EVALUATION OF DIFFERENT GRAFTING METHODS IN PROMISING KIWIFRUIT VARIETIES AT LUMLE, KASKI, NEPAL

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ABSTRACT

Kiwifruit is usually propagated by grafting and cutting. Suitable method of grafting in Kiwifruit should be identified to elaborate the commercial production. To evaluate the success rate of scion varieties with different grafting methods in Kiwifruit a study was conducted for two consecutive years 2018 and 2019 at Lumle, Kaski. Five different varieties of Kiwifruit as scion (Allison, Bruno, Hayward Oblong, Hayward Oval and Monty) and three different grafting methods (tongue, veneer and wedge) were used to identify successful method of grafting in Kiwifruit. Grafting was done on January 1st and 2nd in both years. In the first year, shoot length was recorded highest in Hayward Oblong with veneer grafting (96.10cm) whereas shoot diameter was obtained highest in Monty with wedge grafting (6.61mm). Similarly in the second year shoot length was recorded highest in Hayward Oblong with veneer grafting (97.10 cm) and shoot diameter was observed highest in Monty with wedge grafting (6.71mm). In both years, the highest (100%) graft success was recorded in Allison with wedge grafting.

Keywords: Allison, grafting, kiwifruit, wedge method

INTRODUCTION

Kiwifruit (*Actinidia spp.*) belonging to family Actinidiaceae has spread from China to the other parts of world rapidly (Abedini, 2004). There are about 66 species of Kiwifruit in the world and among them about 62 species are found in China (Wang and Zhang, 1994). *Actinidia deliciosa, A. chinensis, A. arguta* and *A. eriantha* are the four species with high economic value (Honghua *et al.*, 2017). Commercial cultivation of Kiwifruit has gaining worldwide popularity because of its wider climatic adaptability, delicious fruits, precocity, high nutritive and medicinal values and high economic return (Zhengyi *et al.*, 2007). Allison and Hayward Oblong are promising variety in terms of its quantitative parameters (Khanal *et al.*, 2021). It is considered as one of the best fruit due to its high nutritive value, especially vitamin C as compared to other fruits. Along with vitamin C, it has high amount of carbohydrates, proteins and minerals. Kiwifruit is basically consumed as fresh. Besides, it is used in fruit salads, jams, marmalades, cakes as well as in the juice industry too. In Nepal, Kiwifruit is being cultivated in 2116 hectare where productive area is 1167 hectare with production of 4254 mt and yield of 3.65 mt/ha (MoALD, 2021). Due to high capital investment for vines, trellises and a permanent irrigation system production of

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Kiwifruit is expensive. It takes about three to four years for commercial fruit production. In Nepal there is huge potentiality for high quality Kiwifruit production, but it left far behind because of market and lack of awareness and research on this crop. Therefore, there is ample opportunity in Nepal to increase commercial production of Kiwifruit for local as well as international export (Gotame *et al*., 2016).

Kiwifruit is cash crop and it's demand is increasing globally; it helps to improve the economic condition of Kiwifruit growers and nurserymen. Despite the increasing demand of the quality planting materials for the commercial production, farmers usually face the problem of low graft success with huge loss. Occurrence of graft incompatibility due to improper grafting method and unsuitable varietal selection might be the reason for graft failure. Kiwifruit plants are usually propagated by grafting scion varieties onto seedling rootstock or by rooting Kiwifruit cuttings. Grafting is a common method for propagation but its success rate depends on both the rootstock and grafting type (Sedaghathoor and Noie, 2016). They may also be propagated by seed, but the resulting plants are not guaranteed to be true to the parent plants. Identification of appropriate vegetative propagation technique is mandatory in order to reduce the gestation period, increase productivity and ensure uniform product quality. The practice of grafting using desirable scion cultivars upon suitable rootstock will offer good opportunities for the perpetuation of good cultivars and utilization of advantage of rootstock resistant to abiotic and biotic stresses. The objective of this experiment was to identify the appropriate scion variety for the wild rootstock along with method of grafting in order to elaborate the commercial production of Kiwifruit in mid hills of Nepal.

