International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(2): 1985-1988

Received: 24-01-2019
Accepted: 26-02-2019

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Response of different apple clonal rootstocks to varied hydrothermal conditions using different media

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Abstract
The present investigation entitled "Response of different apple clonal rootstocks to varied hydrothermal conditions using different media" 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, Saw dust, FYM, Vermicompost, Vermiculite+ Saw dust+ *Pseudomonas*, Vermicultite + Saw dust +*Azotobacter*, FYM + Vermicompost + *Pseudomonas*, FYM + Vermicompost + *Azotobacter*, *Pseudomonas*+ *Azotobacter*, Control (only soil was used as a hilling material). The experimental results shows that maximum mean media temperature (26.05 ^{0}C) was recorded under saw dust treatment followed by vermiculite+ saw dust+ *Azotobacter* (27.87 ^{0}C). Maximum mean soil moisture content (22.44%) was recorded in under vermiculite which was significantly, higher as compared to all other hilling media. The lowest media temperature (24.33 ^{0}C) and media moisture (20.80%) was recorded under control (only soil was use a hilling media). Among the various rootstock maximum mean media temperature and mean media moisture (24.00 ^{0}C and 21.66%) found in MM-106 whereas, minimum mean media temperature (22.75 ^{0}C) was found in MM-111and minimum mean media moisture (17.39%) was found in M9-T337.

Keywords: Clonal rootstocks, hilling media, media moisture, media temperature and mounding

Introduction
Rootstocks to control tree size have been used in apple production for over 2,000 years. Historically, most of the clonal apple rootstocks that we use in the Jammu and Kashmir traditionally originated in Europe. 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 traits that are absent in the scion, such as pest and disease resistance, better anchorage, improved nutrient uptake, better tolerance to soils and other biotic and abiotic factors. On the other hand, they can modify the performance of scion by reducing tree vigor and modifying canopy structure that would allow the establishment of high density orchards.

Clonal rootstocks are obtained from selected individuals that are vegetatively propagated resulting in individuals with an exact genetic composition. They have the advantages of generating uniform, precious, dwarfing, easier to manage and more productive orchards e.g. M-9 which reduces the tree size up to 70% as compared to seedling rootstocks while as MM-106 reduces up to 40%. Nursery plants of fruits on seedling rootstocks are usually sold as one to three years old and cause the loss of time and cost.

Poor quality, uneven packaging, marginality and fragility and low profits coupled with high production costs are forcing apple growers to improve upon efficiency and productivity. In this regard High Density Planting (HDP), which is only possible by the use of size- controlling rootstocks of homogeneous nature, can increase productivity and ensure improved efficiency (Westwood *et al*., 1976 and Ferree, 1980) [2, 3]. This has stimulated interest in size-controlling clonal rootstocks. The behaviour of these clonal rootstocks which include the aspects like their propagating propensities, performance with different stionic combinations in field, reaction to major insect pests and diseases, agroclimatic conditions and soils etc. have been amply studied in various countries and to some extent in India under local agroclimatic conditions. 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 plant material for the experiment consisted of M-9 T337, M-27, MM-106, P-22 and MM-111rootstocks. The plant material was imported from Holland in 2016 and established at spacing of 90cm × 45cm. At the time of conducting present experimental studies, the age of rootstock stools was one year**.** Media hydro thermal conditions viz., Media temperature (^oC) and media moisture (%) of experimental area was recorded at depth of 0-15 with the help of soil thermometer and soil moisture metre. First reading was taken on 15th, April and subsequent readings at 60 days intervals. Final reading was recorded at the end of growing season. 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 (1984) [1]. Statistical analysis were done by using Assex Software (Statistix PC Dos Version 2.0 NH Analytical Software).

The data regarding the effect of different rooting media on media temperature at 0-15 cm depth in different apple clonal rootstocks is given in Table-1.

The perusal of data (Table-1 and Fig-1) reveals that average media temperature at 0-15 cm depth was significantly influenced under all the hilling media. Maximum mean media temperature (28.05 ^0C) was recorded under saw dust treatment followed by Vermiculite+ Saw dust+ *Azotobacter* (27.87 ^0C). The minimum media temperature (17.27 ^0C) was recorded in control (when only soil was used as hilling media).

The media temperature at 0-15cm depth also varied significantly during different months and maximum mean media temperature was recorded during the month of August. The minimum media temperature was observed on 15th April. In general, the media temperature showed an increased trend during the whole growing season except in the month of October where the media temperature decreases. Maintenance of relatively higher media temperature under saw dust is attributed to its ability to create insulation over the soil surface, thereby restricting the temperature inversion and negative heat flux from the soil. The results of the present study are in agreement with the findings of Manu *et al*. (2017) [5] Wherein they studied the effect of mulch on successive crop yields and soil carbon in Tonga and found increased soil temperature under saw dust.

