

# Effect of grafting dates and wrapping materials on grafting success of apple (*Malus domestica* cv. Royal Delicious) in Jumla, Nepal

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**ABSTRACT:** Grafting is a successful method of propagation of cultivated apple (*Malus domestica* Borkh.). However, the most suitable grafting date and wrapping material have not been well understood. The field experiment was conducted to study the effect of grafting dates and wrapping materials on grafting success of royal delicious apple at Horticulture Research Station, Jumla of Karnali Province. The experiment was laid out in Two Factorial Randomized Complete Block Design (RCBD) with four replications. The treatments span four grafting dates (25th February, 4th March, 11th March, and 18th March of 2018) and two wrapping materials (grafting tape and normal plastic). Data for different parameters were taken at 60 days after grafting (DAG) and 90 DAG. The results revealed that the treatment of grafting date March 11 and grafting tape recorded minimum days (24.38) for first sprouting, minimum days (28.88) for 50% sprouting, maximum success percentage (92.51%), maximum increment in length (54.88 cm), and highest number of fully opened leaves (23.62) of grafted scions at 90 DAG. The results indicate that the suitable time for grafting of royal delicious apple is between 1st and 2nd weeks of March and suitable wrapping materials is grafting tape. The orchard or nursery owners of Jumla are suggested to carry out grafting in first half of March and to use grafting tape as wrapping material of graft.

**Keywords:** Apple, grafting dates, grafting success, scion, wrapping materials.

## INTRODUCTION

Apple (*Malus domestica* Borkh.,  $2n = 34$ ) is a major temperate fruit, which is commercially grown all over temperate region of the world (Velasco et al., 2010). It belongs to family Rosaceae, subfamily Pomoideae (Collett, 2011), and tribe Pyreae (Velasco et al., 2010). The cultivated apple (*Malus domestica* Borkh.) is an interspecific hybrid of ancestor *M. sieversii* (Lodeb.) Roem., which hybridized both European and Asian species during its domestication (Ibanez and Dandekar, 2007). There are several hypotheses regarding origin of apple. The accurate origin of the present apple is not clear; however, it is believed to be evolved from apple forest of central Asia (Collett, 2011), Kazakhstan to be more exact (Hull, 2019).

Apple is a cross-pollinated plant (Viana et al., 2019) and pollination is fundamental as well as enhance production (Chauhan et al., 2004). It does not become true to type when propagated through seed; therefore, vegetative means are necessary. The vegetative propagation employs grafting or budding or layering (Kumar, 1996). Generally, two chip budding is done while grafting can be done in two methods: tongue grafting and cleft grafting. Cleft grafting is the most successful method of grafting. At mean time, cleft grafting is done for top working to rejuvenate old trees or to change variety (Cholid et al., 2014).

The discovery of grafting as vegetative propagation method improved fruit quality faster than before (Pereira-

Lorenzo et al., 2009). Moreover, grafting of seedlings with dwarfing rootstock make earlier flowering (Jain and Priyadarshan, 2009). Grafting influences the yield (Maršić and Osvald, 2004), quality (Rouphael et al., 2010), and post-harvest life (Fallik and Ilic, 2015) of fruits and vegetables. Time and method of grafting affect the success of grafting (Kumar et al., 2014). Similarly, wrapping materials influence grafting success as it prevented desiccations of cut surface and increased callus formation that has positive effect on the growth of apples (Zenginbal et al., 2006).

At the same time, the selection of suitable grafting date and wrapping materials remains major consideration for the success or failure of the apple propagation. Farmers or orchard owners are not well known about the most suitable date and wrapping material for grafting at particular location such as Jumla. Jumla is an organic district with increasing cultivation area and production of organic apples. Government of Nepal is supporting local apple growers of Jumla for organic apple cultivation as a cash crop to uplift livelihood (Christensen and Gaire, 2015).

