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Effect of grafting height and scion length on growth of *Citrus reticulata* cv. Nagpur Mandarin grafts

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Abstract

The effects of grafting height (10 cm, 15 cm and 20 cm) and scion length (5 cm, 10 cm and 15 cm) on the growth performance of citrus cultivar Nagpur Mandarin as scion and Rough Lemon as rootstock were studied. The studies were carried out at the experimental field of Horticultural Research Farm, Andro, College of Agriculture, Central Agricultural University, Imphal during 1st April 2014 to 30th March 2015, with a view to find out the best grafting heights and scion length and their reciprocal influence of the rootstock and scion on each other. Plant height (56.18 cm), scion shoot length (39.72 cm), number of leaves (58.56), diameter above 2.5 cm of the graft union (0.90 cm), diameter below 2.5 cm of the graft union (1.05 cm) and girth (0.99 cm) were observed maximum when 15 cm scion length were grafted at 15 cm height. Maximum success percentage (96.67 %) was observed when 10 cm scion length was grafted at 15 cm height.

Keywords: Rootstock, rough lemon, grafting, reciprocal influence

Introduction

Citrus industry in India is the third largest fruit industry of the country after Mango and Banana. The total diversity of *Citrus* and its wild relative's world over is spread over 33 genera and 224 species (Swingle and Reece, 1967) ^[1]. In India 27 species of *Citrus* is being reported (Anonymous, 1950) ^[2] of which 23 species is available in North East Region of India. The rich wealth of *Citrus* genetic resources makes India to enjoy a remarkable position in the “*Citrus* belt of the world”. The North-East region of India and the parts of North-Western India is considered the best locations for collecting primitive *Citrus* germplasm (Singh, 1981) ^[3]. Even though there is availability of large germplasm and suitable conditions of NER that favours the growth. *Citrus* industry of the region is in poor shape as its productivity is extremely low. Absence of disease free planting material, plantation of nucellar plantlets, plantation at slopes without taking up measures of nutrient conservation, high rainfall leading to soil acidity, higher incidence of various insects and pests due to high humidity and rainfall conditions are major factors for low productivity of the region.

In India, citrus trees are propagated both by seeds and vegetative means. Seed propagation is still practiced in the case of acid limes and to produce rootstocks for budding purposes. Shield or T-budding is the most commonly used method of vegetative propagation. Budding is generally done either in spring or in September.

However, in North-East India, citrus cultivation depends on seedling with seed source such as home collection, processing industries without any serious efforts for getting good quality planting materials. The seedlings obtained from such seed sources results into varieties of problem like variation in growth behaviour, commencement of fruiting, yield and quality and thereby rendering considerable degrees of difficulties in cultural operations and subsequently disposal of the produce. On the other hand, employment of vegetative propagation technique like budding, grafting, etc. have been advocated for quality planting materials in majority of fruit crops. Considerable success has been made to multiply citrus on the commercial scale by budding.

Off-late, wedge-grafting of citrus has been tried with fair amount of success, yet it requires further investigation for fullest utilization of the technique in terms of grafting height and scion length. Therefore, the objective of this study was to determine the best grafting height and scion length and their reciprocal effect on growth of citrus plants.

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Materials and Methods

The study was carried out in the experimental field of Horticultural Research Farm, Andro, College of Agriculture, Central Agricultural University, Imphal during 1st April 2014 to 30th March 2015. Nagpur Mandarin as scion and Rough Lemon seedlings as rootstock were used for the study. About 2-3 cm long two smooth slanting cuts was made at the proximal end of the scion on both sides opposite to each other in such a way that the end portion became very thin. It was done with the help of sharp knife. The smooth long slanting cuts at the base of the scion gave an appearance of a sharp chisel. The rootstock was at first beheaded by giving a cut and then a vertical split cut was made by a thin and sharp bladed grafting knife at the centre of the cut surface of the stock having a depth of approximately 2-3 cm. Then, the scion was inserted into the wedge cut of rootstock through slight opening the splits. Thus, both components were brought into close contact particularly cambia in face to face and tied firmly with polythene strip. After wrapping the graft union, the scion along with the union portion was covered with a polythene cap to protect the scion from loss of moisture through transpiration.

