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Standardization of Rootstock for Almond Propagation under Sub Tropical conditions

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ABSTRACT: Recently, due to an increase in price of various commodities, almond cultivation has become a very profitable culture. This has changed the scenario of not only the productive sector, but also for breeders who have to face the challenges for satisfaction of the increased demands of commercial sector. There is a great need to produce the superior planting material. For successful vegetative propagation and trait improvement grafting is a common practice in horticultural plants. Taxonomic proximity between the root stock and scion acts as a general necessary condition for successful grafting and long survival of grafted plants. A close relationship between rootstock and scion is essential for the success of a grafting operation. The rootstock/scion compatibility is the most essential factor for their better performance and longevity in grafted plants. Graft incompatibility occurs due to graft type, unfavorable physiological responses across the graft union, transmission of virus and anatomical deformities of vascular tissue at the graft union. Hence an appropriate grafting method through a suitable rootstock is a prerequisite for successful grafting operation. The research study investigated different seed rootstocks (Kala Amritsari, Kabal Green Gage and Sharbati) and their reactions on almond cv. California Paper Shell through tongue and wedge grafting and their effect on success and survival of the grafts along with their vegetative growth. The experiment was carried out in Randomized Block Design with factorial arrangement in three replications in which the original factor of scion cultivar and sub factor of rootstock type was applied. The obtained results indicate that among propagation methods, tongue grafting was found to be superior to wedge grafting, whereas, among rootstocks Sharbati was superior to Kala Amritsar and Kabal Green Gage for days to bud break, graft success, survival, plant height, leaf production, leaf area, stock and scion girth. The trend of this study is the provision of the opportunity for further research in the productive year of the almond cultivation under sub tropical conditions.

Keywords: Girth, Grafting, Propagation, Rootstock, Sharbati, Sprouting, Success.

INTRODUCTION

Almond (*Prunus dulcis* Miller) is an especially nutrient-dense nut with growing scientific substantiation of its health benefits. Because of their serum lipid lowering effects it has gained the public's attention (Stephane *et al*., 2021). It belongs to family Rosaceae and sub family Prunoidae. It is of religious, ethnic and social significance and a symbol of divine approval. It is extensively known by the name of greek nut. Presently the scientific name, *Prunus dulcis* acknowledges its affinity with other prunus taxonomically on the basis of similar morphology, molecular-genetic relatedness and its hybridization with peach, apricot and plum. According to literature cited that *Prunus dulcis* has superseded the scientific name *Prunus amygdalus* (Gradziel, 2009). Botanically, almond is a drupe with a pubescent exocarp (skin) a fleshy but thin mesocarp (hull) and a distinct hardened endocarp (shell). Horticulturally, it is a nut with seed or kernel as an edible portion which is a commercial product (Mori *et al*., 2019). Almond application to health promotion and disease prevention is well known. Great interest has been reported in dietary modification in global incidence and severe complications in obesity and diabetes. Its consumption reduces colon cancer, inhibits cell growth and suppress tumour proliferation due to terpenoids in almond hull (Vincenzo and Grasso 2006). Almonds are a rich source of phytates and phenolic compounds reducing amylolytic digestion and post prandiel glycemia thus lowers serum glucose levels. Nuts contain dense energy with high levels of unsaturated fats (Autio and Krupa 2001). They are a rich source of vitamin E and various trace elements showing evidences regarding reduction of plasma cholesterol levels and other heart disease risk factors. Its positive role in healthy weight maintenance and fat loss has been reported by various researchers (Richardson *et al*., 2009). Almond is a highly nutritious nut. Its seed when raw, dried or in the powdered form are used in confectionary, cakes and pastry. Oil