Red delicious is a popular variety in Nepal and other south Asian countries. The fruit is long and conical in shape with protuberance near calyx. Its skin is yellow with red stripes, but not all over the surface. Moreover, it is firm, sweet, and juicy (Peng and Lu, 2006) and matures tentatively in the third week of August. In this scenario, it is important to study the effect of different grafting dated and wrapping materials in order to find out most suitable for highest grafting success in red delicious cultivar in Jumla, Nepal.

## MATERIALS AND METHODS

### Site of experiment

The experiment was carried out at Horticulture Research Station, Rajikot, Jumla, Nepal during January to July of 2018. Jumla locates at high altitude of mountainous region of Karnali Province of Nepal (Christensen and Gaire, 2015). It is situated in longitude between 81° 28' E to 82° 18' E and latitude between 28° 58' N to 29° 30' N. The elevation ranges 915 to 4679 m above sea level.

### Experimental design and treatments

The experiment was laid out in two factorial randomized complete block design (RCBD) with eight treatment combinations and four replications of each. There are two factors: factor 1 is grafting dates (D) and factor 2 is wrapping materials (W). Grafting dates includes: D<sub>1</sub>- 25th February 2018, D<sub>2</sub>- 4th March 2018, D<sub>3</sub>- 11th March 2018, and D<sub>4</sub>- 18th March 2018. Similarly, wrapping materials includes: W<sub>1</sub>- grafting tape and W<sub>2</sub>- normal plastic. The

treatment combination includes D<sub>1</sub>W<sub>1</sub>, D<sub>2</sub>W<sub>1</sub>, D<sub>3</sub>W<sub>1</sub>, D<sub>4</sub>W<sub>1</sub>, D<sub>1</sub>W<sub>2</sub>, D<sub>2</sub>W<sub>2</sub>, D<sub>3</sub>W<sub>2</sub>, and D<sub>4</sub>W<sub>2</sub>.

### Collection of scion sticks and rootstocks

Defoliated scion sticks of 6 to 8 month-old were collected without damaging the buds from the previous season growth. About 5 cm long scion wood of royal delicious apple having 2 to 3 healthy buds were cut into pieces with the help of secateurs. The indigenous rootstocks (Edimayal) of 1 year old were de-headed 15 cm above the crown region and the rootstocks were ready for grafting. The selected scions were cut slanted and make tongue. Similarly, the rootstocks were cut slanted to form tongue. The scions were inserted into the rootstocks completing tongue grafting which is strong enough to resist the wind breakage and mechanical shaking during intercultural operations. Ten plants were selected under each treatment and the plants were wrapped with grafting tape and normal plastic to avoid desiccation of the graft (Figure 1).

### Data collection and analysis

The data for different parameters viz., length of scion, number of leaves of new shoot, scion diameter was taken at 60 and 90 days after grafting (DAG), whereas, days to first sprout, days to 50% sprouts and success rate were taken at once. Collected data were entered into Excel sheet and subjected to analysis of variance (ANOVA) by means of least significant difference (LSD) test at  $p < 0.05$ . Statistical analysis was done using GenStat.

## RESULTS AND DISCUSSION

The least days took place for first sprouting (24.38) and 50% sprouting (28.88) when grafting was done on 11th March. The maximum increment in length of new shoots (14.28 cm, 54.88 cm), maximum number of leaves (9.51, 23.62) of sprouted scion, maximum increment in scion diameter (2.04 mm, 6.12 mm), and highest grafting success (92.5%) were recorded in the rootstocks grafted on 11th March at 60 DAG and 90 DAG (Table 1). The grafting dates did not significantly influenced number of leaves on scion. But, scion diameter and scion lengths were significantly influenced by date of grafting.

Among wrapping materials, grafted rootstocks tied with grafting tape recorded minimum days to first sprouts (29.62), minimum days to 50% sprouts (35.5), maximum number of leaves (8.05, 23.62) of sprouted scion, maximum increment in length of new shoots (12.07 cm, 51.38 cm), and highest success percentage (89.19%) were recorded among the rootstocks grafted on 11th March at 60 and 90 DAG as compared to other grafting



**Figure 1.** Collected scions ready for grafting (left) and experiment plots (right).

**Table 1.** Effect of grafting dates on grafting success of Royal delicious apple (*Malus domestica* cv. Royal Delicious) in Jumla, 2018.

