Evaluation of hardwood and semi-hardwood cuttings for rooting performance in exotic kiwifruit cultivars

ABSTRACT

The investigation was conducted in the kiwifruit block of Department of Fruit Science, Dr. Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan (H.P.) during the year 2019-20. The experiment entitled "Evaluation of hardwood and semi-hardwood cuttings for rooting performance in exotic cultivars of Kiwifruit (Actinidia spp.)". The experiment consisted of eight exotic cultivars as treatments, and the research trial was laid out according to Randomized Block Design (RBD). The entire programme of study was conducted undertaken to elucidate the comparative rooting performance of hardwood and semi-hardwood cuttings in exotic cultivars of kiwifruit i.e. Anna, Chung Bai, Cordifolia, Issai Kiwi, Kens Red, Meader Male, MSU Klur, and 74-49 Among different cultivars, Kens Red exhibited the best performance in terms of root characteristics. The cultivar Anna performed the least on the basis of the aforesaid parameters.

Among different cutting types, semi-hardwood cuttings of different cultivars performed better as compared to hardwood cuttings with respect to parameters like number of primary roots, number of secondary roots, total root length (cm) and fresh and dry weight of roots per cutting. The information generated on the propagation of these new exotic kiwiberry cultivars will serve as a basis for the researchers in developing new rootstocks for quality production of plants.

Keywords: Kiwifruit, Cuttings, Exotic cultivars, Survival Percentage

1. INTRODUCTION

The kiwifruit, or Chinese gooseberry, belongs to the genus Actinidia and family Actinidiaceae. It is a dioecious, deciduous, and perennial fruiting vine native to Southern China (Ferguson 1984). The genus Actinidia includes twenty different species, out of which ten species are of commercial importance in the world. Seven species are used as ornamental vines and three other species, including Actinidia chinensis, Actinidia arguta, and Actinidia kolomickta, are used to produce fruits (Nargesi and Sedaghathoor 2015). Among these three species, Actinidia chinensis has a special economic importance owing to its high export quality (Ebrahimi 1981). The kiwifruit has achieved great popularity due to its commercial potential. The fruit has been widely accepted because of its unique flavour, high vitamin-C content, dietary fiber, and mineral nutrients like potassium, phosphorus, and calcium, which have beneficial effects on human health. The total kiwifruit production in the world is 4.03 million metric tonnes in an area of 2.78 lakh ha. It is cultivated on a large scale in China, Italy, New Zealand, and Chile. The area under kiwifruit cultivation in India is 5,000 ha and total production is 13,000 metric tonnes (NHB 2021).

The kiwifruit industry has been dominated by only one cultivar, 'Hayward', due to many desirable characteristics like stiff hairs, large fruit size, and TSS of 12-14 percent. However, the hairs on the fruit surface are not liked by the consumers (Ferguson and Bollard 1990). Actinidia arguta is also called "peewee kiwi" because its fruit is about the size of a grape. Cho et al. (2007) found that it has a higher soluble solid content of 17–18%. Although, the fruit size of Actinidia arguta is only 5–8 g, the fruits have smooth, hairless, and thin skin that is readily eaten. The fruits and leaves of A. arguta are considered to possess antipyretic, astringent, tonic, thirst-quenching, and insecticidal properties (Ivanek 2006). Attempts have also been made to develop better 'Hayward' types with little success for hairless and green skins by hybridization between Actinidia deliciosa and Actinidia arguta. Kiwifruit propagation by cutting with the application of plant growth regulators (PGRs) is one of the most common practices (Rana et al. 2022). Auxin is one of the most important PGRs for regulating the speed of rooting. Plants produce natural auxin in their branches and young leaves, but synthetic auxin should be applied for better rooting (Rana et al. 1999; Preet and Rana 2014). Natural auxins are more sensitive to catabolism enzymes than synthetic auxins (Stenfanic and Vodnik 2007; Sharma and Rana 2015). The hardwood rooted cuttings of different kiwifruit cultivars, namely; Allison and Abbott, have been reported to produce the best rooting percentage and number of roots per cutting with the application of 4000 ppm IBA (Rana et al 2004). Whereas, leafy semi-hardwood cuttings taken from the apical and central parts of the current season's growth in late spring and mid-summer can be rooted under mist propagation chambers. In a study on the effect of different levels of IBA on the rooting of semi-hardwood cuttings of kiwifruit, the best results have been obtained with the treatment of 4000 ppm IBA (Singh et al. 2008). In general, the semi-hardwood cuttings of kiwifruit are known to have higher rooting success than the hardwood cuttings. The higher rooting potential of semi-hardwood cuttings has been attributed to the endogenous auxin in the tender vegetative growth of semi-hardwood cuttings (Hartmann et al. 1983).

