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Research Article

STUDIES ON SHOOT PHYSIOLOGY AND ROOT MORPHOLOGY OF LOCAL PEACH AND PLUM GENOTYPES

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Abstract: Study on variation in shoot physiology and root morphology in local peach (RC Peach-1; RC Peach-2 and RC Peach-3) and plum (RC Plum-1 and RC Plum-2) genotypes were conducted during season 2018-19 and 2019-20 at Horticultural Experimental Farm, ICAR Research Complex for NEH Region, Umiam, Meghalaya. Among the genotypes, highest germination per cent and seedling survival was recorded in RC Peach-1 (84.0 per cent and 81.08 per cent) while lowest in Flordaguard (72.67 per cent and 69.86 per cent). The maximum seedling height and diameter was recorded in RC Peach-1 (90.33 cm and 6.00 mm) while minimum seedling height and diameter were recorded in RC Plum-2 (60.67 cm and 4.01 mm). Similarly, RC Peach-1 recorded highest leaf area (14.17 cm^2); specific leaf weight (6.10 mg/cm^2) and relative water content (87.41 per cent). While, lowest leaf area and relative water content was noticed in RC Plum-2 (6.83 cm^2 and 72.22 per cent) and specific leaf weight in RC Peach-2 (3.87 mg/cm^2). RC Peach-1 had highest total root length (222.20 cm) and root surface area 180.0 cm^2), while lowest total root length was observed in RC peach-2 (120.0 cm) and root surface area in RC Plum-1 (102.43 cm^2). Root diameter was recorded highest in RC Peach-1 (2.84 mm), while lowest in Flordaguard (2.00 mm). Considering the seedling survival, shoot physiology and root morphological traits our results pointed out the better performance of RC Peach-1 over other local peach and plum genotypes.

Keywords: *Peach, Plum, Genotypes, Variability, Scion physiology, Root morphology*

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Introduction

Peaches and plum are acclimatized well at humid tropics of NE India and presently growing on 2.80-thousand-hectare area with the production of 9.91 thousand tonnes [1]. Despite of suitable agro-ecology peaches and plum has low productivity (3.54 t/ha) in the region compared with national average (6.42 t/ha). Might be due to short productive tree life, absence of suitable genotype as a rootstock or variety and differential response to biotic and abiotic stresses [2]. Local germplasm as cultivars or rootstocks have proved to improve growth, yield and quality attributes [3,4] and also response well to adverse growing conditions and act as source of several desirable traits to combat biotic and abiotic stresses [5]. Thus peach, apricot, behmi and plum seedlings were used as rootstocks in India with varied success and compatibility with different varieties [6].

Thus, information on functional equilibrium between shoot leaves and roots are essential to know assimilates partitioning and movement of water and nutrients [7] among diverse genotypes. In addition, understanding on root morphology using imaging technologies [8] is pertinent to differentiate genotypes on the basis of rooting behaviour, which has practical implications for nutrient and water management. Thus, screening genotypes on the basis shoot physiology and root morphology is useful tool to identify the promising genotypes at early stage when still growing in nursery. Considering above, the current experiment was attempted to differentiate the peach and plum genotypes on the basis of scion physiology and root morphology.

Materials and methods

Experiment was conducted at Horticultural Experimental Farm, ICAR Research Complex for NEH Region, Umiam, Meghalaya during 2018-19 and 2019-20. Experimental site is situated at an elevation of 910 meters and lies between 25°40' to 25°21 N altitude and 90°55'15 to 91°55'16 E longitude.

On the basis of pomological traits, three promising local peach (*Prunus persica* L.) Batsch) and two plum (*Prunus salicina* Lindl.) genotypes identified from the north eastern region of India [9] were used to study shoot and root morphology. The experiment was laid out in randomized block design comprising of six treatments *viz*., T_1 (RC Plum-1), T_2 (RC Plum-2), T_3 (RC Peach-1), T_4 (RC Peach-2), T_5 (RC Peach-3) and T6 (Flordaguard) during season 2018-19 and 2019-20. The experiment was conducted inside the polyhouse and treatments were replicated thrice with fifty seeds in each replication. The mean average minimum and maximum temperature inside polyhouse during experimental period were also recorded to be 11.8°C & 35.2°C.

