



Evaluation of Darjeeling mandarin on different rootstocks of citrus in Darjeeling and Kalimpong hills of West Bengal

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Received: 19-12-2019; Revised: 28-07-2020, Accepted: 30-07-2020

DOI : <https://doi.org/10.22271/09746315.2020.v16.i2.1327>

ABSTRACT

An experiment was conducted at ICAR-Indian Agricultural Research Institute (IARI), Regional Station, Kalimpong to evaluate the performance of Darjeeling mandarin on different rootstocks. Experiment was laid out in Randomized Block Design (RBD) with 7 treatments and 3 replications. Treatment details were T_1 - Trifoliolate orange T_2 - Rough Lemon, T_3 - Rangpur Lime, T_4 - Sour Orange, T_5 - Soh Sarkar, T_6 - Carrizo Citrange, T_7 - Taiwanica. With regard to budding success, Treatments T_2 , T_3 , T_4 , T_5 , T_7 were on par at 5% level of significance whereas lowest budding success (61.00 %) was observed in T_6 (Carrizo citrange). Highest rootstock length (12.06 cm), scion length (23.01 cm), number of leaves (15.77 cm) was recorded in Rough lemon which was found to be on par with Rangpur lime at 90 DAB (Days after budding). Maximum graft diameter (1.38 cm), shoot diameter (1.14 cm), shoot length (44.01) and leaves/plant (60.12) was recorded in Rough lemon at 180 DAB (Days after budding). The rootstocks rough lemon and rangpur lime were found to show vigorous effect on Darjeeling mandarin.

Keywords: Budding success, Darjeeling mandarin, Rangpur lime, rough lemon and trifoliolate orange

Citrus is third most important fruit crop in India after banana and mango. The most important commercial citrus groups in India are the mandarin (*Citrus reticulata* Blanco), followed by sweet orange (*Citrus sinensis* Osbeck) and acid lime (*Citrus aurantifolia* Swingle). A few ecotypes of mandarin (*Citrus reticulata* Blanco) including Sikkim mandarin, Darjeeling mandarin and Khasi mandarin are excellent in quality and have good export potential (Singh and Singh, 2006). The area and production of mandarin in India are 428 thousand ha and 5101 thousand tons, respectively. In West Bengal, mandarin occupies an area of 4.14 thousand ha with a production of 40.18 thousand tons and productivity of 9.71 thousand tons per ha (Horticultural Statistics, 2018). In Darjeeling and Kalimpong hills of West Bengal, mandarin is grown since time immemorial. However, the area and production of mandarin has been decreasing over the years. In 1999-2000, the mandarin cultivated area was 30,000 ha. In 2007-2008, it was 1972 hectares and now 1600 hectares area is under Darjeeling mandarin (Tarafer *et al.*, 2017). Over the past decade there has been a huge decline in mandarin production in the Darjeeling region due to some serious abiotic and biotic factors. The main reasons for decreasing area and production is due to attack of diseases (Citrus gummosis, CTV (Citrus Tristeza Virus), Citrus greening), pests (citrus trunk borer, fruit fly *etc.*), poor cultural practices, old and senile orchards and lack of quality planting materials. In Darjeeling and Kalimpong hills, mandarin is mostly propagated through seeds, most of the seedlings are obtained from diseased mother plant resulting in low

production. Vegetative propagation through budding/grafting ensures true to type to mother plant. Rootstocks are known to have profound effect on the vigour, precocity, productivity, internal quality, and longevity of the scion varieties grafted on them. They are also known to influence the susceptibility of trees to various diseases and insects. Furthermore, it is recognized that optimum performances depends on the proper selection of rootstocks for a given set of growing conditions. Rootstocks such as rough lemon is vigorous with extensive root system and have shown tolerance to tristeza, exocortis and xyloporosis (Wutscher, 1979) while Rangpur lime is tolerant to soil salinity (Walker and Douglas, 1983). Therefore, it is an appropriate time to review the general citrus rootstock situation as prevailing at this time and to consider the rootstocks available to the citrus growers in Darjeeling region with the change of time. While the problem of rootstock selection is important in all major fruit crops, it is of even greater importance in citrus due to tristeza virus disease now present in many areas of the world. Keeping in mind, the importance of rootstock and vegetative propagation through budding and grafting an experiment was conducted at research farm of IARI regional station, Kalimpong to evaluate the performance of different rootstocks on Darjeeling mandarin.

