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Effect of Size of Cuttings on Rooting of Different Clonal Rootstocks of Apple

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ABSTRACT

Keywords

Apple, Merton 793, Malling merton, Rooting percentage, Size of cuttings

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The present investigation entitled “Effect of size of cuttings on rooting of different clonal rootstocks of apple” was carried out in shade net house conditions of apple and pear block of Department of Fruit Science, Dr Y S Parmar University of Horticulture and Forestry Nauni, Solan HP during the year 2018-19. The experiment was laid out in Randomised Block Design comprising of 12 treatments replicated thrice. The results revealed that maximum rooting percentage (73.53%), total root length (17.46 m), fresh and dry weight of roots (6.43 g and 2.88 g, respectively), average length and diameter of roots (25.87 cm and 3.25 mm, respectively) were recorded in the treatment combination of cutting length 12 cm of Merton 793 rootstock, whereas the maximum number of main roots (7.43) were observed in treatment combination of 12 cm long cuttings of MM 106 rootstock.

Introduction

Apple is the most important fruit crop of temperate region. It belongs to family Rosaceae and sub-family Maloideae. The crop originated in Central Asia and was grown in Asia and Europe for thousands of years and introduced to North America by European colonists. In India, apple is cultivated widely in the North Western

Himalayan region including Jammu and Kashmir, Himachal Pradesh and Uttarakhand states. Apple occupies a unique position among temperate fruits of India and ranks fifth worldwide with a production of 2,371 thousand MT per year from an area of 307 thousand hectares (Anonymous, 2018a). Himachal Pradesh has been named as “Apple bowl of India” because of high production and best apple fruit quality. In Himachal

Pradesh, the apple plantations occupy an area of 113 thousand hectares with a production of 368 thousand MT (Anonymous, 2018b).

Apple is one of the most commercially important fruit crop grown worldwide (Karakurt *et al.*, 2009) and it is essential to solve propagation problems in order to expand its cultivation on large scale (Uosukainen 1992). The propagation of apple is traditionally done through grafting and budding by using seedling rootstocks in the nursery. Generally, hardwood cuttings are used for vegetative propagation as, it is the cheapest and simplest method of propagation and rooting can be improved with the use of growth regulators and suitable growing media (Ercisli *et al.*, 2003). The vegetatively propagated clonal rootstocks produce uniform plants which do not exhibit genetic variations, have a short juvenile phase with precocity in bearing as compared to seedling rootstocks. Nowadays, clonal rootstocks have been used commercially because of their reliable importance such as control of vigour, winter hardiness and adaptation to adverse soil conditions (Doglov and Hanke, 2006) and less pre-bearing period. Although, clonal rootstocks are used worldwide for commercial purpose, but in India seedlings are still the most frequently used rootstocks.

With the popularization of high density plantation in apple, the demand for clonal rootstocks of apple has increased manifold in the recent past. Many experiments on high density plantation have remained successful and now the orchardists are convinced about the benefits from apple orchards under high density plantation. The rootstock plays major role in establishing high density plantation of apple. With the import of new colour strains and regular bearing cultivars of apple, this fruit is becoming popular in mid-hill areas as well where ample flat land and irrigation facilities are available. Rootstocks play a

crucial role in determining orchard efficiency in fruit crops. Combining the desirable attributes of two different plant parts by budding or grafting can produce different growth effects. The differences can be illustrated by comparing the relative importance of rootstocks for precocity, yield and tree size control.

Conventionally, the clonal rootstocks of apple are propagated through mound layering, cuttings and micro-propagation. Among these methods, propagation through mound layering is the most popular method for multiplication of apple clonal rootstocks. While grafting, upper major portion of rootstock is generally wasted. If this part can be utilized as hardwood cuttings the clonal rootstock multiplication rate can be increased manifold. Generally, hardwood cuttings are used for vegetative propagation as it is the cheapest and simplest method of propagation, Cutting length also play a prime role in the rooting of cuttings which affects the rooting behavior, survival percentage, number of roots, total root length etc. Long cuttings due to more food material generally give better growth and higher rooting percentage in comparison to short ones (Osterc and Stampar, 2008).