In light of what has been said so far, the proposed study was done to find out how exotic cultivars root in hardwood and semi-hardwood kiwifruit cuttings when they are in a shadow net.

2. MATERIAL AND METHODS

Location and Climate: The experiments were carried out in the Department of Fruit Science, Dr. Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan (H.P.), in the kiwifruit block, which is located at 30o50'N latitude and 77o11'30" E longitude. The elevation is 1260 metres above sea level, and the yearly precipitation is 10-15 cm.

Planting Material: The hardwood and semi-hardwood cuttings were extracted from 3 year old vines of 8 exotic cultivars (Actinidia spp.) imported from the United States under the RKVY project in 2017, including Anna, Chung Bai, Cordifolia, Issai Kiwi, Kens Red, Meader Male, MSU Klur, and 74-49.

Experimental details: A Randomized Block Design (RBD) was used to plan the experiment. The cultivars were taken as treatment. Cuttings for this experiment were obtained in mid-January, and each treatment was reproduced three times with 30 cuttings per cultivar.

Preparation and planting cuttings in the nursery bed: In the experiment, well-matured dormant shoots of 25-30 cm in length and 0.5–1.0 cm in thickness with at least 3 healthy, bold buds were selected during mid-January. The cuttings were prepared under shade. The cuttings, after dipping in 4000 ppm IBA solution, were planted in a 1 x 1 m size nursery bed containing sand, forest soil, and FYM in a 1:1:1 ratio under shade net (50%) condition with proper ventilation and irrigation arrangement. For the preparation of a 4000 ppm IBA solution, 4 gram of Indole-3-butyric acid was weighed on an electronic balance and then dissolved in a small quantity of ethyl alcohol, followed by water to make a final volume of one litre. The cuttings were planted at an adequate spacing of 10 cm within each row and 10 cm between the rows.

Root characteristics: The rooted cuttings obtained from both the experiments were uprooted in the first week of January, 2020, and the following observations were recorded. The observations on the rooting parameters of kiwifruit cuttings were made as per standard methods. The total number of rooted cuttings was counted out of the total number of cuttings planted per cultivar and then calculated in percentage. The roots that emerged directly from the planted cuttings were designated as primary (main) roots. The total number of primary roots arising from each rooted cutting was recorded and was expressed as the average number of primary roots per cutting for each cultivar. The numbers of secondary roots which had directly arisen from the main roots of the same cutting were recorded by counting all the roots. This parameter was also represented as the average of the lateral roots acquired by the cuttings of each cultivar. The length of individual primary roots was measured with the help of a measuring tape was expressed in centimetres (cm). The soil of roots was removed by washing with tap water and then cut into small pieces from each of the individual cuts separately. The total length of these small pieces was measured for total root length with the help of the Comair Root Length Scanner and was expressed in centimetres (cm). The entire roots of an individual plant were cut into small pieces to measure the fresh weight of rooted cuttings and then accurately weighed on a Top Pan Electronic Balance. To record the dry weight of roots, the pieces of entire roots were dried in an oven at a temperature of 65 oC for about 48 hours until the constant weight of the sample was obtained. The fresh and dry weight of roots was expressed in grams (g).

3. RESULTS AND DISCUSSION

Rooting Characteristics:- The results of comparisons of exotic kiwifruit cultivars for their rooting behaviour in hardwood and semi-hardwood cuttings are given in Table 1. Results revealed that cultivar had a significant influence on various root characteristics, viz., number of primary roots, number of secondary roots, total root length, fresh and dry root weight in exotic kiwifruit cultivars. It is evident from the data presented in Table 1 that the number of primary roots per cutting ranged from 9.43 to 19.53 and 9.33 to 46.81 in hardwood cuttings and semi-hardwood cuttings, respectively. The highest number of primary roots in hardwood cuttings was recorded with the cultivar, Kens Red. In the case of semi-hardwood cuttings, the highest number of primary roots per cutting was also recorded with Kens Red. In general, the number of primary roots per cutting with the Kens Red cultivar was found to be significantly superior to all other cultivars under study. Biasi et al. (1990) have also reported the difference in the number of roots among different cultivars of kiwifruit. The cultivars Abbott and Allison had a significantly higher number of roots per cutting than the Bruno, Hayward, and Tomuri, whereas, Caldwell et al. (1988) recorded the best results for the Hayward cultivar. In the present study, the semi-hardwood cuttings have performed better than the hardwood cuttings. Ucler et al. (2004) reported that the cuttings taken in July had better rooting ability in terms of the number of main roots. The higher number of primary roots in semi-hardwood cuttings could be associated with the amount of endogenous auxins, carbohydrate availability, and other rooting co-factors.