extracted from it is used for flavoring and cooking. Its paste is preferred for decorating desserts and in making some baked goods. Burnt almond skin ash is used as a tooth powder which strengthens the teeth and gums. It is an excellent laxative (Bohria and Parle 2010). Vegetative propagation is an effective method for quality planting material. The performance of nut crops reveals the integration of genetic composition of scion and rootstock. Greater potential for more cultivable area under almond is by the use of appropriate rootstock. Rootstock selection criteria varies between almond seedling root for calcareous sites, peach seedling rootstock for acidic soils (Wani *et al*., 2012). Commonly peach is used as a rootstock for almond propagation. Almond when grown on peach roots has been reported to grow faster and bears heavily as compared to almond roots (Narir *et al*., 2002). There is a wider availability of plum rootstocks for fresh fruit production of the prunus species than other fruit species. According to the researchers, Shan-i-Punjab performs well with different prunus rootstock. Flordaguard improves the vegetative growth in terms of stock and scion growth parameters (Nagpal, 2019). The present study was based at the effect of rootstocks on success and survival of almond and the effect of rootstocks on vigour of almond .

MATERIAL AND METHODS

One-year-old seedling rootstocks of Kabal Green Gage, Kala Amritsari and Sharbati were procured and selected for grafting which were raised in plots at the Nursery, Khalsa College, Amritsar. The selected seedlings were healthy, vigorous, free from insect-pest and disease infestation, uniform in size and growth. One-year-old shoots of California Paper Shell almond were used as scion wood. The scion woods were healthy and disease-free. They had 3 to 5 well-developed buds with smooth internodes. These were collected during December-January. The scion woods were tongue grafted and wedge grafted in the middle of January. The plant protection measures were employed to impede the insect-pest and disease incidences. Grafts were watered regularly with required quantity of water. Side shoots arising from any portion of rootstock were removed regularly. For achieving success in grafting, different parameters were standardized keeping other factors at a constant level and varying the parameters to be standardized. The data was recorded at 120 days after grafting for plant height, shoot length, number of leaves, girth of plant, scion: stock ratio, plant spread while various rooting parameters, per cent survival and leaf area. The shoot with the opened leaves from the buds of scion was considered as the success of a graft. Results were calculated and expressed on a percentage basis. The number of survival grafts in each treatment was recorded at 120 DAG. Results were calculated and expressed on a percentage basis. The plant height was measured from the base of the plant to the tip of the plant with the help of measuring scale and was expressed as average per plant. All the leaves, irrespective of their size, on the scion shoot were counted and the average number of leaves per plant was calculated and presented in the results. The stionic girth was measured at the union point and the stock girth was measured at 9 cm below the graft union with the help of Vernier Calipers. The statistical analysis was carried out for each observed character under the study using OP Stat. The mean values of data were subjected to analysis of variance at 5 % level of significance and ANOVA was set as per Gomez and Gomez (1984) for Factorial Randomized Complete Block Design.

RESULTS AND DISCUSSION

Graft success per cent. Significant ($P < 0.05$) variation (Table 1) on the graft success of almond was recorded at 120 DAG with the highest graft success (71.67%) achieved when the almond seedlings were grafted on Sharbati rootstock. On the other hand, the minimum graft success (51.17%) was recorded in Kabal Green Gage. Higher graft success of almond grafted on Sharbati seedling might be due to better grafting compatibility which might be due to the genetic framework. Chakraborty and Singh (2011) found higher sprouting percentage with Sharbati rootstock which corroborates with the present findings. Jaipal *et al*. (2021) also suggested Sharbati rootstock to be superior which are in line with the present research. Highly significant ($P < 0.05$) variation was observed on the almond graft success due to the main effect of grafting technique. The highest graft success 63.33 per cent was achieved from tongue grafted plants closely followed by 58.56 per cent which was the minimum achieved in wedge grafted plants. Due to close contact of the cambial layer of rootstock and scion wood higher sprouting might be a possible in tongue grafting (Hartmann *et al*., 2002). The results of present findings are in confirmation with Plathia *et al*. (2016) who showed that tongue grafting showed highest bud take success in peach. Chauhan (2000); Dwivedi *et al*. (2000) in apricot, Joolka *et al*. (2001) in pecannut and Nagpal (2019) in peach also reported the same.