METHODOLOGY

This study on different grafting techniques in Kiwifruit was done for two consecutive years 2018 and 2019 at Directorate of Agricultural Research (DoAR), Lumle, Kaski, Nepal. Two factors; Factor A: Five different varieties of Kiwifruit as scion (Allison, Bruno, Hayward Oblong, Hayward Oval and Monty) and Factor B: three different grafting methods (tongue, veneer and wedge) were used to determine successful method of grafting in Kiwifruit. One year old seedlings of wild Kiwifruit (*Actinidia callosa*) were used as rootstock for all scion varieties. One year old terminal shoots ranging from 0.6 to 0.8 cm in diameter and 10 cm in length having 2 buds each were collected from the Kiwifruit orchard of Lumle, Kaski, Nepal. Grafting was performed on January 1st and 2nd in both year 2018 and 2019. After grafting, the grafted seedlings were placed in media prepared from the mixture of forest soil and sand. The grafts were placed under temporary callus house having restricted light and regulated temperature to enhance callus initiation and reduce grafting failure. De-suckering was regularly carried out to remove the unwanted sucker's growth from rootstock. Observations were recorded regarding the number of suckers per plant, graft union height, graft union diameter, shoot length, shoot diameter, rootstock

diameter, number of leaves and graft success percent. The data were entered using MS-Excel and analyzed through R-Studio for ANOVA. The least significant difference (LSD) was determined at 5% level of significance (Gomez and Gomez, 1984).

RESULTS AND DISCUSSIONS

EFFECTS OF VARIETY ON DIFFERENT PARAMETERS

During the first year of experiment, analysis of variance showed significant differences in three parameters viz; number of sucker/plant, graft union diameter (mm) and number of leaves among the tested varieties (Table 1). The number of sucker/plant was recorded maximum in Bruno and minimum in Hayward Oval (5.92 and 3.40 respectively). Graft union height ranged from 1.89cm in Hayward Oval to 2.20cm in Allison with insignificant difference. On the other hand, graft union diameter showed significant difference with the highest value with Monty (7.83 mm) followed by Allison (7.72 mm). Number of leaves was recorded maximum in Allison (8.46) followed by Hayward Oval (7.13). Graft success ranged from 57.33% in Hayward Oblong to 84.00 % in Hayward Oval (Table 1).

Similarly in the second year, analysis of variance showed significant differences in case of scion variety in four different parameters viz; number of sucker per plant, graft union diameter (mm), rootstock diameter (mm) and no. of leaves. The number of sucker/plant was recorded maximum in Bruno and minimum in Hayward Oval (6.12 and 3.60 respectively). The varieties were insignificantly different in graft union height with the value ranged from 2.09 cm in Hayward Oval to 2.40 cm in Allison. Graft union diameter showed significant difference among the variety with the maximum diameter in Monty (8.03 mm) followed by Allison (7.92 mm). Rootstock diameter was significantly higher in Allison (6.67 mm). Number of leaves was recorded maximum in Allison variety (8.66) followed by Hayward Oval variety (6.30). Graft success (%) ranged from 66.67 in Hayward Oblong to 84.00 in Hayward Oval (Table 2).

EFFECTS OF GRAFTING METHOD ON DIFFERENT PARAMETERS

The result from the first year of experiment showed significant differences in two parameters viz; graft union height (cm) and graft success (%) among the grafting methods (Table1). Grafting method did not show significant effect on number of sucker/ plant, graft union diameter, shoot length, shoot diameter, rootstock diameter and number of leaves. Graft union height significantly differed with grafting methods which had the highest value in tongue grafting (2.53 cm) followed by veneer grafting (2.10 cm). Final sprouting was also recorded maximum in tongue grafting (84%) followed by 82.4% in wedge grafting (Table 1).

Table 1. Performance of scion varieties under different grafting methods in Kiwifruit, Lumle, Kaski, 2018