In modern fruit cultivation, use of clonal apple rootstocks is widespread. Among clonal rootstocks, Merton 793, MM 111, MM 106 and M 9 are preferable for different agro climatic conditions of North-West Himalayas. Merton 793 is a cross between M 2 × Northern Spy and is found suitable for replantation in old orchards because of its adaptability to replant problem. It has better yield performance compared to seedling rootstocks since it is vigorous in nature and is resistant to wooly apple aphid and collar rot. MM 111 rootstock grows fast in establishment phase and is drought tolerant with semi-vigorous nature which adapt well in poor soils and arid areas (Wertheim, 1998). Rootstock M 9

produce small trees, which are suitable for high density plantations and start bearing in first or second year of planting (Pretson, 1955). MM 106 clonal rootstocks produce half of the size of trees of seedling rootstock which have precocious production.

Keeping the above mentioned points in view, the present study on the effect of size of cuttings on rooting performance of different clonal rootstocks of apple was carried out with the objective to standardize length of cuttings to induce best rooting in the cuttings of different apple clonal rootstocks

Materials and Methods

The present investigation was carried out under shade net house conditions of Fruit Nursery Block of Department of Fruit Science, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh during the year 2018-19. The experiment comprised of twelve treatments and three replications laid out in Randomised Block Design with fifteen cuttings per replication. The four different rootstocks of apple viz., Merton 793, MM 106, MM 111, M 9 and three different cutting lengths (8 cm, 10 cm and 12 cm) were used in the present investigation. While preparing the cuttings, care was taken to give a straight cut slightly below a node on the basal end and a slanting cut slightly above a node on apical end. The propagation beds were prepared by mixing vermicompost, cocopeat, sand and forest soil in 1:1:1 ratio. The cuttings were planted in the propagation beds in rows. The planting distance between row to row was kept as 15 cm, whereas distance between adjacent cuttings was kept as 10 cm. The details of different treatment combinations are T₁:R₁L₁ (8 cm length of Merton 793 rootstock), T₂: R₁L₂(10 cm length of Merton 793 rootstock), T₃:R₁L₃(12 cm length of Merton 793 rootstock), T₄ :R₂L₁(8 cm length

of MM 106 rootstock), T₅ :R₂L₂(10 cm length of MM 106 rootstock), T₆:R₂L₃(12 cm length of MM 106 rootstock), T₇ : R₃L₁(8 cm length of MM 111 rootstock), T₈:R₃L₂(10cm length of MM 111 rootstock), T₉:R₃L₃(12 cm length of MM 111 rootstock), T₁₀ :R₄L₁(8 cm length of M 9 rootstock), T₁₁ : R₄L₂(10 cm length of M 9 rootstock), T₁₂:R₄L₃(12 cm length of M 9 rootstock). Cuttings were treated with IBA at the concentration of 2500 ppm in each treatment. The Observations were recorded for percentage of rooted cuttings (%), total root length (m), average fresh and dry weight of roots (g) and average length (cm) and diameter (mm) of roots and analyzed statistically.

Results and Discussion

Rooting percentage

The data on the rooting percentage as influenced by different size of cuttings of various clonal rootstocks of apple presented in Table 1 indicates that length of cuttings had a significant effect on percentage of rooted cuttings. Maximum rooting percentage (65.32%) was recorded in 12 cm long cuttings which were significantly higher than all other cutting lengths. The minimum rooting percentage (48.92%) was however, obtained in 8 cm length of cuttings.

Different rootstocks (Merton 793, MM 106, MM 111 and M 9) also exerted a significant effect on percentage of rooted cuttings (Table 1). The maximum rooting (66.37%) was recorded in Merton 793 rootstock cuttings. However, the minimum rooting (48.15%) was observed in cuttings of M 9 rootstock.

The interaction effects between cutting length and rootstock also exerted a significant effect on percentage of rooted cuttings (Table 1). The highest rooting percentage (73.53%) was recorded in the combination of length 12 cm

and Merton 793 rootstock cuttings, whereas, the lowest rooting percentage (37.23%) was observed in the treatment combination of 8 cm length and M 9 rootstock cuttings.