Treatments	Days to first sprouts	Days to 50% sprouts	Length of scion (cm)		Number of leaves of new shoots		Scion diameter (mm)		Success percentage (%)
			At 60 DAG	At 90 DAG	At 60 DAG	At 90 DAG	At 60 DAG	At 90 DAG	
25 February	37.75 <sup>b</sup>	44.5 <sup>d</sup>	10.58 <sup>b</sup>	46.15 <sup>b</sup>	7.05 <sup>b</sup>	19.43 <sup>b</sup>	1.21	3.43	83.62 <sup>b</sup>
04 March	34.62 <sup>b</sup>	41.12 <sup>c</sup>	10.24 <sup>b</sup>	47.5 <sup>b</sup>	6.83 <sup>b</sup>	18.70 <sup>b</sup>	1.89	5.66	86.25 <sup>b</sup>
11 March	24.38 <sup>a</sup>	28.88 <sup>a</sup>	14.28 <sup>a</sup>	54.88 <sup>a</sup>	9.51 <sup>a</sup>	23.62 <sup>a</sup>	2.04	6.12	92.5 <sup>a</sup>
18 march	27.8 <sup>a</sup>	32.5 <sup>b</sup>	10.21 <sup>b</sup>	46.62 <sup>a</sup>	6.81 <sup>b</sup>	19.57 <sup>b</sup>	1.92	5.75	84.25 <sup>b</sup>
SEm (±)	0.91	0.75	0.5	1.407	0.33	0.623	0.25	0.35	1.558
LSD (0.05)	2.66 <sup>**</sup>	2.214 <sup>**</sup>	1.47 <sup>**</sup>	4.14 <sup>**</sup>	0.98 <sup>**</sup>	1.83 <sup>**</sup>	0.08 <sup>ns</sup>	0.72 <sup>ns</sup>	4.58 <sup>**</sup>

Note: SEm(±), Standard Error of Mean; LSD, Least Significant Difference; Means in the column with same letter (s) in superscript indicate no significant difference between treatments at 0.05 level of significance; <sup>\*\*</sup> Significant at 0.01 level of Significance.

**Table 2.** Effect of wrapping materials on grafting success of Royal delicious apple (*Malus domestica* cv. Royal Delicious) in Jumla, 2018.

Treatments	Days to first sprouts	Days to 50% sprouts	Length of scion (cm)		Number of leaves of new shoots		Scion diameter (mm)		Success percentage (%)
			At 60 DAG	At 90 DAG	At 60 DAG	At 90 DAG	At 60 DAG	At 90 DAG	
Grafting tape	29.62 <sup>a</sup>	35.5 <sup>a</sup>	12.07 <sup>a</sup>	51.38 <sup>a</sup>	8.05 <sup>a</sup>	21.59 <sup>a</sup>	1.75 <sup>a</sup>	5.26 <sup>a</sup>	89.19 <sup>a</sup>
Normal plastic	32.69 <sup>b</sup>	38.06 <sup>b</sup>	10.58 <sup>b</sup>	46.2 <sup>b</sup>	7.05 <sup>b</sup>	19.07 <sup>b</sup>	1.77 <sup>a</sup>	5.31 <sup>a</sup>	84.12 <sup>b</sup>
SEm (±)	0.64	0.53	0.35	0.995	0.24	0.441	0.05	0.17	1.10
LSD (0.05)	1.88 <sup>**</sup>	1.566 <sup>**</sup>	1.04 <sup>**</sup>	2.93 <sup>**</sup>	0.69 <sup>**</sup>	1.29 <sup>**</sup>	0.17 <sup>sn</sup>	0.5 <sup>ns</sup>	3.24 <sup>*</sup>

Note: Sem (±), Standard Error of Mean; LSD, Least Significant Difference; Means in the column with same letter (s) in superscript indicate no significant difference between treatments at 0.05 level of significance; <sup>\*\*</sup> Significant at 0.01 level of Significance.

dates. But the maximum increment in diameter of scions (1.77 mm, 5.31 mm) were recorded among the grafted rootstocks tied with normal plastic at 60 and 90 DAG (Table 2).

