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Hilling media influence on clonal propagation of apple rootstocks through layering

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ABSTRACT

The present study was carried out at Experimental Farm of Division of Fruit Science, SKUAST-Kashmir during 2016-2017 and 2017-2018. During the investigation programme, ten hilling materials were applied *viz.*, Vermiculite (T1), Saw dust(T2), FYM(T3),Vermicompost(T4), Vermiculite+ Saw dust+ *Pseudomonas* (T5), Vermicultite + Saw dust +*Azotobacter* (T6), FYM + Vermicompost + *Pseudomonas* (T7), FYM + Vermicompost+ *Azotobacter* (T8), *Pseudomonas*+ *Azotobacter*+ Soil (T9), Control(T10) (only soil was used as a hilling material). The rootstocks used during the research programme consist of M-9 T337(S1), M-27(S2), MM-106(S3), P-22(S4), MM-111(S5). The experimental results showed that maximum shoot diameter (12.22mm), fresh leaf weight (33.33g), dry leaf weight (16.23g) and relative water content(87.16 per cent) were recorded under FYM + Vermicompost+ *Azotobacter* while as maximum annual production of rooted layers (8.62) was found under saw dust as a hilling media. The minimum shoot diameter (7.12mm), fresh leaf weight (21.83g), dry leaf weight (7.50g), relative water content (70.47 per cent) and annual production of rooted layers (6.81) were recorded under control (only soil was used a hilling material). Among the various propagation techniques it was observed that propagation technique P_2 (trench layering) had a significant effect over P_1 (mound layering) with regard to shoot diameter, fresh leaf weight, dry leaf weight, relative water content and annual production of rooted layers.

Key words: *Malus* × *domestica*, biofertilizers, layering method, rooted layers, RWC.

INTRODUCTION

Jammu and Kashmir is the major apple producing state in terms of area, production and productivity in India, and occupies about 48% of the total area covered under apple (Anonymous, 1). The primary centre of origin of Malus cultivars is with in Asia Minor (Juniper *et al.*, 8). The production potential of an apple tree is distributed between the age from 15 to 30 years, thereafter, the apple yield potential generally declines and gradually shows diminishing returns. In recent years, the demand for fruit plants has increased significantly because of the introduction of the new cultivars and re-plantation of old unproductive orchards.

Rootstock is an essential component to enhance fruit quality and productivity because of their wider adaptability to diverse environmental conditions and cultural practices besides having the pest and disease resistance, tree vigour control for high density planting (HDP), better anchorage, improved nutrient uptake and better tolerance to soils and other biotic and abiotic factors(Webster and Wertheim, 16). In this regard HDP, which is only possible throughthe use of size-controlling rootstocks, can increase productivity and ensure improved efficiency (Westwood *et al.*, 17). This has stimulated interest in size-controlling clonal rootstocks. In Kashmir valley the apple trees, raised on seedling rootstocks are used on commercial scale. These seedling rootstocks are variable in their influence on the scion varieties due to their heterogeneous nature (Gjamovski and Kiprijanovski, 5) and unmanageable scion growth. Besides, the trees on seedling rootstocks have long juvenile phase which delays the commercial bearing. This is considered discreditable by the fruit growers in modern times. Poor quality, uneven packaging, marginality, fragility and low profits coupled with high production costs are forcing apple growers to improve upon efficiency and productivity (Chadha, 2). To compete with the quality and productivity of developed countries, the Department of horticulture, GoJK in collaboration with SKUAST-Kashmir has started a mission on conversion of traditional orchard system to High density orcharding (HDP) which is only possible by the use of size-controlling rootstocks of homogeneous nature and can increase productivity and ensure improved efficiency. In this regard, SKUAST-Kashmir has however introduced various clonal rootstocks from Holland which are under evaluation. In order to produce more number of clonal rootstocks from the mother stock, it is required to

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identify the best possible hilling media combined with best possible propagation method.To the agroclimatic conditions prevailing in Kashmir valley, M-9 T337, M-27, MM-106, P-22, MM-111 clonal rootstocks were found suitable and recommended for commercial use.

