlings	Range	4-8	5-9	6-9	7-9	7-9	8-9
	Mean	5.88	6.13	7.75	8.13	8.13	8.50
	CV	24.83	25.29	13.42	10.21	10.21	6.24
	SE	1.01	1.07	0.72	0.57	0.57	0.37
No. of leaves per seedlings	Range	452-648	505-725	452-648	505-725	560-845	560-845
	Mean	576.25	586.63	590.25	587.13	665.63	665.63
	CV	12.86	15.51	11.83	15.85	13.67	13.67
	SE	51.33	63.01	48.37	64.46	63.00	63.00
Leaf area (cm^2)	Range	14.48-22.92	14.69-24.40	15.22-25.70	15.33-24.30	16.08-25.05	14.04-25.69
	Mean	16.89	20.28	20.30	20.92	21.30	21.44
	CV	15.69	16.91	18.47	16.59	14.98	19.12
	SE	1.84	2.38	2.60	2.40	2.21	2.84
Stomatal density	Range	11-26	13-25	16-25	13-30	15-31	21-28
	Mean	16.50	20.63	22.63	23.00	24.50	24.88
	CV	34.61	16.91	15.82	24.48	22.04	7.88
	SE	3.95	2.38	2.48	3.90	3.74	1.36
Stomatal length (µm)	Range	18.00-23.40	18.00-21.60	18.00-23.40	18.00-23.40	19.80-25.20	18.00-23.40
	Mean	20.03	20.48	20.70	20.70	21.83	20.70
	CV	8.89	6.54	8.07	51.11	8.15	9.28
	SE	1.23	0.93	1.16	7.33	1.23	1.33
Stomatal breadth (µm)	Range	9.00-10.80	9.00-12.60	9.00-12.60	9.00-12.60	9.00-12.60	9.00-12.60
	Mean	10.35	10.58	10.58	10.58	10.58	10.58
	CV	8.02	10.87	10.87	14.18	10.87	16.82
	SE	0.57	0.80	0.80	1.04	0.80	1.23
Chlorophyll content (mg/g)	Range	1.42-1.92	1.45-2.00	1.60-1.91	1.58-2.01	1.58-2.02	1.75-2.04
	Mean	1.68	1.72	1.77	1.78	1.80	1.85
	CV	10.71	12.21	5.65	8.43	8.89	5.41
	SE	0.12	0.15	0.76	0.10	0.11	0.07
Proline content (µg/g)	Range	2071-2382	2005-2188	1771-1856	1242-1475	990-1172	850-956
	Mean	2267	2095.75	1810.88	1357.63	1082.75	899.13
	CV	3.96	3.30	1.53	5.37	5.58	3.96
	SE	72.53	47.93	19.14	50.48	41.85	24.68

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 and are presented in table 4. 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. Per cent 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 no 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 irrigation regimes, 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.

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

Hybrid peach				Wild peach				Wild apricot			
Seedling no.	Per cent rooting (%)	No. of roots	Average root length	Seedling no.	Per cent rooting (%)	No. of roots	Average root length	Seedling no.	Per cent rooting (%)	No. of roots	Average root length
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	-	-				

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.

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 vigour as compared to those under higher moisture levels, but some seedlings showed promise with respect to growth characters and draught tolerance under low soil moisture. On the basis of growth, vigour 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.