Days to sprouting (days), seed germination (%) were recorded and seedling survival (%) was recorded after 120 days, morphological traits *viz*., seedling height (m), seedling diameter (mm) and number of leaves per plant were measured. Physiological traits *viz*., leaf fresh weight (g), dry weight (g), area (cm^2) and specific weight (mg/cm^2) were recorded as per standard protocols. The relative water content (RWC) of fresh leaves was measured using the formula:

RWC= (FW-DW/TW-DW)*100

Where, FW= Fresh weight which was measured with the help of electronic balance; DW= Dry weight which was measured by drying turgid weighted leaves in oven at 60°C for 24 hr. and

TW=Turgid weight of leaves, which was measured with the help of electronic balance by dipping leaves selected for fresh weight in distilled water for 24 hr.

Fresh root systems were removed carefully after 120 days and washed in tap water placed and spread on the Regent's water-proof fabric trays to study root morphology. Image of root system was acquired using an extra optimized Epson perfection V-700 Photo scanner at 200 dots per inch (dpi) and analysed with the WinRHIZO professional software (Regent Instruments Inc., Quebec, QC, Canada)

Table-1 *days to sprouting (days); germination (%); seedling survival (%) and morphological traits of peach and plum genotypes*

Genotypes	Days to sprouting (days)	Germination (%)	Seedling survival (%)	Seedling height (cm)	Seedling diameter (mm)	Leaves/ Seedling (nos.)
T1 (RC Plum-1)(IC-0632362)	35.00	73.33 (59.07)*	76.71 (61.38)*	74.67	4.30	120.33
T2 (RC Plum-2)(IC-0632363)	33.33	76.67 (61.18)*	78.43 (62.56)*	60.67	4.01	109.33
T3 (RC Peach-1)(IC-0632364)	32.00	84.00 (66.63)*	81.08 (64.30)*	90.33	6.00	268.33
T4 (RC Peach-2)(IC-0632365)	40.67	74.67 (59.81)*	76.77 (61.25)*	84.67	5.38	214.00
T5 (RC Peach-3)(IC-0632366)	32.67	79.33 (63.03)*	79.02 (62.82)*	89.00	5.87	280.67
T6 (Flordaguard)	34.33	72.67 (58.53)*	69.86 (56.80)*	89.00	5.14	139.67
SEM (±)	1.49	1.20	1.77	1.03	0.12	5.38
CD (*P=0.05%*)	4.51	3.63	3.55	3.11	0.36	16.31

**Figure in parentheses indicate Arcsine transform value*

Table-2 Shoot physiology of local peach and plum genotypes

Genotypes	Leaf fresh weight (g)	Leaf dry weight (g)	Leaf area (cm^2)	Specific leaf weight (mg/cm^2)	Relative water content (%)
T1 (RC Plum-1)	0.14	0.03	7.50	4.43	81.97
T2 (RC Plum-2)	0.13	0.03	6.83	5.06	72.22
T3 (RC Peach-1)	0.27	0.09	14.17	6.10	87.41
T4 (RC Peach-2)	0.23	0.05	13.07	3.87	78.45
T5 (RC Peach-3)	0.24	0.06	10.63	5.94	82.35
T6 (Flordaguard)	0.18	0.05	11.17	4.61	81.08
SEM (±)	0.01	0.01	0.69	0.35	1.92
CD (*P=0.05%*)	0.03	0.02	2.10	1.07	5.71