MATERIALS AND METHODS

One year old seedling of trifoliolate orange, rough lemon, rangpur lime, sour orange, soh sarkar, Carrizo

citrance and taiwanica were used as rootstocks. Experiment was carried out at IARI Regional Station Kalimpong, Farm, West Bengal. Scions of Darjeeling mandarin from healthy mother plants were selected and budding was done in the month of February and March 2017. Experiment was laid out in Randomized Block Design (RBD) with 7 treatments and 3 replications. Treatment details were T₁- Trifoliolate orange T₂- Rough Lemon, T₃- Rangpur Lime, T₄- Sour Orange, T₅- Soh Sarkar, T₆- Carrizo Citrange, T₇- Taiwanica. Observation for budding success percentage, days required for first sprouting, days required for 50% sprouting and various other growth parameters was taken. Statistical analysis of data was done by following the Fisher's Analysis of Variance (ANOVA) as given by Panse and Suhatme (1967).

RESULTS AND DISCUSSION

With regard to budding success, Treatments T₂, T₃, T₄, T₅, T₇ were on par at 5% level of significance whereas lowest budding success (61.00 %) was observed in T₆ (Carrizo citrange). The present finding is in conformity with the findings of Poon (1998) who worked on grafting of mandarin orange and found 88.73% success. Gautam *et al.*, 2001 reported 87.5% success while working on time of grafting and budding on trifoliolate orange whereas Adhikari (2006) reported 79.73% success in acid lime grafted onto trifoliolate orange rootstock. The reason for high grafting success may be accounted to rapid complete union of xylem and cambium tissue of the scion and rootstock favouring survival of the sprouts (Hartmann *et al.*, 1997). Data with regard to number of days taken for first sprouting is presented in the table 1. The data revealed that different rootstocks had significant effect on number of days taken to first sprouting. The scion

budded on trifoliolate orange required significantly minimum days in first sprouting *i.e.* 21.66 days while Carrizo citrange took maximum days *i.e.* 34.26 days. Also, T₆-Carrizo citrange took maximum days for 50 % sprouting (54.66) while trifoliolate orange took minimum days for 50 % sprouting (31.33). Similar findings were reported by Singh *et al.*, 2012.

Rootstock length was measured at 90 DAB (days after budding), highest rootstock length was recorded in Sour orange (12.27 cm); Rough lemon (12.06 cm) and Rangpur lime (11.99 cm) which were found to be at par 5% level of significance with regard to the said parameter (Table 2). Lowest rootstock length was recorded in Taiwanica (11.25 cm). Dubey and Singh, 2003 reported that the Darjeeling mandarin and Sikkim mandarin had maximum scion length when budded over the rough lemon rootstock. The higher length of scion shoot over rough lemon may be due to quick and strong formation of union between the rootstock and the bud (Skene *et al.*, 1983) and subsequently might be due to greater utilization of nutrient by sprouted shoot. With regard to Scion length, it was found treatments were found to be significant at 5% and 1% level of significance. Highest number of leaves were recorded in Rough Lemon (15.77) 90 DAB (days after budding) and Lowest was recorded in Taiwanica (6.10). There were no significant differences among the treatment with regard to number of internodes between the treatments. Maximum leaf area of 50.50 cm² was recorded in Rough Lemon which was found to be on par with Soh Sarkar (50.47 cm²) and Rangpur Lime (46.56 cm²) whereas minimum leaf area was recorded in Taiwanica (31.73 cm²) and Trifoliolate orange (35.77 cm²). The impact of citrus rootstocks is most commonly associated with plant stature, physiological (biotic and abiotic stresses) flowering,

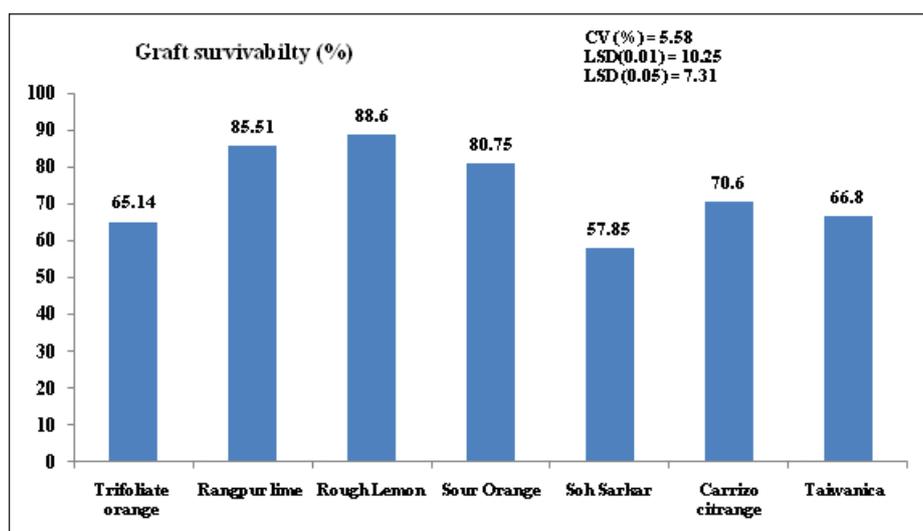


Fig. 1: Effect of different rootstock on bud survivability after 180 DAB (days after survivability)