Treatments	No. of sucker/ plant	Graft union height (cm)	Graft union diameter (mm)	Shoot length (cm)	Shoot diameter (mm)	Rootstock diameter (mm)	No. of leaves	Graft success (%)
Scion Variety								
Allison	4.68	2.20	7.72	66.46	5.64	6.57	8.46	73.33
Bruno	5.92	2.14	5.95	45.88	5.63	5.93	6.19	64.00
Hayward Oblong	4.19	2.02	6.75	75.42	5.54	6.06	6.10	57.33
Hayward Oval	3.40	1.89	7.10	57.80	5.79	8.00	7.13	84.00
Monty	5.11	1.95	7.83	52.59	5.91	6.44	6.89	72.00
Mean	4.66	2.04	7.07	59.63	5.70	6.60	6.95	70.13
CV (%)	32.47	32.41	20.15	53.77	14.03	48.27	30.23	40.54
P value	0.00	0.66	0.001	0.10	0.73	0.40	0.02	0.12
LSD (0.05)	1.10	NS	1.03	NS	NS	NS	1.53	NS
Grafting method								
Tongue	4.70	2.53	6.87	67.59	5.80	7.29	7.38	84.00
Veneer	4.54	2.10	7.11	53.38	5.42	6.30	6.58	44.00
Wedge	4.74	1.49	7.24	57.91	5.90	6.22	6.90	82.40
Mean	4.66	2.04	7.07	59.63	5.70	6.60	6.95	70.13
CV (%)	36.97	24.61	22.10	54.98	13.53	48.36	31.97	32.35
P value	0.91	0.00	0.69	0.29	0.07	0.42	0.44	0.00
LSD (0.05)	NS	0.28	NS	NS	NS	NS	NS	12.79
Variety*Grafting method								
Allison tongue	4.32	3.34	7.39	74.93	5.93	6.76	9.73	92
Allison veneer	3.52	1.88	7.97	32.60	5.02	6.33	6.12	28
Allison wedge	6.20	1.39	7.80	91.83	5.97	6.62	9.53	100
Bruno tongue	5.32	2.50	7.10	50.66	6.20	6.22	7.06	80
Bruno veneer	6.32	2.46	3.54	51.00	5.04	5.74	6.00	40
Bruno wedge	6.12	1.46	7.20	35.96	5.64	5.82	5.50	72
Hayward Oblong tongue	3.24	2.36	6.90	93.70	5.82	6.07	6.60	76
Hyward Oblong veneer	4.84	1.94	7.28	96.10	5.33	6.41	7.10	20
Hayward Oblong wedge	4.48	1.76	6.07	36.46	5.46	5.70	4.60	76
Hayward Oval tongue	4.84	2.18	6.26	56.90	5.24	11.23	6.36	92
Hayward Oval veneer	2.00	2.00	8.48	48.10	6.35	6.70	7.50	76
Hayward Oval wedge	3.36	1.48	6.55	68.40	5.78	6.06	7.53	84
Monty tongue	5.76	2.26	6.67	61.76	5.77	6.15	7.13	80

Treatments	No. of sucker/ plant	Graft union height (cm)	Graft union diameter (mm)	Shoot length (cm)	Shoot diameter (mm)	Rootstock diameter (mm)	No. of leaves	Graft success (%)
Monty veneer	6.04	2.20	8.25	39.10	5.33	6.29	6.20	56
Monty wedge	3.52	1.38	8.57	56.90	6.61	6.88	7.33	80
Mean	4.66	2.04	7.07	59.63	5.70	6.60	6.95	70.13
CV (%)	26.60	22.05	15.17	47.46	12.51	48.98	28.54	28.23
P value	0.00	0.00	0.00	0.00	0.01	0.61	0.05	0.02
LSD (0.05)	1.56	0.56	1.35	35.80	0.90	NS	NS	25.04

During the second year, significant differences were observed in two parameters viz; graft union height (cm) and graft success (%) among the grafting methods. Grafting method showed insignificant effect on number of sucker/plant with minimum in veneer grafting (4.74) and maximum in wedge grafting (4.94). Graft union height showed significant difference between the different grafting methods. The maximum height was measured in tongue grafting (2.73 cm) followed by wedge grafting (1.69 cm). Graft success was also recorded maximum in tongue grafting (88%) followed by 84.80 % in wedge grafting method (Table2).

INTERACTION EFFECTS AMONG VARIETY AND GRAFTING METHOD ON DIFFERENT PARAMETERS

In the first year, significant difference was recorded in case of interaction of scion variety and grafting method in six different parameters viz; final sprouting (%),number of sucker/plant, graft union height (cm), graft union diameter (mm), shoot length (cm), shoot diameter (mm) and graft success (%) (Table1). The number of sucker per plant was recorded maximum in Bruno scion variety grafted in veneer method (6.32) while graft union height was observed as highest with Allison variety grafted using tongue method (3.34cm). Likewise, the graft union diameter was recorded as highest in Monty scion variety grafted in wedge method (8.573mm). Shoot length was measured longest in Hayward Oblong variety grafted using veneer method (96.10 cm) whereas shoot diameter was measured shortest in Monty variety grafted by wedge method (6.616 mm). Rootstock diameter and number of leaves per graft did not show significant difference but the highest value was recorded in Hayward Oval variety grafted with tongue method and Allison variety grafted using tongue method (11.238 mm and 9.734 respectively). Graft success was maximum in Allison variety grafted using wedge method i.e. 100 % (Table 1).