The effect of media temperature on the propagation techniques *viz*., mound layering and trench layering were found non-significant.

The data related to media moisture of different clonal rootstocks as affected by different rooting media and propagation techniques have been presented in Table-2.

Perusal of Table-2 reveals that all the hilling media significantly influenced the media moisture content at 0-15 cm depth in various rootstocks throughout the growing season. Maximum mean media moisture content (28.54%) was recorded in under vermiculite which was significantly, higher as compared to all other hilling media. The minimum media moisture content (18.47%) was recorded under control (when only soil was used a hilling media).

The media moisture content at 0-15cm cm depth also varied significantly during different months and maximum mean soil moisture content (28.54%) was recorded on 15th June and the minimum (%) on 15thApril. The increase in media moisture in vermiculite is attributed due to retention of higher water holding capacity because of its swelling properties and light dark in colour. The results of the present study are in agreement with the findings of Jacobs *et al*. (2003) [4] wherein they studied the Influence of nursery soil amendments on water relations, root architectural development, and field performance of Douglas-fir transplants and found increased soil moisture under vermiculite. The effect of media temperature on the propagation techniques viz., mound layering and trench layering were found non-significant

Table 1: Effect of different rooting media, propagation methods and their interaction effect on the media temperature (^0C) of rooted layers (0-15 cm depth) of different apple clonal rootstocks (pooled over 2017 and 2018)

	15th April					Sub	15th June					Sub
	S1	S2	S3	S4	S5	Mean	S1	S2	S3	S4	S5	Mean
T1	18.86	18.49	18.75	18.5	18.87	18.694	26.48	26.46	26.77	25.51	26.00	26.24
T2	19.83	19.38	19.8	19.63	19.94	19.716	27.04	27.98	27.39	27.01	27.13	27.31
T3	18.68	18.13	18.01	18.65	18.38	18.37	26.44	26.01	26.56	26.26	26.01	26.26
T4	18.94	18.4	18.79	18.65	18.6	18.676	26.96	26.66	26.89	26.48	26.72	26.74
T5	18.68	18.38	18.07	18.95	18.52	18.52	25.64	25.55	26.36	26.99	26.65	26.24
T6	18.69	18.9	18.71	18.56	18.22	18.616	25.59	25.59	26.79	26.58	26.63	26.24
T7	17.9	18.35	18.7	18.71	18.08	18.348	26.23	25.61	26.18	26.36	26.05	26.09
T8	18.81	18.37	18.96	18.44	18.27	18.57	25.83	25.41	26.92	26.82	26.44	26.28
T9	18.88	17.34	18.22	18.03	18.16	18.126	25.04	24.84	26.51	26.63	26.80	25.96
T10	17.27	18.37	16.31	17.04	17.09	17.216	22.55	22.48	25.87	24.41	25.41	24.14
Mean	18.654	18.411	18.432	18.516	18.413	18.4852	25.78	25.659	26.624	26.305	26.384	26.1504

15th August					Sub	15th October					Sub	Factor Mean	
S1	S2	S3	S4	S5	Mean	S1	S2	S3	S4	S5	Mean	Media	Rootstock
27.66	27.56	27.50	27.51	27.05	27.46	23.58	23.03	23.51	23.66	23.38	23.43	25.71	23.9
28.94	28.76	28.02	28.01	28.53	28.45	24.94	24.48	24.01	24.86	24.05	24.47	26.74	23.733
27.47	27.36	27.66	27.26	27.73	27.50	23.44	23.77	23.26	23.50	23.25	23.44	25.73	24.00775
27.97	27.61	27.49	27.48	27.08	27.53	23.55	23.38	23.48	23.61	23.03	23.41	25.89	23.96425
27.56	27.17	27.84	27.99	27.35	27.58	23.39	23.95	23.99	23.77	23.62	23.74	25.85	22.75967
27.55	27.48	27.56	27.58	27.74	27.58	23.52	23.61	23.58	23.62	23.33	23.53	25.78	
27.81	27.04	27.57	27.36	27.70	27.50	23.24	23.86	23.36	23.53	23.80	23.56	25.71	
27.57	27.12	27.52	27.82	27.35	27.48	23.47	23.14	23.82	23.12	23.99	23.51	25.76	
27.70	27.44	27.27	27.63	27.23	27.45	23.42	23.29	23.63	23.11	23.98	23.49	25.63	
26.46	26.03	26.27	26.41	26.34	26.30	22.42	22.92	22.41	22.53	22.39	22.53	24.33	
27.669	27.357	27.47	27.505	27.41	27.4822	23.497	23.543	23.505	23.531	23.482	23.5116	25.71473	