Survival percent. Among various rootstocks used Sharbati reported the highest (97.72) per cent survival while the lowest (91.11%) survival was achieved by the plants raised on Kabal Green Gage respectively (Table 1). The variation observed in survival per cent of almond grafts might be due to the better compatibility of the Sharbati rootstock under study. Quicker healing, more sprouting and growth of bud by easy swelling of buds led to more survival (Hartmann *et al*., 2002). The findings of Chakraborty and Singh (2011); Nagpal (2019) in peach are similar to the present results. Jaipal *et al*. (2021) also suggested Sharbati rootstock to be superior which are in line with the present findings. Significantly slight variations were found among the propagating methods employed in the study being the average maximum survival (95.71 %) calculated in the seedlings propagated by tongue grafting followed by 94.13 per cent by wedge grafting. Survival with tongue grafting might be because of the optimum temperature and relative humidity prevailing during the period and better rapid sap flow in stock and scion through close contact which might have favoured the healing process and established the continuity of cambium and vascular

tissues. In the cambial region of bud union the cells might have protected by relative humidity or moisture resulting in quick healing, more sprouting and finally resulting in maximum survivality (Srivastava *et al*., 2007). The present results are in support with the findings of Saran and Kumar (2006) in apple and Mehta *et al*. (2018) in pecannut. Plathia *et al*. (2016); Nagpal (2019) also reported the same in peach.

Plant height (cm). Data presented in Table 2 depicts that Sharbati rootstock gave significantly maximum average plant height (57.73 cm) at 75 DAG which showed enlargement measuring 66.92 and 74.38 cm at 90 and 105 DAG with further increased upto 79.50 cm at 120 DAG. Similar trend was shown by Kala Amritsari with measurement of 53.17, 62.57 and 70.05 cm at 75, 90 and 105 DAG which finally attained 75.30 cm at 120 DAG which was lesser than Sharbati rootstock. Out of the rootstocks under study Kabul green Gage showed a decline in plant height with 51.48 cm at 75 DAG with an inclination of 60.30 and 66.82 cm at 90 and 105 DAG which finally reached to 73.50 cm at 120 DAG respectively. This might be due to the effect of rootstock on scion. It might possibly be speculated due to close contact of the cambial region and better rooting system of Sharbati seedling which facilitated greater translocation of water and nutrients from the soil (Hartmann *et al*., 2002). The research findings of Shah and Baghel (2017) revealed maximum plant height on peach rootstocks. These results are also in accordance with the earlier findings of Chakraborty and Singh (2011); Nagpal (2019) advocating increased height of seedlings raised on Sharbati rootstock. The findings of Bal and Sandhawalia (2000) contradict the present results. Significant variations were found in the plant height among the various propagation techniques at various data collection intervals. The plants propagated by tongue grafting exhibited maximum average plant height (54.36 cm) at 75 DAG. A similar trend was also reported at 90 DAG measuring 63.68 cm and later on 71.04 cm at 105 DAG. At the end of the data collection interval at 120 DAG an increment noted in the plant height was 77.20 cm while minimum plant height was noted in the plants grafted with wedge grafting to the tune of 53.90, 62.87, 69.79 and 75.00 cm at 75, 90, 105 and 120 DAG respectively. The possible reason for more plant height in tongue grafting is better translocation of nutrients and water from rootstock to scion via graft union (Hartmann *et al*., 2007). The present results are in accordance with Mehta *et al*. (2018) who reported maximum plant height with tongue grafting in pecan nut and Ahmed *et al*. (2016) in walnut. Nagpal (2019) reported the same in peach.

Scion girth (mm). It is evident from the data (Table 3) that scion girth varied significantly with respect to various rootstocks used. It was found to be maximum (4.45, 4.55, 4.60, 4.67 mm) in Sharbati rootstock measured after 75, 90, 105 and 120 DAB followed by (Kala Amritsari) with 3.73, 4.17, 4.29, 4.39 mm. However minimum diameter measuring 3.63, 3.97, 4.16, 4.28 mm was reported in Kabal Green Gage rootstock. The variation in scion girth in different cultivars might be due to the variant compatibility potential of cultivars on the rootstocks. The bud take success as well as graft compatibility of the almond might be greater on Sharbati as compared to other cultivars, which resulted in maximum scion girth. It might also be speculated due to the better cambial contact resulting in greater uptake of water and nutrients. The research findings of Nagpal (2019) reported the same but the findings of Bal and Sandhawalia (2000) are in contradiction with the present results. From the data, it has been observed that the scion girth of the seedlings grafted with tongue grafting was found to be maximum (4.37, 4.58, 4.72, 4.83 mm) which was followed by 3.51, 3.86, 3.98, 4.06 mm in P_1 at 75, 90, 105 and 120 DAG. The results of the research study are in agreement with Chauhan (2000) in apricot, Plathia *et al*. (2016) in Shan-i-Punjab and Mehta *et al*. (2018) in pecan nut. Nagpal *et al*. (2019) also reported the same in peach cv. Shan-i-Punjab.