The scion with three lengths (5 cm, 10 cm and 15 cm) were tried at three different heights (10 cm, 15 cm and 20 cm heights from the ground level), comprising 9 treatment combinations (3x3). The two-factor experiment consisting of 9 treatment combinations was laid out in Factorial Randomized Block Design (FRBD) with three replications. For each treatment combination grafting operations were performed on ten rootstocks. Thus, in total grafts 3 x 3 x 10 x 3 = 270 were made. Treatments were following:

Factor A: Grafting Height (3)

- i. 10 cm (G₁) ii. 15 cm (G₂) iii. 20 cm (G₃)

Factor B: Scion Length (3)

- i. 5 cm (S₁) ii. 10 cm (S₂) iii. 15 cm (S₃)

The observations were recorded on success percentage (%), plant height (cm), scion shoot length (cm), girth of the scion shoot (cm), diameter above and below 2.5 cm of the graft union (cm) and number of leaves at 1 month interval up to 360 days after grafting. The means of all the treatments after 360 days of the observations were calculated and the analyses of variances (ANOVA) for all the characters were performed by 'F' variance test. The significance of differences between treatments means were compared by Least Significant Difference (LSD) test (Gomez and Gomez, 1993) [4].

Results and Discussion

Success Percentage

Effect of Grafting Height

Different grafting height had non-significant influence on success of the graft union among the treatments (Table 1). However, maximum success percentage of the graft union was observed in grafting height 15 cm (G₂), whereas minimum success was observed in grafting height 10 cm (G₁). The present finding is in conformity with the findings of Poon (1998) [5] who worked on grafting of mandarin orange and found 88.73% success. Guatam *et al.* (2011) [6] reported 87.5% success while working on time of grafting and budding on trifoliate orange whereas Adhikari (2006) [7] reported 79.73% success in acid lime grafted onto trifoliate orange rootstock. Similarly, Chalise *et al.* (2013) [8] who observed

99.37% success at 16 cm grafting height in acid lime sapling also lends an ample support to the present findings.

Effect of scion length

Different scion length was found to have significant influence on success of the graft union (Table 1). The maximum success percentage was observed in scion length 10 cm (S₂), whereas minimum success was observed in scion length 5 cm (S₁). The highest percentage of success as observed with 10 cm scion length as compared to the 5 cm and 15 cm graft height might have resulted for a faster graft take probably due to more rapid formation of callus and vascular continuity. Similar kind of observation was showed by the earlier work of Chakrabarty and Sadhu (1984) [9] in Mango. Saifullah (2004) [10] also reported highest success (93.3% at 90 days after grafting in mango cv. Amrapalli when 10 cm long scion was used.

Effect of grafting height and scion length interaction

Grafting height and scion length interaction exhibited non-significant difference among the different treatments combination on success of the graft union (Fig. 1 and Table 1). However, maximum success percentage was observed in treatment combination S₂G₂ (10 x 15 cm), whereas minimum success percentage was recorded in treatment combination S₁G₁ (5 x 10 cm). The maximum graft success observed in graft combination S₂G₂ (10 x 15 cm) may be accounted to rapid completion of union of xylem and cambium tissue of the scion and rootstock favouring survival of the sprout.

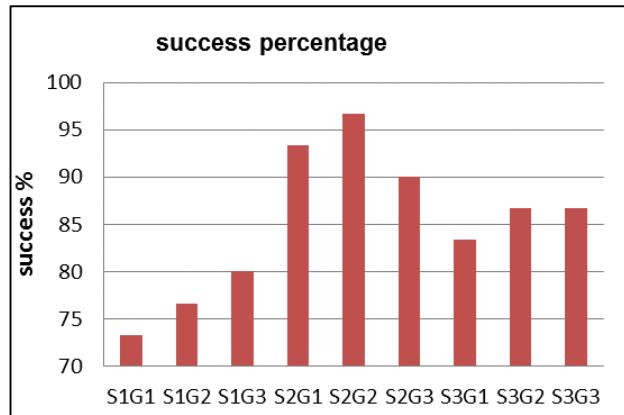


Fig 1: Effect of grafting height and scion length on success %.

a) Growth Characters

Effect of grafting height on growth

Plant height, scion shoot length, diameter of stock and scion, girth of scion shoot and leaf numbers were significantly affected by grafting height (Table 1). In general, higher values were recorded for almost all these parameters in plants with grafting height 15 cm than those with 10 and 20 cm grafting height. However, in case of internode length, grafting height 20 cm was found to be maximum and 15 cm to be minimum which is at par with 10 cm graft height.