The shorter length of cuttings resulted in poor rooting percentage which increased as the size of cuttings increased to 12 cm. The increase in rooting percentage in longer cuttings may be due to the higher level of endogenous auxins, water and nutrient holding capacity and other root inducing factors which may be lower in smaller cuttings and may be the reason for reduction in rooting percentage (Palanisamy and Kumar 1997). Significant effect of clonal rootstock and cutting length were observed with highest rooting in the larger size of cuttings. This could be attributed to the high storage reserves and photosynthetic area which produced more roots. In most of studies, cutting length has influenced rooting (Wang *et al.*, 1997, Kowalczyk and Kobryn, 1999). Similarly, Al-Abbasi (2012) also reported that 12 cm long cuttings recorded maximum rooting percentage (66.1%) than 8 cm and 10 cm in geranium plants.

Total root length

The data pertaining to total root length as influenced by the size of cuttings of different clonal rootstocks of apple is presented in Table 1.

The perusal of data presented in Table 1 showed a significant effect on total root length. The highest total root length (13.97 m) was recorded in 12 cm long cutting, whereas, the minimum total root length (9.91 m) was observed in 8 cm cutting length.

Different rootstocks (Merton 793, MM 106, MM 111 and M 9) also showed a significant effect on total root length. The maximum total root length (15.28 m) was recorded in Merton

793 rootstock cuttings. However, the minimum total root length (8.05 m) was observed in M 9 rootstock cuttings.

The interaction between cutting length and rootstock also showed a significant effect on total root length (Table 1). The highest total root length (17.46 m) was observed in 12 cm long cuttings of Merton 793 rootstock. Whereas, the lowest total root length (5.43 m) was found in 8 cm length of M 9 rootstock. The rootstocks with maximum cutting length also recorded maximum rooting percentage and total root length. These results could be attributed to higher carbohydrate contents of longer cuttings, and more accumulation of dry matter (Bojarczuk and Jankiewicz, 1975). Al-Abbasi (2012) also recorded maximum total root length in 12 cm long geranium cuttings. Similar results were obtained by Verma *et al.*, (2015) who reported that cuttings with a length of 45 cm gave maximum total root length than 15 cm long cuttings in Merton 793 apple rootstock.

Average length of main roots

The data mentioned in Table 2 reveals that the average length of main roots was also significantly influenced by size of cuttings of different clonal rootstocks of apple.

The perusal of data (Table 2) also showed the significant effect on length of main roots by size of cuttings. Twelve cm long cuttings showed maximum average length of main roots (23.44 cm), which was significantly higher than all other cutting lengths. Whereas, the 8 cm cuttings length recorded minimum length of main roots (20.89 cm).

Different rootstocks (Merton 793, MM 106, MM 111 and M 9) also exhibited a significant effect on length of main roots. The maximum length of main roots (24.69 cm) was observed in Merton 793 rootstock cuttings. While, the

minimum length of main roots (19.23 cm) was recorded in the cuttings of M 9 rootstock.

The interaction effect of various cutting length and rootstock clearly exerted a significant effect on average length of main roots of different clonal rootstock cuttings (Table 2). The maximum length of main roots (25.87 cm) was recorded in treatment combination of 12 cm length of cuttings and Merton 793 rootstock. On the other hand, the minimum length of main roots (17.46 cm) was observed in treatment combination with 8 cm length of cuttings and M 9 rootstock. The greater length of roots may be as a result of more available carbohydrate reserves, nutrients and optimum hormonal supply. These results are also in line with Awan *et al.*, (2012) who found maximum root length in 20 cm length of olive cv. Azarbaizan.

Average diameter of main roots

The average diameter of main roots was also significantly influenced by the size of cuttings of different clonal rootstocks of apple (Table 2).

The perusal of data showed that the size of cuttings exhibited a significant effect on average diameter of main roots. The highest average diameter of main roots (2.62 mm) was recorded in the cuttings of 12 cm length. While the lowest diameter of main roots (2.19 mm) was observed in cuttings of 8 cm length.

Cuttings from different rootstocks (Merton 793, MM 106, MM 111 and M 9) also had significant effect on average diameter of main roots (Table 2). Cuttings from Merton 793 rootstock recorded maximum average diameter of main roots (2.95 mm). Whereas, M 9 rootstock cuttings recorded minimum average diameter of main roots (1.94 mm).

The interactions effect between various cutting length and rootstock exhibited non-

significant effect on average diameter of main roots (Table 2). The longer cuttings with maximum root length also recorded maximum diameter of roots due to proper assimilation of carbohydrates, nutrients and supply of rooting co-factors for development of length and diameter of roots. These results are in agreement with the findings of Verma *et al.*, (2015) who, recorded highest average diameter of roots with 45 cm long cuttings of Merton 793 rootstock when compared with 15 cm long cuttings.