C.D (p ≤ o.o5)	Days (D)	0.21
	Stock (S)	0.18
	Media (M)	0.26
	Propagation (P)	NS
	D*S	0.32

Table 2: Effect of different rooting media, propagation methods and their interaction effect on the media moisture (%) of rooted layers (0-15cm depth) of different apple clonal rootstocks (pooled over 2017 and 2018)

	15th April					Sub Mean	15th June					Sub Mean
	S1	S2	S3	S4	S5		S1	S2	S3	S4	S5	
M1	27.38	27.10	26.76	26.87	27.11	24.67	24.61	25.51	22.79	23.85	24.28	23.28
M2	25.85	25.94	25.76	25.85	25.95	22.77	23.30	23.77	24.50	23.33	23.53	22.11
M3	26.00	26.00	27.06	25.17	26.07	23.07	23.25	22.82	23.14	23.44	23.14	22.31
M4	26.09	26.09	25.99	26.42	26.19	23.27	23.14	23.08	23.01	22.84	23.07	22.14
M5	26.19	26.30	26.34	26.23	26.24	23.17	22.85	23.10	23.14	23.40	23.13	22.01
M6	26.12	26.11	26.06	26.40	26.17	23.20	22.89	23.25	23.00	23.15	23.10	22.09
M7	25.97	26.02	25.92	26.00	25.98	22.95	23.13	22.90	22.78	22.61	22.87	22.12
M8	25.17	26.05	25.98	25.87	25.79	22.66	22.58	23.04	23.19	23.01	22.89	22.29
M9	25.81	25.55	25.83	25.84	25.80	23.05	22.93	22.69	22.91	22.81	22.88	22.23
M10	24.82	24.28	26.03	24.80	24.95	21.80	21.99	22.20	22.20	22.19	22.07	21.26
Mean	25.94	25.94	26.17	25.94	26.02	23.06	23.07	23.23	23.07	23.06	23.10	22.18

15th August					Sub Mean	15th October					Sub Mean		Factor Mean
S1	S2	S3	S4	S5		S1	S2	S3	S4	S5		Media	Rootstock
23.12	23.47	22.06	21.53	22.69	16.83	15.44	15.34	15.33	15.33	15.66	22.44	22.44	17.39
21.81	22.25	23.41	23.26	22.57	15.68	15.41	15.34	15.33	15.33	15.42	21.87	21.87	21.58
22.07	22.39	22.12	22.06	22.19	15.56	15.40	15.33	15.33	15.33	15.39	21.70	21.70	21.66
21.91	22.32	22.07	21.80	22.05	15.80	15.36	15.33	15.33	15.33	15.43	21.68	21.68	21.68
22.08	22.23	21.95	22.11	22.07	15.74	15.32	15.33	15.33	15.33	15.41	21.71	21.71	21.57
21.88	21.73	22.07	21.93	21.94	15.35	15.32	15.33	15.33	15.33	15.33	21.63	21.63	
22.15	22.00	21.91	22.07	22.05	15.26	15.33	15.33	15.33	15.33	15.31	21.55	21.55	
22.10	21.97	22.35	22.10	22.16	15.78	15.28	15.33	15.33	15.33	15.41	21.56	21.56	
21.86	21.97	22.35	21.67	22.01	15.30	15.28	15.34	15.33	15.33	15.32	21.50	21.50	
20.64	21.05	21.12	21.03	21.02	14.38	15.37	15.33	15.33	15.33	15.15	20.80	20.80	
21.96	22.14	22.14	21.95	22.07	15.57	15.35	15.33	15.33	15.33	15.38		22.44	

C.D (p ≤ o.o5)	Days (D)	0.10
	Stock (S)	0.13
	Media (M)	0.17
	Propagation (P)	NS
	D*S	0.20
	D*M	0.22