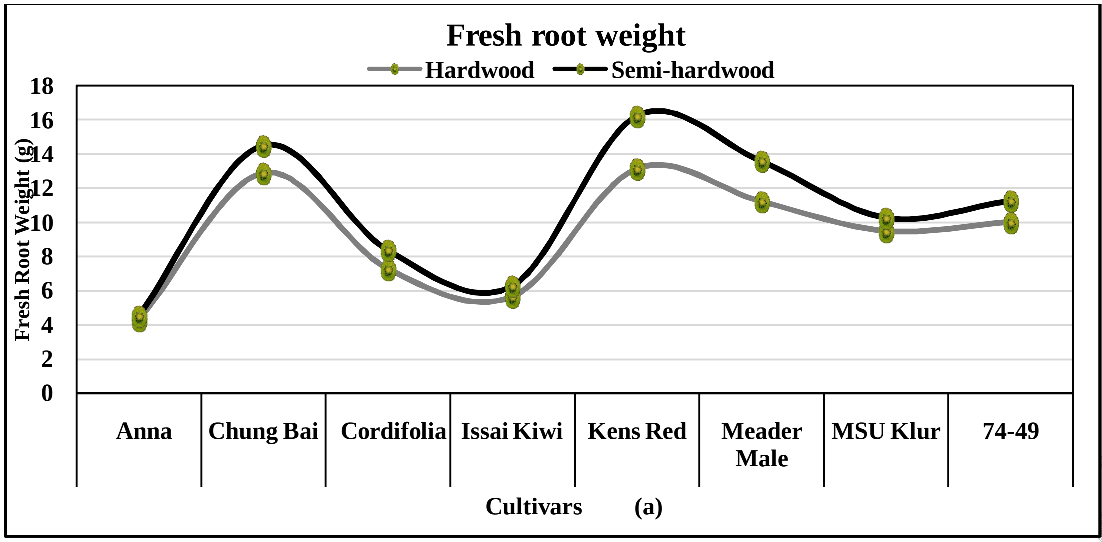
Similarly, the average number of secondary roots ranged from 61.09 to 83.10 and 50.61 to 109.88 in hardwood cuttings and semi-hardwood cuttings, respectively. The highest number of secondary roots in hardwood cuttings was recorded with Kens Red. Similarly, in semi-hardwood cuttings, the highest (109.88) number of secondary roots was recorded with Kens Red. Rahman et al. (2015) observed significant effects of rooting media besides other factors on the rooting characteristics. Cuttings with the maximum number of roots were found in cuttings planted on February 20th, while cuttings planted on January 20th had the minimum number of roots. Ercisli et al. (2002) also reported that kiwi cuttings planted in February produced more roots. The variation in rooting might be due to the climatic conditions during the time of planting. The temperature in winters is low, which does not favour the formation of roots, whereas in summers, the temperature, rainfall and humidity are conducive to the formation of roots.

Table 1 Different responses of cuttings of exotic kiwifruit cultivars on the rooting performance

Cultivar	Primary Roots		Secondary Roots		Total root length	
	Hardwood	Semi-hardwood	Hardwood	Semi-hardwood	Hardwood	Semi-hardwood
Anna	9.43	9.33	61.09	50.61	127.66	59.00
Chung Bai	17.11	29.90	76.50	85.40	256.33	98.66
Cordifolia	12.11	18.32	66.45	68.77	148.33	83.00
Issai Kiwi	10.53	11.33	64.23	55.03	142.33	65.33
Kens Red	19.53	46.81	83.10	109.88	273.66	128.33
Meader Male	16.10	39.55	74.66	96.86	209.66	114.33
MSU Klur	13.91	13.41	68.37	60.10	156.00	73.00
74-49	15.40	21.32	71.20	73.97	189.33	87.00
****$LSD_{0.05}$**	2.17	5.04	5.18	8.67	4.53	3.69

*Figures in parentheses are angular transformed values **Least significant difference