Average number of main roots

The effect of size of cuttings of different clonal rootstocks of apple showed significant effect on average number of main roots (Table 3). The maximum average number of main roots (6.44) was observed in the cuttings with a length of 12 cm, which was significantly higher than all other cutting lengths. However, the minimum average number of main roots (3.92) was recorded in the cuttings of 8 cm length.

Different rootstocks (Merton 793, MM 106, MM 111 and M 9) also exerted a significant effect on average number of main roots. The maximum number of main roots (5.90) was recorded in the cuttings of MM 106 rootstock, which was statistically at par with cuttings of Merton 793 rootstock with 5.59 number of main roots. Whereas, the minimum number of main roots (4.22) were observed in M 9 rootstock cuttings.

Interactions between cutting length and rootstock also exerted a significant influence on average number of main roots (Table 3). Maximum number of main roots (7.43) was observed in treatment combination of 12 cm cutting length and MM 106 rootstock. The minimum number of main roots (2.87) were however, found in treatment combination with length of 8 cm and M 9 rootstock.

Longer cuttings produced higher number of roots than shorter cuttings due to more storage reserves and photosynthetic area which led to production of sufficient roots (Naidu and Jones 2009). These results were also in agreement with the findings of Govinden – Soulange *et al.*, (2009) who reported that the number of roots produced per cutting was determined by type of cuttings used, plant growth regulators applied, temperature and health status. Al- Abbasi (2012) also recorded maximum number of roots in 12 cm long cuttings of geranium. Similar results were also recorded by Gautam *et al.*, (2010) who found that root induction was maximum in cuttings with length of 10 and 15 cm as compared to the cuttings with length of 5 cm in juvenile shoot cuttings of guava.

Fresh weight of roots (g)

It is clear from the perusal of data presented in Table 3 that the length of cuttings exhibited a significant effect on fresh weight of roots. The highest fresh weight of roots (4.91 g) was recorded in the cuttings of 12cm length. Whereas, the lowest fresh weight of roots (3.53 g) was found in the cuttings of 8 cm length.

Among different rootstocks, (Merton 793, MM 106, MM 111 and M 9) maximum fresh weight of roots (5.56 g) was obtained from Merton 793 rootstock cuttings, which was significantly higher than remaining rootstocks. Whereas, the minimum fresh weight of roots (2.88 g) was recorded in M 9 rootstock cuttings.

The interaction between cutting length and rootstock also had a significant effect on fresh weight of roots (Table 3). The highest fresh weight of roots (6.43 g) was found in the treatment combination of 12 cm cutting

length and Merton 793 rootstock. In contrast, the least fresh weight of roots (2.44 g) was observed in the treatment combination of cutting length 8 cm of M 9 rootstock. The longer cuttings of rootstocks produced maximum fresh weight of roots because the root weight largely depends upon the amount of photosynthates transferred from source. Kakade *et al.*, (2019) also reported that the 20-25 cm long cuttings transport more carbohydrates for formation of new roots which might have resulted in production of longer and higher number of roots and is proportionally correlated with fresh weight of roots.

Dry weight of roots (g)

The perusal of data presented in Table 3 revealed that the length of cuttings exhibited a significant effect on dry weight of roots. The highest dry weight of roots (2.02 g) was recorded in 12cm long cuttings. Whereas, the lowest dry weight of roots (1.93 g) was observed in the cuttings of 8 cm length.

Rootstocks (Merton 793, MM 106, MM 111 and M 9) also had a significant effect on dry weight of roots (Table 3). Maximum dry weight of roots (2.78 g) was recorded in Merton 793 rootstock cuttings. Whereas, it was minimum (1.21 g) in M 9 rootstock cuttings.

The interaction between cutting length and rootstock exhibited non-significant effect on dry weight of roots. Naidu and Jones (2009) also recorded maximum dry weight of roots (0.52 g) in 13 cm long cuttings than 5 cm cuttings. Fresh weight of roots represents water and assimilates present in the root tissues, whereas dry weight of roots give actual amount of assimilates.