Table 1: Effect of different rootstocks on budding and sprouting of Darjeeling mandarin

Rootstocks	Budding Success (%)	Days required for first sprouting	Days required for 50 % sprouting
Trifoliolate orange	78.00 (62.16) ^b	21.66 ^c	31.33 ^f
Rangpur Lime	89.00 (71.17) ^a	25.33 ^c	33.33 ^c
Rough Lemon	95.00 (78.35) ^a	24.00 ^d	34.33 ^e
Sour orange	95.00 (78.52) ^a	25.26 ^c	34.12 ^d
Soh Sarkar	91.00 (74.55) ^a	24.66 ^{cd}	38.33 ^e
Carrizo citrange	61.00 (71.56) ^c	34.26 ^a	54.66 ^a
Taiwanica	91.00 (72.99) ^a	26.66 ^b	47.33 ^b
CV (%)	4.21	2.61	1.32
LSD (0.05)	6.45	1.21	0.91

Note: Figure in parentheses indicate angular transformed values. Means in a column followed by the same letters are not significantly different at 5 % level of significance

Table 2: Effect of different rootstocks on plant growth characteristics at 90 days after budding

Rootstock	Rootstock length (cm)	Scion length (cm)	No. of leaves	No. of internodes	Maximum leaf area(cm ²)
Trifoliolate orange	11.08 ^{ab}	11.58 ^{dc}	7.19 ^{de}	7.67	35.77 ^c
Rangpur Lime	11.99 ^a	18.67 ^b	10.97 ^{bc}	7.65	46.56 ^a
Rough Lemon	12.06 ^a	23.01 ^a	15.77 ^a	10.33	50.50 ^a
Sour orange	12.27 ^a	16.98 ^{bc}	7.63 ^{de}	9.23	45.91 ^{ab}
Soh Sarkar	10.49 ^{bc}	12.99 ^{cd}	9.20 ^{cd}	8.36	50.47 ^a
Carrizo citrange	9.49 ^{ab}	8.29 ^e	12.20 ^b	10.25	38.91 ^{bc}
Taiwanica	11.25 ^c	12.20 ^{dc}	6.10 ^e	9.15	31.73 ^c
CV (%)	6.05	16.20	12.40	44.63	9.82
LSD (0.01)	1.69	5.99	3.05	NS	10.49
LSD (0.05)	1.21	4.27	2.17	NS	7.48

Note: Means in a column followed by the same letters are not significantly different at 5 % level of significance

Table 3: Effect of different rootstocks on plant growth characteristics at 180 DAB (days after budding)

Rootstock	Graft diameter (cm)	Shoot diameter (cm)	Shoot length (cm)	Leaves per plant (cm)
Trifoliolate orange	1.13 ^c	0.88 ^{cd}	30.03 ^c	52.53 ^b
Rangpur lime	1.26 ^b	0.98 ^b	39.24 ^{ab}	57.79 ^{ab}
Rough lemon	1.38 ^a	1.14 ^a	44.01 ^a	60.12 ^a
Sour Orange	1.12 ^c	0.89 ^{bc}	35.42 ^{bc}	56.83 ^{ab}
Soh Sarkar	1.05 ^{cd}	0.78 ^{de}	21.50 ^d	45.35 ^c
Carrizo citrange	1.06 ^{cd}	0.79 ^{de}	15.01 ^d	32.83 ^d
Taiwanica	1.03 ^d	0.75 ^e	18.46 ^d	30.24 ^d
CV (%)	4.11	5.80	16.13	6.78
LSD (0.01)	0.12	0.13	11.71	8.11
LSD (0.05)	0.08	0.09	8.35	5.78

Note: Means in a column followed by the same letters are not significantly different at 5 % level of significance

fruiting plants from controlling scion vigour (Goswami *et al.*, 2001) and its effect on different philological and biochemical parameters causing different in plant growth, productivity and fruit quality (Dubey and Sharma, 2016).

The effect of different rootstocks on plant growth characteristics at 180 DAB (Days after Budding) is presented in the table 3. Highest graft diameter, Shoot diameter, shoots length and number of leaves/plant was recorded in Rough lemon (1.38 cm), (1.14 cm), (44.01 cm) and (60.12) followed by Rangpur lime while lowest was recorded in Taiwanica followed by Carrizo citrange. Rootstock had significant effect on survivability of graft at 180 DAG (Fig. 1). Percent survivability was recorded maximum in Rough lemon (88.60%) as well as in Rangpur lime (85.51%), while it was recorded the minimum in Carrizo citrange (57.85%). Talukder *et al.*, 2015 reported maximum graft survivability of (82.90%) in Rough lemon and (81.17%) in Rangpur lime, while it was recorded the minimum in Calamonsi (65.63%).

The rootstocks rough lemon and rough lemon were found to show vigorous effect on Darjeeling mandarin.

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