Rootstock girth (mm). According to data in Table 4 Considerable increase in the stock girth was noticed at the data collection intervals in all the almond seedlings grafted on various rootstocks. Maximum average stock girth was noticed in Sharbati rootstock measurable as (5.05, 5.18, 5.25 and 5.35 mm) followed by (4.73, 4.86, 4.99 and 5.12 mm) while the minimum (4.44, 4.59, 4.78 and 4.91 mm) was calculated at 75, 90, 105 and 120 DAG. Increment in stock diameter can be attributed to the availability of soil nutrition and other metabolites to the stock along with the compatibility of Sharbati with the scion (Hartmann *et al*., 2007). The present results agree with the findings of Nagpal (2019). The findings of Singh *et al*. (2010); Gangwar and Arora (2005) are in contradiction with the present results. The data related to the propagation also showed a significant effect on stock girth at various observations in tongue grafted plants measuring 5.13 mm at 75 DAG further increasing to 5.22 mm at 90 DAG, 5.41 mm at 105 DAG and 5.54 mm at 120 DAG. Wedge grafted plants were with stock diameter (4.35 mm) at 75 DAG which increased to 4.53 and 4.59 mm at 90 and 105 DAG which finally turned 4.71 mm at 120 DAG. The present findings are in accordance with the findings of Mehta *et al*. (2018) in pecan nut and Nagpal (2019) in peach cv. Shan-i-Punjab. From the given data, significant interaction has not been observed among various treatment combinations of rootstocks and propagating methods.

Table 1: Effect of various rootstocks and propagation methods on graft success and survival percentage in almond.

Rootstock	Propagation Method					
	Graft Success (%)			Survival (%)		
	Wedge Grafting (P_1)	Tongue Grafting (P_2)	Mean	Wedge Grafting (P_1)	Tongue Grafting (P_2)	Mean
Kala Amritsari (V_1)	58.00	62.00	60.00	95.65	95.84	
Kabal Green Gage(V_2)	48.33	54.00	51.17	90.92	91.30	95.74
Sharbati (V_3)	69.33	74.00	71.67	95.83	100.00	91.11
Mean	58.56	63.33		94.13	95.71	97.92
Effects	SE(m). ±	C D at 5%		C D at 5%	SE(m). ±	
Rootstock(V)	0.18	0.57		0.08	0.03	
Propagation Method (P)	0.15	0.46		0.07	0.02	
Interaction effect (V×P)	0.25	0.80		0.12	0.04	

Table 2: Effect of various rootstocks and propagation methods on plant height (cm) in almond.

Propagation Method												
	75 DAG			90 DAG			105 DAG			120 DAG		
Rootstocks	Wedge Grafting (P_1)	Tongue Grafting (P_2)	Mean	Wedge Grafting (P_1)	Tongue Grafting (P_2)	Mean	Wedge Grafting (P_1)	Tongue Grafting (P_2)	Mean	Wedge Grafting (P_1)	Tongue Grafting (P_2)	Mean
Kala Amritsari (V_1)	52.90	53.43	53.17	62.40	62.73	62.57	69.63	70.47	70.05	74.20	76.40	75.30
Kabal Green Gage (V_2)	50.87	52.10	51.48	59.90	60.77	60.33	66.63	67.30	66.82	72.53	74.47	73.50
Sharbati (V_3)	57.40	58.07	57.73	66.30	67.53	66.92	73.40	75.37	74.38	78.27	80.73	79.50
Mean	53.90	54.36		62.87	63.68		69.79	71.04		75.00	77.20	
Effects	SE(m). ±	CD at 5%		SE(m). ±	CD at 5%		SE(m). ±	CD at 5%		SE(m). ±	CD at 5%	
Rootstock (V)	0.33	1.06		0.27	0.87		0.12	0.38		0.09	0.27	
Propagation Method (P)	0.27	NS		0.22	0.71		0.09	0.31		0.07	0.22	
Interaction effect (V×P)	0.47	NS		0.39	NS		0.17	0.53		0.12	NS	

Table 3: Effect of various rootstocks and propagation method on scion girth (cm) in almond.