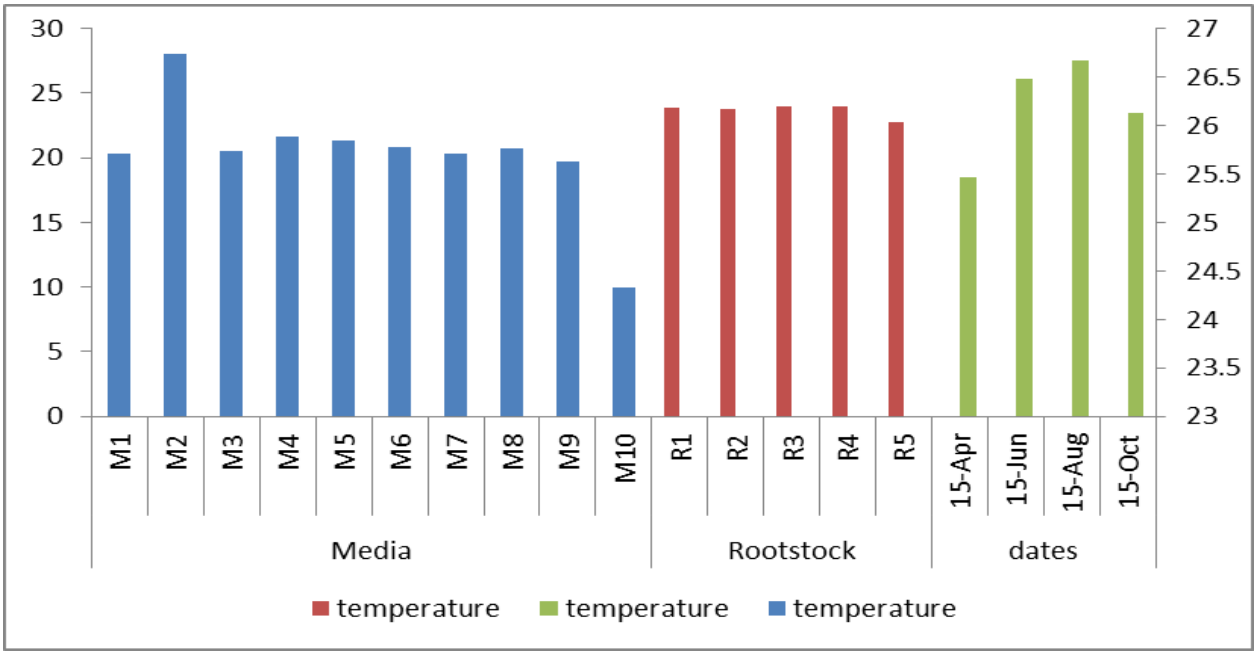

Fig 1: Effect of different hilling media on the media temperature (^{0}C) of different apple clonal rootstocks

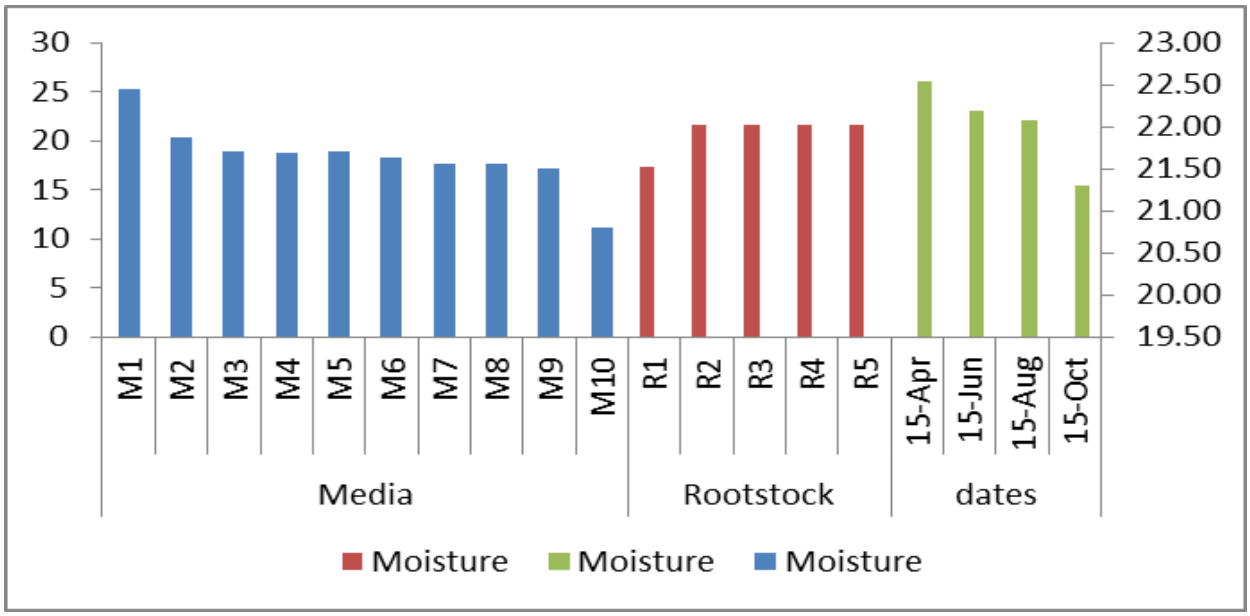

Fig 2: Effect of different hilling media on the media moisture (0 C) of different apple clonal rootstocks

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