In the second year, significant differences was recorded in case of interaction of scion variety and grafting method in seven different parameters viz; number of sucker/plant, graft union height (cm), graft union diameter (mm), shoot length (cm), shoot diameter (mm), rootstock diameter (mm) and number of leaves. The number

of sucker per plant was recorded maximum in Bruno variety grafted using veneer method (6.52). Likewise, graft union height was observed highest in Allison variety grafted using tongue method (3.54cm) and graft union diameter was recorded as highest in Monty variety grafted using wedge method (8.77mm). Shoot length was measured longest in Hayward Oblong grafted by veneer method (97.10 cm) whereas shoot diameter was recorded highest in Monty variety grafted using wedge method (6.71 mm). Maximum rootstock diameter was observed in Monty variety grafted using wedge method (6.98 mm) and maximum number of leaves per graft (9.93) was in Allison variety grafted using tongue method. Graft success was maximum in Allison variety grafted using wedge method i.e. 100 % (Table 2).

Table 2. Performance of scion varieties under different grafting methods in Kiwifruit, Lumle, Kaski, 2019

Treatments	Avg. no of sucker/ plant	Graft union height (cm)	Graft union diameter (mm)	Shoot length (cm)	Shoot diameter (mm)	Rootstock diameter (mm)	No. of leaves	Graft success (%)
Scion Variety								
Allison	4.88	2.40	7.92	67.46	5.81	6.67	8.66	80.00
Bruno	6.12	2.34	6.15	46.88	5.73	6.03	6.39	77.33
Hayward Oblong	4.39	2.22	6.95	76.42	5.64	6.16	6.30	66.67
Hayward Oval	3.60	2.09	7.30	58.80	5.89	6.30	7.33	84.00
Monty	5.31	2.15	8.03	53.59	6.07	6.54	7.09	78.67
Mean	4.86	2.24	7.27	60.63	5.83	6.34	7.15	77.33
CV (%)	30.29	31.49	19.91	51.67	13.12	9.62	27.93	27.72
P value	0.00	0.71	0.00	0.09	0.59	0.03	0.01	0.25
LSD (0.05)	1.07	NS	1.05	NS	NS	0.44	1.45	NS
Grafting method								
Tongue	4.90	2.73	7.07	68.59	5.94	6.31	7.58	88.00
Veneer	4.74	2.30	7.31	54.38	5.56	6.40	6.78	59.20
Wedge	4.94	1.69	7.44	58.91	6.00	6.32	7.10	84.80
Mean	4.86	2.24	7.27	60.63	5.83	6.34	7.15	77.33
CV (%)	34.73	24.88	21.77	52.92	12.75	10.20	29.74	22.71
P value	0.91	0.00	0.69	0.28	0.08	0.87	0.41	0.00
LSD (0.05)	NS	0.31	NS	NS	NS	NS	NS	9.90
Variety*Grafting method								
Allison tongue	4.52	3.54	7.59	75.93	6.03	6.86	9.93	92
Allison veneer	3.72	2.08	8.17	33.60	5.32	6.43	6.32	48
Allison wedge	6.40	1.59	8.00	92.83	6.07	6.72	9.73	100
Bruno	5.52	2.70	7.30	51.66	6.30	6.32	7.26	88

Treatments	Avg. no of sucker/ plant	Graft union height (cm)	Graft union diameter (mm)	Shoot length (cm)	Shoot diameter (mm)	Rootstock diameter (mm)	No. of leaves	Graft success (%)
tongue								
Bruno veneer	6.52	2.66	3.74	52.00	5.14	5.84	6.20	60
Bruno wedge	6.32	1.66	7.40	36.96	5.74	5.92	5.70	84
Hayward Oblong tongue	3.44	2.56	7.10	94.70	5.92	6.17	6.80	84
Hayward Oblong veneer	5.04	2.14	7.48	97.10	5.43	6.51	7.30	40
Hayward Oblong wedge	4.68	1.96	6.27	37.46	5.56	5.80	4.80	76
Hayward Oval tongue	5.04	2.38	6.46	57.90	5.34	5.93	6.56	92
Hayward Oval veneer	2.20	2.20	8.68	49.10	6.45	6.80	7.70	76
Hayward Oval wedge	3.56	1.68	6.75	69.40	5.88	6.16	7.73	84
Monty tongue	5.96	2.46	6.87	62.76	6.07	6.25	7.33	84
Monty veneer	6.24	2.40	8.45	40.10	5.43	6.39	6.40	72
Monty wedge	3.72	1.58	8.77	57.90	6.71	6.98	7.53	80
Mean	4.86	2.24	7.27	60.63	5.83	6.34	7.15	77.33
CV (%)	24.29	23.31	15.24	45.06	11.70	9.13	25.92	20.80
P value	0.00	0.03	0.00	0.00	0.01	0.04	0.02	0.051
LSD (0.05)	1.49	0.66	1.40	34.56	0.86	0.73	2.34	NS

In both years, the Allison variety of Kiwifruit grafted with wedge method gave maximum success rate. Taking average of both years, the Allison grafted with wedge method gave 100% final graft success followed by Allison with tongue method (92 %) and Hayward Oval with tongue (92%) (Figure 1).