In the interaction effect of grafting dates and wrapping materials, interaction between grafting date 11th March (D<sub>3</sub>) and grafting tape (W<sub>1</sub>) recorded significantly maximum increment in length of new shoots (16.4 cm) and maximum number of leaves (10.93) of sprouted scion at 60 DAG. These significance difference may be attributed due to combination of congenial weather conditions

prevailed during grafting in the month of March and proper wrapping materials, grafting tape which prevented desiccation of cut surface and increased callus formation that has positive effect on the growth of grafted scions (Zenginbal et al., 2006). Whereas, for other parameters, both the wrapping materials (grafting tape and normal plastic) and grafting dates were found non-significant (Table 3).

Dimri et al. (2005) reported tongue grafting on 1st March to be more superior for scion diameter and numbers of leaves. The experiment reveals that dates of grafting do

**Table 3.** Interaction effect of grafting dates and wrapping materials on grafting success of Royal Delicious apple (*Malus pumila* cv. Royal Delicious) in Jumla, 2018.

Treatments	Length of new shoot at 60 DAG		Number of leaves of new shoots at 60 DAG	
	W <sub>1</sub>	W <sub>2</sub>	W <sub>1</sub>	W <sub>2</sub>
D <sub>1</sub>	9.85 <sup>b</sup>	11.30 <sup>b</sup>	6.56 <sup>b</sup>	7.53 <sup>b</sup>
D <sub>2</sub>	11.6 <sup>b</sup>	8.88 <sup>b</sup>	7.73 <sup>b</sup>	5.91 <sup>b</sup>
D <sub>3</sub>	16.40 <sup>a</sup>	12.15 <sup>b</sup>	10.93 <sup>a</sup>	8.1 <sup>b</sup>
D <sub>4</sub>	10.43 <sup>b</sup>	10 <sup>b</sup>	6.95 <sup>b</sup>	6.66 <sup>b</sup>
SEm (±)	0.707	-	0.47	-
LSD (0.05)	2.08 <sup>*</sup>	-	1.38 <sup>**</sup>	-

Note: SEm (±), Standard Error of Mean; LSD, Least Significant Difference; Means in the column with same letter (s) in superscript indicate no significant difference between treatments at 0.05 level of significance; \*\*\*\* Significant at 0.01 level of Significance; \*\* Significant at 0.05 level of Significance.

not significantly affect the scion diameter; however, the highest scion diameter was recorded in grafting on 11th March at 60 and 90 DAG. In case of number of leaves on scion, dates had significant influence and highest number was observed on 11th March at 60 and 90 DAG.

It was found that grafting date, wrapping material, and both affect that success of grafting. February-March is suitable time for higher grafting success of temperate fruits in India and surrounding nations (Das et al., 2018). To be more exact, the most favourable date for success of grafting was found to be 1st to 2nd week of March in Jumla, Nepal. Moreover, grafting tape was found to prevent graft union from desiccation. Eventually, callus formation process was found to be enhanced. It is possible to perform grafting in the month of later March, but difficult to store scions sticks for long time as apple begins to sprouts from 4th week of March onward.

For higher grafting success rate, most suitable time for grafting royal delicious apple in Karnali region of Nepal is found to be 1st to 2nd week of March with grafting tape as wrapping material. In addition, good agricultural practices should be followed to increase productivity of grafted plant (Cholid et al., 2014).

## Conclusion

The grafting dates and wrapping materials had significant influence on days to sprouting, days to 50% sprouting, scion length, number of leaves in sprouted scion, and grafting success. The best increment in length of new shoots and number of leaves of sprouted scion at 60 DAG was D<sub>3</sub>W<sub>1</sub>, but not at 90 DAG. In Jumla, Nepal, apple orchard farmers and owners are suggested to carry out grafting from 1st to 2nd week of March and to use grafting tape as wrapping material.

## CONFLICT OF INTEREST

Authors declare that they have no conflict of interest.

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