MATERIALS AND METHODS

The present investigation was carried out at Experimental Farm SKUAST-Kashmir, during 2016-2017 and 2017-2018. The planting material for the experiment consisted of M-9 T337 (S1), M-27(S2), MM-106(S3), P-22(S4) and MM-111(S5) rootstocks. The planting material was imported from Holland in 2016 and planted at spacing of 90cm × 45cm. At the time of conducting present experimental studies, rootstock stools were one year old. During the present investigation programme two propagation techniques *viz.,* mound layering (P1) and trench layering (P2) were adopted for the multiplication of clonal rootstocks. Ten hilling materials were applied *viz.*, Vermiculite (T1), Saw dust(T2), FYM (T3) ,Vermicompost (T4), Vermiculite+ Saw dust+ *Pseudomonas*(T5), Vermicultite + Saw dust +*Azotobacter* (T6), FYM + Vermicompost + *Pseudomonas* (T7), FYM + Vermicompost+ *Azotobacter* (T8), *Pseudomonas*+ *Azotobacter*+ Soil (T9), Control (T10) (only soil was used as a hilling material).

The one year old mother stocks were cut back to the ground level during first week of March. After 25 days emerging shoots were mounded up with hilling media. The hilling media was subsequently applied at 45 days intervals amounting to the total of 5kg per plant up to the growing season (october). These mother stools were managed routinely. During this investigation programme two propagation techniques were employed viz., mound and trench layering. The two year mean data on the shoot diameter of rooted layers (mm) was recorded at the end of the growing season when the cessation of growth had taken place. The diameter of each stool shoot was recorded with the help of 'Digital Vernier Caliper' (Mitutoyo Corporation – Digimatic Caliper) at the height of 5 cm above the ground level and the average was expressed in mm. The fresh leaf weight was recorded with the help of electronic weighing balance and average was expressed in grams (g). The dry leaf weight of shooted layers (g) were taken from same samples which were used for fresh weight after keeping it in hot air oven till they attained constant weight at 65 ^{0}C temperature. Dry leaf weight was recorded with the help of electronic weighing balance and average was expressed in grams (g). Relative water content of leaves (RWC%) was determined by using Weath Erly's method as described by Slavik (15).

The two year mean data on rooting was collected at the end of growing season (during dormancy). On separating the layers from mother stocks the number of rooted layers were counted in every stool from each replication under each treatment and added up to get average annual production of rooted layers. The data presented is pooled data of two years (2016-2017 and 2017-2018) was statistically analyzed as per standard method attained by Gomez and Gomez (6). Statistical analysis were done by using Assex Software (Statistix PC Dos Version 2.0 NH Analytical Software). The details of treatments are below.