Table-3 *Root morphology of local peach and plum genotypes*

Genotypes	Total root length (cm)	Root SA (cm^2)	Root Vol. (cm^3)	Avg. root diameter (mm)	Root: Shoot ratio
T1 (RC Plum-1)	150.42	102.43	5.71	2.14	0.33
T2 (RC Plum-2)	158.82	105.85	5.65	2.16	0.37
T3 (RC Peach-1)	222.20	180.00	8.00	2.84	0.18
T4 (RC Peach-2)	120.00	127.54	7.75	2.17	0.14
T5 (RC Peach-3)	176.59	154.00	8.18	2.43	0.14
T6 (Flordaguard)	124.87	112.00	7.22	2.00	0.16
SEM (±)	1.92	2.02	0.23	0.02	0.04
CD (*P=0.05%*)	5.83	6.12	0.70	0.06	0.12

and total root length (cm), root surface area (cm^2), root volume (cm^3) and average root diameter (mm) were recorded. Roots of eight seedlings were scanned for each treatment and average data was work out. The root to shoot ratio was also computed by using formula (root dry weight/shoot dry weight). The average data of two years were subjected to analysis of variance (ANOVA) using statistical software SPSS version 17.0 and difference were considered statistically significant at P = 0.05.

Results and discussion

Germination success and Seedling survival

Among the genotypes [Table-1] RC Peach-1 took minimum days to sprouting (32.0 days) followed by RC Peach-3 (32.67 days) and RC Plum-2 (33.33 days) while delayed sprouting was recorded in RC Peach-2 (40.67 days). The significantly (P=0.05) higher germination per cent was recorded in genotype RC Peach-1 (84.0%), while lowest germination was recorded in control *i.e.*, Flordaguard (72.67%) at par with RC Plum-1 (73.33%) and RC Peach-2 (74.67%). The variation in sprouting and germination per cent might be due to differential response of diverse genotypes [4]. While balance sugars and C: N ratio contributed to the higher percentage of germination in RC Peach-1.

The seedling survival [Table-1] was recorded at 120 days indicated that, the genotype RC Peach-1 (81.08%) had highest seedling survival followed by RC Peach-3 (79.02%) and RC Plum-2 (78.43%). However, lowest seedling survival was noticed in Flordaguard (69.86%). This may be due to genetic makeup and variation in interactions between shoot and roots which alter the assimilates partitioning and free movement of water and essential nutrients [10].

Morphological traits

The perusal of data [Table-1] showed significant (P=0.05) variations among the local peach and plum genotype for morphological traits. Highest seedling height was recorded in genotype RC Peach-1 (90.33 cm) followed by Flordaguard and RC Peach-3 (89.0 cm each) while, lowest seedling height was observed in RC Plum-2 (60.67 cm). The seedling diameter was recorded maximum in RC Peach-1 (6.00 mm) followed by RC Peach-3 (5.87 mm) while, lowest in RC Plum-2 (4.01 mm). The number of functional leaves per seedling was recorded higher in RC Peach-3 (268.33 nos.) followed by RC Peach-1 (280.67 nos.). Our results showed higher value for above traits in genotype RC Peach-1 possibly due to rapid and strong cohesion between shoot and roots [11] improving absorption of nutrients by sprouted shoots.

Shoot Physiology

The results related to the shoot physiology showed significant (P=0.05) variation among the selected peach and plum genotypes [Table-2]. Leaf fresh weight and leaf dry weight was recorded highest RC Peach-1 (0.27 g and 0.09 g). Leaf area and specific leaf weight was also recorded highest in RC Peach-1 (14.17 cm^2 and 6.10 mg/cm^2) followed by RC Peach-2 (13.07 cm^2) for leaf area and RC Peach-3 (5.94 mg/cm^2) for specific leaf weight. The lowest leaf area was recorded in RC Plum-2 (6.83 cm^2) and specific leaf weight in RC Peach-2 (3.87 mg/cm^2). Higher specific leaf weight provides higher number of layers of mesophyll cells for high rate of apparent photosynthesis during growth and development.

Similarly, improvement in apparent leaf attributes was observed with proportionate increase in specific leaf weight in soybean [12]. While reduced values of leaf growth parameters in other genotypes may be due to metabolic inhibition and genetic difference [13]. The relative water content was recorded highest in RC Peach-1 (87.41 %) followed by RC Peach-3 (82.35%) and RC Plum-1 (81.97%), while lowest in RC Plum-2 (72.22%). Water retention has direct relation with overall health and biomass accumulation in plants. Higher relative water content in leaves was observed in genotype RC Peach-1 and RC Peach-3 may be attributed to higher water uptake and retention which is directly related to better root growth and proliferation [14, 15].