The significant differences observed in plant height, scion shoot length, diameter above and below the union and girth due to different grafting height might be due to different variations in the level of graft union, time required for bud breaking and amount of nutrient supply to the growing shoot. The present finding is in conformity with the earlier work of Singh (2001) [11] who reported that plant growth was significantly affected by grafting height, with grafting at 15 cm to be the highest in Apple cvs. MM111, M9, M7 and Crab seedling. However, these results are in sharp contrast to the

earlier work of Sampaio (1993)^[12] who reported that vegetative development of Valencia orange plants were not affected by budding heights of 15, 25 and 35 cm respectively.

Effect of scion length on growth

Plant height, scion shoot length, diameter of stock and scion, girth of scion shoot and number of leaf were also found to be significantly affected by scion length (Table 1). Scion length 15 cm recorded the maximum values as against the lowest values in 5 cm graft almost all the parameters except for length of internode, where maximum value was recorded at 20 cm and minimum at 10 cm long scion stick (Table 1). The maximum values observed in 15 cm scion length in the present findings might be probably due to more food materials reserved in longer scion that enhanced early bud break and leaf opening, thereby, resulting in maximum growth. The maximum plant height (51.11 cm) and scion shoot length (36.31 cm) were observed in 15 cm scion length. These results are in conformity with the results of Alam *et al.*, (2006)^[13] on Mango who reported that scions of 15 cm length produced the longest shoot. Similarly, Majumder *et al.*, (1972)^[14] compared 5, 7.5, 10 and 12.5 cm scion length in Mango and concluded that the grafts having larger scions made more linear growth of scion shoot. Sadhu (1992)^[15] was also of the view that scions of 15 cm long in Sapota resulted in taller grafts.

In another experiment, 10 cm long scions showed better performance than those of 5 and 15 cm length in Mango (Chakrabarty and Sadhu, 1984)^[9]. Kanwar and Bawja (1974)^[16] reported that there was no appreciable effect of length of scions on the linear growth of successful grafts in Mango side-grafting.

Table 1: Effect of grafting height and scion length on success percentage, plant height, number of leaf, scion shoot length, girth, diameter above and below 2.5 cm of the graft union.

Treatment	Success Percentage	Plant Height (cm)	Number of Leaf	Scion Shoot Length (cm)	Girth (cm)	Diameter Above 2.5 cm of The Union (cm)	Diameter Below 2.5 cm of The Union (cm)
Grafting Height							
G ₁	83.33 (67.62)	45.30	53.35	31.69	0.89	0.73	0.93
G ₂	86.67 (71.54)	52.92	55.78	36.14	0.96	0.82	0.99
G ₃	85.56 (69.26)	45.75	54.14	31.81	0.91	0.81	0.96
SE(d) \pm	3.78	0.92	0.54	0.55	0.02	0.02	0.02
CD(0.05)	NS	1.94	1.14	1.16	0.04	0.05	0.04
Scion Length							
S ₁	76.67 (61.62)	43.80	52.41	28.91	0.88	0.71	0.93
S ₂	93.33 (78.86)	49.06	54.23	34.42	0.93	0.82	0.96
S ₃	85.56 (67.95)	51.11	56.63	36.31	0.95	0.83	1.00
SE(d) \pm	3.78	0.92	0.54	0.55	0.02	0.02	0.02
CD(0.05)	8.01	1.94	1.14	1.16	0.04	0.05	0.04
Grafting height and scion length interaction (SxG)							
S ₁ G ₁	73.33 (59.00)	41.20	51.07	26.20	0.81	0.66	0.90
S ₁ G ₂	76.67 (61.92)	48.80	52.94	31.40	0.94	0.71	0.94
S ₁ G ₃	80.00 (63.93)	41.40	53.22	29.13	0.88	0.78	0.93
S ₂ G ₁	93.33 (77.71)	47.39	54.32	34.84	0.91	0.74	0.97
S ₂ G ₂	96.67 (83.86)	53.77	55.84	37.31	0.94	0.86	0.97
S ₂ G ₃	90.00 (75.00)	46.02	52.52	31.10	0.94	0.87	0.93
S ₃ G ₁	83.33 (66.14)	47.31	54.67	34.02	0.95	0.80	0.93
S ₃ G ₂	86.67 (68.86)	56.18	58.56	39.72	0.99	0.90	1.05
S ₃ G ₃	86.67 (68.86)	49.84	56.66	35.19	0.92	0.79	1.02
SE(d) \pm	6.54	1.59	0.93	0.95	0.03	0.04	0.03
CD(0.05)	NS	3.36	1.98	2.01	0.06	0.08	0.07

G₁ = 10 cm, G₂ = 15 cm and G₃ = 20 cm; S₁ = 5 cm, S₂ = 10 cm and S₃ = 15 cm; NS = Non-significant at 5 % level of significance. (Figure in the parenthesis are angular transformed values.