RESULTS AND DISCUSSION

The two year data recorded on the average shoot diameter of rooted layers of different apple clonal rootstocks and as affected by different rooting media and two propagation techniques presented in Table 1 reveals that all the rooting media had a significant effect on shoot diameter. The perusal of the data shows that layers of MM-111 attained the maximum shoot diameter (10.95 mm) followed by layers of MM-106 (10.17 mm). The effect of different rooting media on the average shoot diameter was also found to be significant. The stools of different apple clonal rootstocks with FYM+Vermicompost+*Azotobacter* as hilling medium showed maximum shoot diameter (12.22 mm) followed by 10.88 mm in FYM+Vermicompost+*Pseudomonas* as hilling material and the least shoot diameter (7.12 mm) was observed in control. Interaction between different rooting media, propagation methods and rootstocks were also found to be significant. The maximum shoot diameter (14.75mm) was recorded in M-111 with FYM+Vemicompost+*Azotobacter* as hilling medium under mound layering and the least shoot diameter (5.06 mm) was recorded in M-27. However, the effect of propagation techniques on the shoot diameter was found to be non significant. This increase in shoot diameter might be due to the fact that tissues involved in diameter of stool shoot are the lateral meristems *viz*. vascular cambium and cork cambium. The vascular cambium is completely secondary in origin and originates from the tissues located just below the phloem bundles, a portion of pericycle tissue, above the protoxylem forming a complete and continuous wavy ring, which later becomes circular. It increases the girth (diameter) of the organs by the activity of the vascular cambium and the cork cambium. The formation of such type of tissues to the maximum extent may be due to all favourable conditions needed for increasing stool shoot diameter. Nutrients (both macro and micro) are required by plants for the synthesis of protoplasm and act as source of energy. The results of the present study regarding the shoot diameter are in agreement with the findings of Kumar and Gupta (9) wherein they studied the effect of vermicompost and chemical fertilizers on growth and yield of Radish (*Raphanus sativus*) and found maximum stem diameter in vermicompost. Correia *et al.* (3) found that the guava rootstocks Ogawa increased stem diameter in the vermiculite + vermicompost substrate. Danner *et al.* (4) recorded the best development of diameter of stem in 'jabuticaba' fruit tree seedlings in the substrate ½ soil + ½ vermicompost.

The two year pooled data related to fresh leaf weight of different clonal rootstocks as influenced by different rooting media and propagation techniques have been presented in Table 2. It is apparent from the data that rootstocks had a significant effect on fresh leaf weight of rooted layers. Maximum fresh leaf weight (32.93 g) was found in MM-111 followed by MM-106 (29.13g). However, M-27 produced the minimum fresh leaf weight (27.40 g). It is also clear from the data that different rooting media caused a significant effect on fresh leaf weight of rooted layers of different apple clonal rootstocks. The maximum fresh leaf weight (33.33 g) was observed with FYM+Vermicompost+*Azotobacter* as hilling medium, whereas the minimum fresh leaf weight (21.83 g) was recorded in control. Interaction between rooting media, rootstocks and propagation techniques were also found to be significant. Maximum fresh leaf weight (41.91 g) was found in MM-111 with FYM+ Vermicompost+ *Azotobacter* as hilling medium under trench layering. The minimum fresh leaf weight (15.97 g) was recorded in M-27 with soil as hilling material under mound layering. Further it was observed that propagation technique P_2 (trench layering) had a significant effect over P_1 (mound layering) in terms of fresh leaf weight 30.91 g as compared to 27.76 g.

The two year pooled data related to dry leaf weight of different clonal rootstocks as influenced by different rooting media and propagation techniques have been presented in Table 3. It is clear from the data that different rooting media had a significant effect on dry leaf weight. The maximum dry leaf weight (16.23 g) was observed with FYM+Vermicompost+*Azotobacter* as hilling material and the minimum dry leaf weight (7.50 g) was recorded in control. It is also evident from the data that rootstocks had a significant effect on dry leaf weight of rooted layers. Maximum dry leaf weight (13.75 g) was found in MM-111 however, M-27 produced the lowest dry leaf weight (9.90 g). Interaction between rooting media, rootstocks and propagation methods were also found to be significant. Maximum dry leaf weight (20.30 g) was found in MM-111 with FYM+Vermicompost+*Pseudomonas* as hilling media under trench layering whereas,

Table 1. Effect of different rooting media and layering methods on the shoot diameter (mm) of rooted layers of different apple clonal rootstocks (Two years pooled means).