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	0.79-0.94	0.80-1.04	0.96-1.03	1.00-1.35	1.16-1.32	1.22-1.47
	Mean	0.87	0.92	0.99	1.12	1.23	1.37
	CV	5.75	8.70	3.03	10.71	4.07	5.84
	SE	0.03	0.06	0.02	0.08	0.03	0.08
Plant spread (m)	Range	0.42-0.59	0.25-0.35	0.28-0.36	0.31-0.42	0.38-0.52	0.42-0.59
	Mean	0.51	0.29	0.32	0.36	0.44	0.51
	CV	13.73	13.79	15.00	11.11	11.36	13.73
	SE	0.05	0.03	0.02	0.03	0.03	0.05
Trunk cross sectional area (cm^2)	Range	1.96-2.99	2.09-2.99	2.14-3.06	1.99-3.66	2.14-3.14	2.65-3.08
	Mean	2.20	2.59	2,61	2.64	2.71	2.85
	CV	15.00	13.51	12.64	21.97	14.39	5.96
	SE	0.23	0.24	0.23	0.40	0.27	0.12
Internodal length (cm)	Range	0.96-1.31	0.88-1.54	1.08-1.39	0.98-1.56	1.06-1.59	1.06-1.66
	Mean	1.07	1.18	1.25	1.28	1.38	1.49
	CV	11.21	20.34	9.60	20.31	12.32	12.75
	SE	0.08	0.82	0.08	0.18	0.12	0.14
Number of shoots per seedlings	Range	4-8	5-9	6-9	7-9	7-9	8-9
	Mean	5.88	6.13	7.75	8.13	8.13	8.50
	CV	24.83	25.29	13.42	10.21	10.21	6.24
	SE	1.01	1.07	0.72	0.57	0.57	0.37
No. of leaves per seedlings	Range	452-648	505-725	452-648	505-725	560-845	560-845
	Mean	576.25	586.63	590.25	587.13	665.63	665.63
	CV	12.86	15.51	11.83	15.85	13.67	13.67
	SE	51.33	63.01	48.37	64.46	63.00	63.00
Leaf area (cm^2)	Range	14.48-22.92	14.69-24.40	15.22-25.70	15.33-24.30	16.08-25.05	14.04-25.69
	Mean	16.89	20.28	20.30	20.92	21.30	21.44
	CV	15.69	16.91	18.47	16.59	14.98	19.12
	SE	1.84	2.38	2.60	2.40	2.21	2.84
Stomatal density	Range	11-26	13-25	16-25	13-30	15-31	21-28
	Mean	16.50	20.63	22.63	23.00	24.50	24.88
	CV	34.61	16.91	15.82	24.48	22.04	7.88
	SE	3.95	2.38	2.48	3.90	3.74	1.36
Stomatal length (µm)	Range	18.00-23.40	18.00-21.60	18.00-23.40	18.00-23.40	19.80-25.20	18.00-23.40
	Mean	20.03	20.48	20.70	20.70	21.83	20.70
	CV	8.89	6.54	8.07	51.11	8.15	9.28
	SE	1.23	0.93	1.16	7.33	1.23	1.33
Stomatal breadth (µm)	Range	9.00-10.80	9.00-12.60	9.00-12.60	9.00-12.60	9.00-12.60	9.00-12.60
	Mean	10.35	10.58	10.58	10.58	10.58	10.58
	CV	8.02	10.87	10.87	14.18	10.87	16.82
	SE	0.57	0.80	0.80	1.04	0.80	1.23
Chlorophyll content (mg/g)	Range	1.42-1.92	1.45-2.00	1.60-1.91	1.58-2.01	1.58-2.02	1.75-2.04
	Mean	1.68	1.72	1.77	1.78	1.80	1.85
	CV	10.71	12.21	5.65	8.43	8.89	5.41
	SE	0.12	0.15	0.76	0.10	0.11	0.07
Proline content (µg/g)	Range	2071-2382	2005-2188	1771-1856	1242-1475	990-1172	850-956
	Mean	2267	2095.75	1810.88	1357.63	1082.75	899.13
	CV	3.96	3.30	1.53	5.37	5.58	3.96
	SE	72.53	47.93	19.14	50.48	41.85	24.68

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 and are presented in table 4. 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. Per cent 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 no 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 irrigation regimes, 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.

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

Hybrid peach				Wild peach				Wild apricot			
Seedling no.	Per cent rooting (%)	No. of roots	Average root length	Seedling no.	Per cent rooting (%)	No. of roots	Average root length	Seedling no.	Per cent rooting (%)	No. of roots	Average root length
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	-	-				

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.

References

Beakbane AB and Majumdar PK 1975. A relationship between stomatal density and growth potential in apple rootstocks. J. Hortic. Sci. **50**:285-90.

Dwivedi MP 1973. Studies on the rooting propensity and bud take in some clonal rootstocks of plum. M Sc Thesis, Himachal Pradesh Krishi Vishvavidyalaya, College of Agriculture, Solan (unpublished).

Giulivo C, Ponchia G, Gianola A and Pitacco A 1985. Effect of rootstock on water balance of Golden delicious apple. Acta Horticulturae **171**: 463-67.

Guirguis NS. and Khalil MA 1995. Leaf stomata and stem lenticels as a means of identification of some stone fruit rootstocks. Acta Horticulturae **409**:229-33.

Hiscex JD and Isralistan JF 1979. A method for the extraction of chlorophyll from leaf tissue without maceration. Canadian J. Biol. **57**:332-34.

Jha A 1996. Studies on the effect of low and high density planting under different training systems in peach. M Sc Thesis, Dr Y S Parmar University of Horticulture and Forestry, Nauni, Solan (unpublished).

Kaundal GS and Bindra AS 1987. Variability studies stromatal counts and growth potential in pea and almond rootstocks. J. Res., Punj Agricultural University **24** (4):601-06.

Mishra AK 1997. Performance of peach cv. Ju Elberta under various planting systems of hi density plantation. M Sc Thesis, Dr Y S Parm University of Horticulture and Forestry, Nau Solan (unpublished).

Mishra KA, Sud G and Arora IK 1980. Vegetati propagation of indigenous peach rootstocl Indian J. Horti. **41**(1-2):85-87.

Uma D 2000. Evaluation of different amino aci related to abiotic stress. In: *Breeding for abio stresses in crop plants*. Khan AKF, Kumar and Vanniarajan C (eds). pp 21-22.

Unal A, Gulcan R and Misirli A 1994. A study seedling rootstock properties of some Almo cultigens. Acta Horticulturae **373**:105-10.

Yadav N 1988. Studies on propagation of peach cottage. Ph D Thesis, Dr Y S Parmar Univers of Horticulture and Forestry Nauni, Sol (unpublished).

VIR SOFTECH