Root morphology

The results showed that total root length, root surface area, root volume, root diameter and root to shoot ratio were significantly (P=0.05) varied in different local peach and plum genotype [Table-3]. Information on root morphology help in differentiating genotypes on the basis of rooting behaviour, which has practical implications for nutrient and water management.

Table-4 *Correlation coefficient among the morpho-physiological characters*

	Seedling survival	Germination	Seedling height	Seedling diameter	Leaves/ Seedling	Leaf area	Specific leaf weight	Relative water content	Total root length	Root SA	Root Vol.	Avg. root diameter
Seedling survival (%)	1											
Germination (%)	0.79**	1.00										
Seedling height (cm)	0.14	0.28	1.00									
Seedling diameter (mm)	0.23	0.61*	0.91**	1.00								
Leaves/ Seedling (nos.)	0.52*	0.74**	0.73**	0.94**	1.00							
Leaf area (cm^2)	0.10	0.47	0.84**	0.88**	0.75**	1.00						
Specific leaf weight (mg/cm^2)	0.57*	0.87**	0.25	0.50	0.60*	0.19	1.00					
Relative water content (%)	0.17	0.49	0.80**	0.73**	0.63*	0.63*	0.46	1.00				
Total root length (cm)	0.76**	0.94**	0.17	0.43	0.56*	0.25	0.90**	0.55*	1.00			
Root SA (cm^2)	0.60*	0.91**	0.65**	0.88**	0.92**	0.75**	0.75**	0.70**	0.78**	1.00		
Root Vol. (cm^3)	0.15	0.51*	0.89**	0.98**	0.91**	0.88**	0.39	0.59*	0.27	0.80**	1.00	
Avg. root diameter (mm)	0.77**	0.97**	0.4	0.66**	0.77**	0.55*	0.80**	0.65**	0.93**	0.93**	0.54*	1

** Significant at 5% level, r value at 5% - 0.514, **Significant at 1% level, r" value at 1% - 0.6411*

In present study, total root length and root surface area was recorded highest in RC Peach-1 (222.20 cm and 180.0 cm^2), however lowest total root length was recorded in RC peach-2 (120.0 cm) and root surface area in RC Plum-1 (102.43 cm^2). The root volume was recorded maximum in RC Peach-3 (8.18 cm^3) at par with RC Peach-1 (8.00 cm^3) and RC Peach-2 (7.75 cm^3). Root diameter was recorded highest in RC Peach-1 (2.84 mm), while lowest in Flordaguard (2.00 mm). Root to shoot ratio was recorded highest in RC Plum-2 (0.37) which was at par with RC Plum-1 (0.33). The peach and plum genotypes showed significant variation for root traits and highest total root length, root surface area and root to shoot ratio and recorded highest value in RC Peach-1 might be due to synthesis of required quantities of secondary metabolites like phenolic and alkaloid compounds required for better root growth [7,10].

Correlation studies

Correlation co-efficient estimated for different pairs of characters were depicted in [Table-4]. Seedling survival had strong positive correlation with germination per cent; total root length and average root diameter. It has significant positive correlation with leaves per seedlings, specific leaf weight and root surface area with week positive relationship with seeding height and diameter, leaf area, relative water content and root volume. The correlation study revealed that selection based on seedling survival would helpful in identification superior local peach and plum genotype.

Conclusion

Considering the seedling survival, scion physiology and root morphological traits of local peach and plum genotypes, our results pointed out the better performance of RC Peach-1 genotype over others.

Application of research: Results are helpful in identification of promising local stone fruit genotypes.

Research Category: Horticultural crops

Abbreviations: m-Meter, mm-millimetre, g-Gram, cm-Centimetre

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Study area / Sample Collection: Horticultural experimental farm

Cultivar / Variety / Breed name: peach and plum genotypes

Conflict of Interest: None declared

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