Propagation	P1; Mound Layering					Sub Mean	P2; Trench Layering					Sub Mean	Media Mean	Rootstock Mean
Rootstock / Media	S1	S2	S3	S4	S5		S1	S2	S3	S4	S5			
T1	7.69	5.58	7.68	6.99	8.55	7.32	8.74	6.30	8.97	6.60	8.80	7.89	7.60	S1=9.82
T2	7.76	6.88	9.38	7.17	9.86	8.22	9.12	6.51	9.13	7.00	9.78	8.32	8.27	S2=7.81
T3	10.47	8.68	10.93	9.23	11.89	10.25	10.49	8.91	11.09	9.00	11.52	10.21	10.23	S3=10.17
T4	10.57	8.88	11.22	10.05	12.15	10.58	10.79	8.92	11.26	9.73	11.91	10.54	10.56	S4=8.52
T5	9.42	7.01	9.43	7.80	10.73	8.89	9.31	7.00	9.90	7.54	10.18	8.79	8.84	S5=10.95
T6	9.78	7.72	9.76	8.73	10.83	9.38	9.50	7.15	10.93	7.60	11.01	9.26	9.32	
T7	11.15	9.00	11.27	10.64	12.53	10.94	10.80	9.64	11.36	9.97	12.30	10.83	10.88	
T8	12.04	10.49	13.79	11.59	14.75	12.54	11.36	11.12	11.83	11.20	13.91	11.90	12.22	
T9	10.01	8.09	9.86	8.97	10.86	9.56	10.46	7.60	11.04	7.70	11.41	9.66	9.61	
T10	7.00	5.06	6.99	6.97	8.90	6.99	8.50	5.80	7.98	5.90	7.98	7.24	7.12	
Mean	9.71	7.73	9.91	8.81	11.11	9.47*	9.93	7.93	10.43	8.23	10.78	9.47*	9.47	

S1; M-9 T337 S2; M-27 3; MM-106 S4; P-22 S5; MM-111

C.D($p \leq 0.05$)

Media (M)	:	0.24	;	M×P	:	NS
Rootstock (S)	:	0.37	;	M×S	:	1.10
Propagation (P)	:	NS	;	P×S	:	0.53
M×P×S	:	1.60				

*layering mean

Table 2. Effect of different rooting media and layering methods on the fresh leaf weight(g) of rooted layers of different apple clonal rootstocks (Two years pooled means).

Propagation	P1; Mound Layering					Sub Mean	P2; Trench Layering					Sub Mean	Media Mean	Rootstock Mean
Rootstock / Media	S1	S2	S3	S4	S5		S1	S2	S3	S4	S5			
T1	24.19	22.06	24.25	23.02	30.40	24.78	28.76	24.21	28.53	30.08	30.09	28.33	26.56	S1=28.73
T2	25.15	22.23	22.55	26.75	31.14	26.16	30.26	27.27	30.29	30.25	31.11	29.84	28.00	S2=27.40
T3	28.94	26.89	30.22	28.82	31.81	29.74	31.36	28.92	32.04	30.97	38.53	32.36	31.05	S3=29.13
T4	29.41	27.16	32.22	29.29	31.87	30.39	31.64	29.38	32.26	31.01	40.79	33.02	31.70	S4=28.50
T5	26.92	23.64	24.64	25.81	31.48	26.90	30.39	27.28	30.48	30.26	32.30	30.14	28.52	S5=32.93
T6	27.86	23.88	26.54	26.96	31.51	27.75	30.58	27.52	31.06	30.60	32.92	30.54	29.14	
T7	29.48	27.34	33.28	29.96	32.39	30.89	32.25	32.06	32.44	31.50	41.71	33.99	32.44	
T8	30.83	28.12	33.63	30.98	32.88	31.69	32.93	33.64	32.43	33.96	41.91	34.97	33.33	
T9	28.72	25.75	29.47	26.97	31.63	28.91	30.94	27.75	31.99	30.85	33.01	30.91	29.91	
T10	20.12	15.97	20.46	20.86	22.69	20.42	23.93	20.83	23.96	22.96	24.50	23.24	21.83	
Mean	27.17	22.40	27.52	26.94	30.78	27.76*	30.29	28.40	30.74	30.05	35.09	30.91*	29.34	

S1; M-9 T337 S2; M-27 S3; MM-106 S4; P-22 S5;MM-111

C.D($p\leq0.05$)

Media (M)	:	0.50	;	M×P	:	0.71
Rootstock (S)	:	0.35	;	M×S	:	1.10
Propagation (P)	:	0.22	;	P×S	:	0.50
M×P×S	:	1.50				

*layering mean

Table 3. Effect of different rooting media and layering methods on the dry leaf weight (g) of rooted layers of different apple clonal rootstocks (Two years pooled means).