Table.1 Effect of size of cuttings on percentage of rooted cuttings and total root length of different clonal rootstocks of apple

Percentage of rooted cuttings (%)					Total root length (m)			
Length Rootstock	8 cm	10 cm	12 cm	Mean	8 cm	10 cm	12 cm	Mean
Merton 793	60.43 (50.64)	65.17 (53.42)	73.53 (58.65)	66.37 (54.24)	13.74	14.65	17.46	15.28
MM 106	53.51 (46.68)	57.34 (48.82)	66.40 (54.20)	59.08 (49.90)	11.70	12.65	15.52	13.29
MM 111	44.50 (41.49)	52.73 (46.25)	62.33 (51.81)	53.18 (46.52)	8.76	11.33	12.62	10.90
M 9	37.23 (37.33)	48.17 (43.73)	59.06 (49.99)	48.15 (49.99)	5.43	8.45	10.27	8.05
Mean	48.92 (44.03)	55.85 (48.05)	65.32 (53.66)		9.91	11.77	13.97	

CD_(0.05) Per cent rooting

Rootstock: 0.39
Length: 0.33
Rootstock ×Length: 0.67

CD_(0.05) Total root length

Rootstock: 0.32
Length: 0.28
Rootstock ×Length: 0.56

Table.2 Effect of size of cuttings on average length and diameter of main roots of different clonal rootstocks of apple

Average length of main roots (cm)					Average diameter of main roots (mm)			
Length Rootstock	8 cm	10 cm	12 cm	Mean	8 cm	10 cm	12 cm	Mean
Merton 793	23.67	24.55	25.87	24.69	2.66	2.96	3.25	2.95
MM 106	21.64	22.82	24.47	22.97	2.33	2.55	2.83	2.57
MM 111	20.82	21.59	22.67	21.69	1.96	2.10	2.25	2.10
M 9	17.46	19.48	20.75	19.23	1.81	1.86	2.15	1.94
Mean	20.89	22.11	23.44		2.19	2.37	2.62	

CD_(0.05) Root length

Rootstock: 0.29
Length: 0.25
Rootstock ×Length: 0.51

CD_(0.05) Root diameter

Rootstock: 0.15
Length: 0.13
Rootstock ×Length: NS

Table.3 Effect of size of cuttings on average number of main roots, fresh and dry weight of roots in different clonal rootstocks of apple

Rootstock \ Length	Average number of main roots				Fresh weight of roots (g)				Dry weight of roots (g)			
	8 cm	10 cm	12 cm	Mean	8 cm	10 cm	12 cm	Mean	8 cm	10 cm	12 cm	Mean
Merton 793	4.67	5.68	6.42	5.59	4.63	5.64	6.43	5.56	2.72	2.76	2.88	2.78
MM 106	4.54	5.74	7.43	5.90	3.83	4.50	5.22	4.52	2.14	2.16	2.21	2.17
MM 111	3.61	4.72	6.56	4.96	3.22	3.57	4.64	3.81	1.68	1.73	1.75	1.72
M 9	2.87	4.46	5.34	4.22	2.44	2.87	3.34	2.88	1.17	1.22	1.25	1.21
Mean	3.92	5.15	6.44		3.53	4.15	4.91		1.93	1.97	2.02	

CD_(0.05) Number of main roots CD_(0.05) Fresh weight of roots CD_(0.05) Dry weight of roots
 Rootstock: 0.31 Rootstock: 0.22 Rootstock: 0.04
 Length: 0.27 Length: 0.19 Length: 0.04
 Rootstock ×Length: 0.54 Rootstock ×Length: 0.38 Rootstock ×Length: NS

Cuttings with the length greater than 35 cm had more dry matter as compared to smaller cuttings which might be because the larger cuttings would have managed to maintain the balance between photosynthesis and transpiration (Leakey and Coutts 1989) and source-sink interaction (Gifford *et al.*, 1984), essential for rooting.

It is concluded that among the different cutting length of apple clonal rootstocks, the treatment combination of 12 cm length of cuttings of Merton 793 rootstock was found to be the best among all treatment combinations in respect of different rooting parameters such as rooting percentage, number of main roots, average length of main roots, average diameter of main roots, fresh and dry weight of roots. However, 8 cm long cuttings of M 9 rootstock gave the lowest rooting parameters.

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