The data depicted in Figure 1a shows the influence of cultivars on the fresh root weight per cuttings. It is evident that the highest fresh root weight per cutting was recorded in the cultivar Kens Red and the lowest in the Anna cultivar in hardwood cutting. In the case of semi-hardwood cuttings, the highest fresh root weight was also recorded with Kens Red. The data on the dry weight of roots per cutting as influenced by different cultivars is illustrated in Figure 1b. A perusal of the data depicted in Figure 1b revealed that the highest dry root weight per cutting was recorded with the cultivar Kens Red and the lowest in Anna in both types of cuttings, viz., hardwood and semi-hardwood cuttings, respectively. As understandable, the dry weight of roots followed a similar trend to that of the fresh weight of roots per cutting. The present investigation revealed that the Kens Red cultivar exhibited the best performance in terms of percent rooted cutting and the least performance was noticed with the Anna cultivar. The poor rooting behaviour in cuttings of Anna cultivar in the present study might be attributed to their genetic constitution, besides their physiological conditions and anatomical characteristics. These findings are supported by the observations of Bartolini and Roselli (1979) and Bartolini et al. (1982), who found that eight Japanese plum cultivars rooted better than others of European plum cultivars. These results are also in conformity with the findings of Beyl et al. (1995), who studied the rooting characteristics of 13 kiwifruit cultivars. They reported that the cultivar significantly affected the number of roots, root grade, and length of the longest root. Goswami (1995) has reported that different cultivars significantly influence the rooting behaviour. According to Lawes and Sim (1980) and Valenta (1996), the percentage of rooted cuttings was higher in cuttings prepared in the summer than in those prepared in the winter season. The higher rooting success in semi-hardwood cuttings of kiwifruit might be due to the presence of more endogenous auxins in the tender vegetative growth of semi-hardwood cuttings (Hartmann et al. 1983).The results are also supported by the findings of Went (1938) who reported that the presence of leaves in the cuttings at the time of planting not only supplies nutrients but also specific root forming substances during rhizogenesis, which increases rooting by 30 percent.



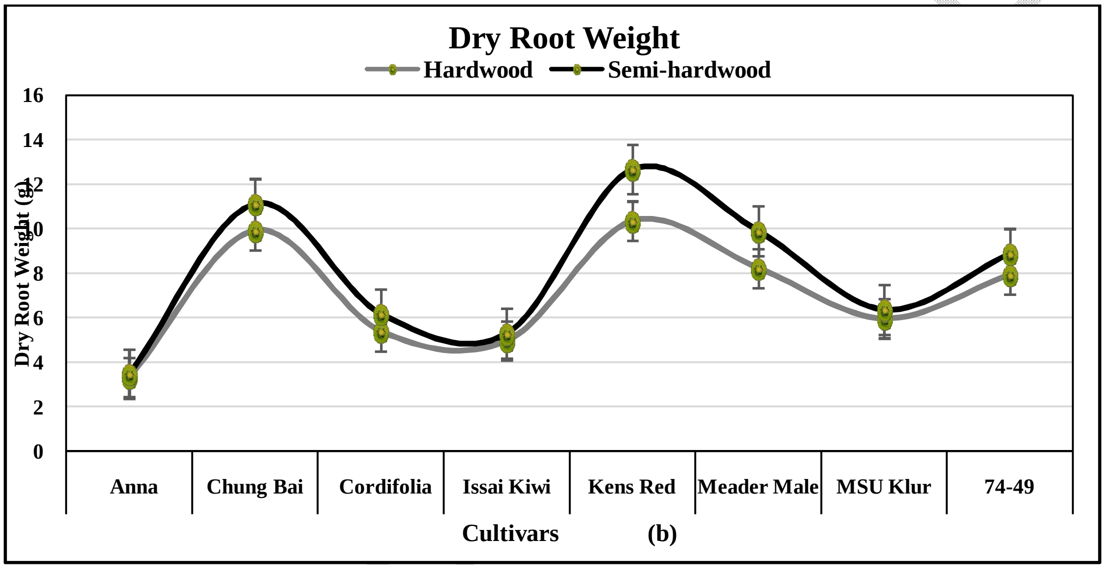


Figure 1 Different responses of cutting of exotic kiwifruit cultivars on the fresh and dry root weight

4. Conclusion

On the basis of analysis of data obtained from the present study, it may be concluded that among different cultivars, Kens Red was proved best cultivar followed by Chung Bai, Meader Male, 74-49, MSU Klur, Coridifolia, Issai Kiwi and Anna. Cultivar Kens Red exhibited finest performance in term of root characteristics. The cultivar Anna performed least on the basis of aforesaid parameters. Among different cutting types, semi-hardwood cuttings of different cultivars performed better as compared to hardwood cuttings with respect to parameters like number of primary roots, number of secondary roots, total root length (cm) and fresh and dry weight of roots per cutting. The information generated on the propagation of these new exotic kiwi-berry cultivars will serve as a basis for the researchers in developing new rootstocks for quality production of plants.

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