Propagation	P1; Mound Layering					Sub Mean	P2; Trench Layering					Sub Mean	Media Mean	Rootstock Mean
Rootstock / Media	S1	S2	S3	S4	S5		S1	S2	S3	S4	S5			
T1	7.20	6.80	8.25	7.00	9.10	7.67	10.20	8.90	9.40	8.60	13.40	10.10	8.89	S1=11.23
T2	8.40	8.20	8.50	8.30	9.20	8.52	10.70	9.00	12.00	9.30	13.90	10.98	9.75	S2=9.90
T3	10.80	9.70	12.10	9.80	9.90	10.46	12.70	11.40	17.00	12.60	17.20	14.18	12.32	S3=12.78
T4	12.90	11.20	13.50	12.88	14.30	12.96	12.90	10.50	17.20	12.80	18.20	14.32	13.64	S4=10.71
T5	9.40	9.00	10.00	9.30	10.30	9.60	11.40	9.80	13.60	10.02	15.00	11.96	10.78	S5=13.75
T6	10.00	9.50	10.60	9.50	11.20	10.16	11.60	9.90	15.40	10.40	15.50	12.56	11.36	
T7	13.20	11.30	14.10	13.20	15.00	13.36	15.20	12.00	17.50	13.50	18.70	15.38	14.37	
T8	14.70	13.10	15.30	14.70	17.01	14.96	16.10	15.80	17.90	17.40	20.30	17.50	16.23	
T9	10.10	9.65	11.60	9.60	11.65	10.52	12.60	10.00	15.90	11.90	16.10	13.30	11.91	
T10	6.40	5.50	6.45	5.70	8.00	6.41	8.00	6.80	9.30	7.80	11.00	8.58	7.50	
Mean	10.31	9.40	11.04	10.00	11.57	10.46*	12.14	10.41	14.52	11.43	15.93	12.89*	11.68	

S1;M-9 T337 S2; M-27 S3; MM-106 S4; P-22 S5; MM-111

C.D($p\leq0.05$)

Media (M)	:	0.50	;	M×P	:	0.71
Rootstock (S)	:	0.35	;	M×S	:	1.10
Propagation (P)	:	0.22	;	P×S	:	0.50
M×P×S	:	1.50				

*layering mean

the minimum dry leaf (5.50g) was found in M-27. Further it was observed that propagation technique P_2 (trench layering) had a significant effect over P_1 (mound layering) in terms of dry leaf weight 12.89 g as compared to 10.46 g. Conducive growing environment provided to the rooted layers in the media could have helped the layers to acquire more nutrient as a result of increased microbial activities in the rhizosphere, which may have helped the plant to acquire more vegetative growth and hence increased the fresh leaf and dry leaf of rooted layers. These results were supported by the work of Mir *et al*. (11) wherein they had also obtained maximum fresh and dry leaf weight in Vermicompost+ FYM+*Azotobacter* than the treatments used individually