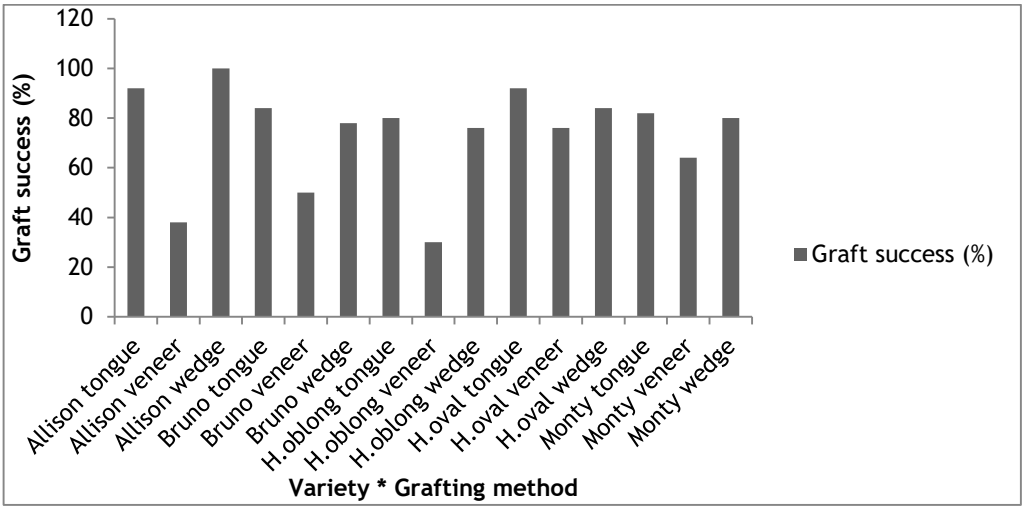

Figure1. Graft success (%) of different variety of Kiwifruit in different grafting method

Pandey et.al (2019) conducted an experiment at Bonch, Dolakha under callus house having restricted light and regulated temperature to enhance callus initiation for 2 months and transplanted in the main field. The effect of scion variety and wrapping materials on growth performance of kiwi seedling rootstock was studied and reported the maximum graft success (96.87%) and survival percentage of grafts (93.75%) in Allison variety which was statistically at par with Bruno and Hayward and the lowest graft success (73.44%) and survivability (64.21%) in Monty due to high mortality of the sprouted grafts. Sedaghathoor and Noie (2016) found that the highest graft union percentage (100%) was obtained under treatment cleft grafting × 'Bruno' rootstock and tongue grafting ×'Matua' rootstock at open field condition. The result of this study shows the higher graft success in tongue and wedge grafting. It might be due to the better attachment of cut surface of both rootstock and scion with formation of wound tissue for healing and cambial connectivity between stock and scion. Zenginbal (2007) in his study reported that among the grafting types, whip grafting was superior to chip budding and among varieties, Matua and Tomari were superior than others. Hartmann et.al (2007) reported that genetic factors had a significant effect on grafting success. So the varietal genetic composition may be crucial factor to graft success. To form a healthy graft union from two plants, it is dependent on their natural relationship (Sharma, 2002). The grafting success could be affected by several factors such as temperature, hygiene, pest and disease, humidity, developing capability of both scions (bud) and rootstock, grafting time and conservation of healing union against water loss and drying (Kaoka and Yılmaz, 1974; Tanimoto, 1994).

CONCLUSIONS

Graft success rate depends on scion variety and grafting method which influence various growth parameters and pomological traits of grafted plants such as plant height, leaves number, growth habit of the tree, time of fruit maturity and yield. From this study we can conclude that the different varieties of Kiwifruit prefer different grafting techniques. Only one method of grafting may not be suitable for all the varieties. All over, wedge grafting and tongue grafting gave better graft success rate in Kiwifruit than veneer grafting. In both years, graft success was better in Allison variety done with wedge grafting.

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