Interaction effect of grafting height and scion length on growth

Plant height, scion shoot length, diameter of stock and scion, girth of scion shoot and leaf numbers were significantly affected by grafting height and scion length interaction at the end of the observation i.e., 360 days after grafting (Fig. 2, 3 and 4; Table 1). The treatment combination S₃G₂ (15 x 15 cm) produced maximum values and treatment combination S₁G₁ (5 x 10 cm) produced minimum values for these parameters. The highest value in terms of plant height, scion shoot length, diameter of stock and scion, girth of scion shoot, number of node, number of leaf, leaf area, root length and diameter, fresh and dry weight of shoots and roots observed in the treatment combination (S₃G₂) may be ascribed to its ability to build up more of the photosynthates and its subsequent partitioning thereby resulting into development of greater framework such as height, leaf area, number of nodes, diameter of the stem and total root volume etc.

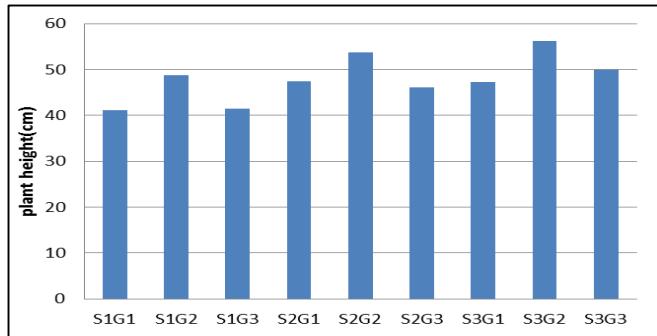


Fig 2: Effect of grafting height and scion length on plant height

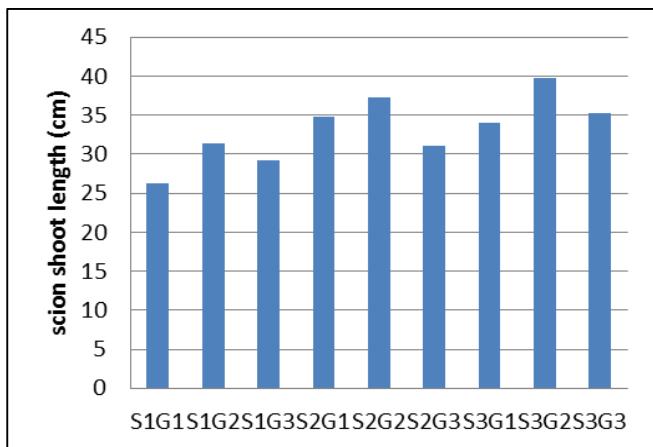


Fig 3: Effect of grafting height and scion length on scion shoot length

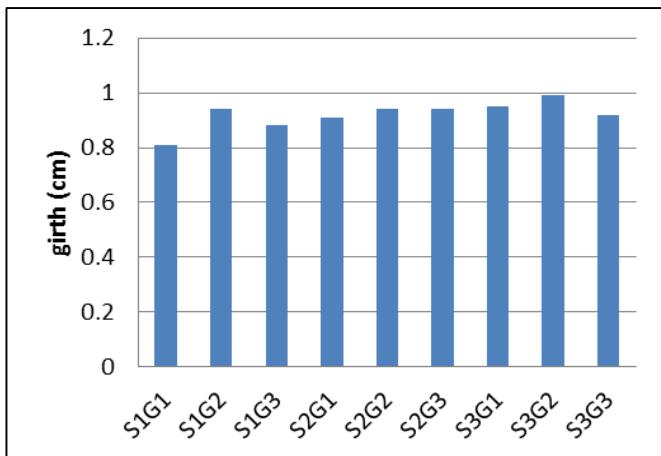


Fig 4: Effect of grafting height and scion length on girth

In conclusion, 15 cm scion length when grafted at 15 cm height exhibited best results in terms of desirable quality parameters of sapling within a year of grafting of Nagpur Mandarin onto rough lemon rootstock with success upto 96.67%. However, recommendation for future course will require a further investigation for reaffirmation.

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