The observation on the effect of different rooting media, propagation methods and their interaction on the relative water content (RWC) of rooted layers of different apple clonal rootstocks presented in Table 4 reveals that all the rooting media as well as propagation techniques had a significant effect on relative water content of leaf (RWC). Among the different rooting media maximum relative water content (87.16 per cent) was recorded under saw dust whereas, the minimum relative water content (70.47 per cent) was recorded in control. Among the various rootstocks maximum relative water content (84.57 per cent) was found in MM-111 followed by MM-106 (81.83 per cent) whereas, the minimum relative water content (71.73 per cent) was recorded in M-27. Interaction between hilling material, rootstocks and their propagation methods were also found to be significant. The maximum relative water content was found in MM-111(89.55 per cent) with saw dust as rooting medium under trench layering whereas, the minimum relative water content (61.21 per cent) was recorded in control. Further it was observed that propagation technique P_2 (trench layering) had a significant effect over P_1 (mound layering) in terms of relative water content 79.02 per cent as compared to 77.16 per cent. This result lends support with that of Puspa *et al*. (12), who reported that biofertilizers and organic manures improve soil physical condition for enhancing moisture retention capacity leading to increase uptake of water. Increase in leaf RWC with the integrated use of organic and inorganic fertilizers along with biofertilizers and vermicompost was also reported by Rupnawar and Novale (14) in pomegranate and Mahmoud and Mahmoud (10) in peach. Thus, the increase in leaf RWC can reasonably be related to soil ameliorating effect mediated through biological and organic sources of nitrogen.

Table 4. Effect of different rooting media and layering methods on the relative water content of leaf (RWC%)of rooted layers of different apple clonal rootstocks (Two years pooled means).

Propagation	P1; Mound Layering					Sub Mean	P2; Trench Layering					Sub Mean	Media Mean	Rootstock Mean
Rootstock / Media	S1	S2	S3	S4	S5		S1	S2	S3	S4	S5			
T1	79.72	76.67	82.91	77.33	84.70	80.27	82.35	77.19	83.34	81.67	86.54	82.22	81.24	S1= 77.99
T2	82.25	79.89	84.17	81.78	86.64	82.95	87.36	85.22	88.16	85.49	89.55	87.16	85.05	S2= 71.73
T3	75.24	72.20	82.11	68.14	84.66	76.47	80.16	70.20	81.40	76.17	84.76	78.54	77.50	S3= 81.83
T4	76.95	72.92	82.14	76.79	84.72	78.70	80.55	76.64	83.22	80.49	85.57	81.29	80.00	S4= 74.33
T5	80.42	79.12	84.00	79.27	85.61	81.68	85.35	83.16	85.82	85.22	88.66	85.64	83.66	S5= 84.57
T6	79.81	77.70	83.71	77.33	84.81	80.67	82.71	82.19	83.71	82.67	86.82	83.62	82.15	
T7	74.97	66.03	82.08	67.46	83.25	74.76	76.89	65.82	80.12	75.90	83.08	76.36	75.56	
T8	73.21	64.29	82.04	66.54	82.83	73.78	75.30	63.00	80.04	72.31	82.73	74.68	74.23	
T9	71.98	62.61	80.36	64.69	82.03	72.05	69.05	62.77	79.91	69.86	82.70	72.86	72.46	
T10	70.99	61.21	77.93	59.68	79.82	70.21	76.78	56.12	78.40	60.60	81.81	70.74	70.47	
Mean	75.74	71.79	82.16	72.19	83.92	77.16*	80.24	71.67	81.49	76.48	85.22	79.02*	78.09	

S1; M-9 T337 S2; M-27 S3; MM-106 S4; P-22 S5; MM-111

C.D ($p \leq 0.05$)

Media (M)	:	0.68	;	M×P	:	0.97
Rootstock (S)	:	0.48	;	M×S	:	1.50
Propagation (P)	:	0.30	;	P×S	:	0.68
M×P×S	:	2017				