Propagation Method												
	75 DAG			90 DAG			105 DAG			120 DAG		
Rootstocks	Wedge Grafting (P_1)	Tongue Grafting (P_2)	Mean	Wedge Grafting (P_1)	Tongue Grafting (P_2)	Mean	Wedge Grafting (P_1)	Tongue Grafting (P_2)	Mean	Wedge Grafting (P_1)	Tongue Grafting (P_2)	Mean
Kala Amritsari (V_1)	3.32	4.15	3.73	3.81	4.53	4.17	3.89	4.69	4.29	3.96	4.82	4.39
Kabal Green Gage (V_2)	3.16	4.11	3.63	3.61	4.32	3.97	3.79	4.52	4.16	3.89	4.66	4.28
Sharbati (V_3)	4.05	4.84	4.45	4.19	4.90	4.55	4.26	4.94	4.60	4.33	5.00	4.67
Mean	3.51	4.37		3.86	4.58		3.98	4.72		4.06	4.83	
Effects	SE(m). ±	CD at 5%		SE(m). ±	CD at 5%		SE(m). ±	CD at 5%		SE(m). ±	CD at 5%	
Rootstock (V)	0.11	0.35		0.10	0.31		0.09	0.30		0.09	0.28	
Propagation Method (P)	0.09	0.29		0.08	0..25		0.08	0.24		0.08	0.23	
Interaction effect (V× P)	0.16	NS		0.14	NS		0.13	NS		0.12	NS	

Table 4: Effect of various rootstocks and propagation method on stock girth (mm) in almond.

Propagation Method												
	75 DAG			90 DAG			105 DAG			120 DAG		
Rootstocks	**Wedge Grafting (P_1)**	**Tongue Grafting (P_2)**	**Mean**	**Wedge Grafting (P_1)**	**Tongue Grafting (P_2)**	**Mean**	**Wedge Grafting (P_1)**	**Tongue Grafting (P_2)**	**Mean**	**Wedge Grafting (P_1)**	**Tongue Grafting (P_2)**	**Mean**
Kala Amritsari (V_1)	4.36	5.10	4.73	4.46	5.26	4.86	4.58	5.41	4.99	4.71	5.53	5.12
Kabal Green Gage(V_2)	3.87	5.01	4.44	4.14	5.04	4.59	4.23	5.32	4.78	4.37	5.46	4.91
Sharbati (V_3)	4.83	5.28	5.05	4.99	5.36	5.18	4.98	5.51	5.25	5.06	5.63	5.35
Mean	4.35	5.13		4.53	5.22		4.59	5.41		4.71	5.54	
Effects	SE(m). ±	CD at 5%		SE(m). ±	CD at 5%		SE(m). ±	CD at 5%		SE(m). ±	CD at 5%	
Rootstock (V)	0.11	0.37		0.12	0.37		0.10	0.32		0.10	0.32	
Propagation Method (P)	0.09	0.29		0.09	0.30		0.08	0.27		0.08	0.26	
Interaction effect (V×P)	0.16	NS		0.16	NS		0.14	NS		0.14	NS	

CONCLUSION

The outcome of the present research indicated that the rootstocks used and propagation methods had significantly influenced the nursery plant growth performance of almond cultivar California Paper Shell on Sharbati rootstock. It proved to be an outstanding among other rootstocks and propagation methods under the agro-climatic conditions of Amritsar in terms of grafting success and vegetative growth of the grafts so formed. Facilitation of superior planting material availability on commercial basis will help in boosting the production of almond plants on a large scale.

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