*layering mean

The two year pooled data on annual production of rooted layers produced by different clonal rootstocks and as affected by different rooting media and propagation techniques are presented in Table 5. It is evident from the data that rootstocks had a significant effect on annual production of rooted layers. MM-111(S5) produced the highest rooted layers (9.62) which was statistically superior to P-22 and M9-T337. However, MM-27 (S2) produced the lowest number of rooted layers (6.93). The effect of rooting media on the annual production of rooted layers was also found to be significant. However, layers of MM-111 (S5) with saw dust as hilling material produced highest rooted layers (8.62) followed by 8.18 in Vermiculite+ Saw dust+ *Pseudomonas* and the lowest rooted layers (6.81) were produced in control (only soil was used as a hilling media). Interaction between rooting media, rootstocks and propagation techniques were also found to be significant. The highest annual production of rooted layers (11.26) was recorded in MM-111(S5), with saw dust as hilling medium under trench layering and the minimum annual production of rooted layers (5.26) was recorded in T10 under mound layering. Further it was observed that propagation technique P_2 (trench layering) had a significant effect (8.18) over P_1 (7.18) (mound layering) in terms of annual production of rooted layers.

The increase in annual production of rooted layers in saw dust might be due to excellent aeration, good drainage of water, better water holding capacity better root penetration and moderate cation exchange capacity which could promote root growth and development. Optimum media temperature under saw dust as hilling media increased soil flora and fauna thus improving soil fertility status. The results of the present study are in conformity with the findings of Gautam (7). The increase in root characters/ traits in saw dust may be attributed to continuous increase in media temperature during the period of investigation leading to an increase in metabolic activity of root cells and the development of lateral roots which in turn improves root growth and other rooting characters (Repo *et al*., 13)

From the present study it can be concluded that that application of Vermicompost+FYM+*Azotobacter* resulted in optimisation of shoot diameter, fresh leaf weight, dry leaf weight and relative water content (RWC %) of different clonal rootstocks while as application of saw dust resulted in maximum annual production of rooted layers.

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Table 5. Effect of different rooting media and layering methods on annual production of rooted layers of different apple clonal rootstocks (Two years pooled means).

Propagation	P1; Mound Layering					Sub Mean	P2; Trench Layering					Sub Mean	Media Mean	Rootstock Mean
Rootstock / Media	S1	S2	S3	S4	S5		S1	S2	S3	S4	S5			
T1	7.08	6.46	7.90	6.95	9.23	7.52	7.65	7.29	8.54	7.53	10.29	8.26	7.89	S1=7.04
T2	8.06	7.46	8.58	7.51	9.41	8.25	8.26	7.98	9.78	7.88	11.26	8.99	8.62	S2=6.93
T3	6.51	6.00	7.51	6.35	8.93	7.06	7.58	7.21	8.11	7.44	10.08	8.08	7.57	S3=7.96
T4	6.83	6.15	7.71	6.41	9.03	7.23	7.60	7.27	8.37	7.49	10.10	8.17	7.70	S4=6.86
T5	7.56	6.78	8.31	7.13	9.33	7.82	7.91	7.32	8.72	7.80	10.89	8.53	8.18	S5=9.62
T6	7.10	6.50	8.10	7.05	9.28	7.61	7.80	7.30	8.67	7.70	10.80	8.45	8.03	
T7	6.36	6.08	7.30	6.31	8.83	6.98	7.50	7.18	8.05	7.32	10.00	8.01	7.49	
T8	5.80	5.71	6.88	6.21	8.80	6.68	7.40	7.14	7.88	7.28	9.88	7.92	7.30	
T9	6.05	5.46	6.53	5.63	8.71	6.48	7.23	6.92	7.45	7.02	9.53	7.63	7.05	
T10	5.51	5.26	6.46	5.80	8.70	6.35	7.01	6.23	6.91	6.94	9.26	7.27	6.81	
Mean	6.53	6.40	7.53	6.43	9.03	7.18	7.68	7.19	8.40	7.44	10.21	8.18	7.68	

S1; M-9 T337 S2; M-27 S3; MM-106 S4; P-22 S5; MM-111

C.D($p \leq 0.05$)

Media (M)	:	0.07	;	M×P	:	0.10
Rootstock (S)	:	0.05	;	M×S	:	0.17
Propagation (P)	:	0.03	;	P×S	:	0.07
M×P×S	:	2.24				

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