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Standardization of Time for Inarching in Guava cv. Allahabad Safeda

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ABSTRACT: Guava (*Psidium guajava* L.) is an important fruit known for its food and nutritional values. It occupies a key position among all the fruit crops. Propagation of guava by the means of inarching has been reported by the various researches. Inarching is an old traditional method of propagation in which two plants are joined while growing on their own roots. To find the most appropriate time of inarching in guava, a research study was carried in Randomized Block Design comprising of nine dates of inarching from May 1st -September 1st with 15 days interval replicated thrice. The findings of the research study revealed that inarching performed in the middle of July (15th) resulted in the highest sprouting and survival percentage of guava with maximum vegetative growth in terms of new growth, primary branches, leaf production and rooting parameters. Hence inarching during July can be considered as the most suitable time for inarching in guava.

Keywords: Guava, Inarching, Propagation, Rooting, Sprouting, Success, Survival.

INTRODUCTION

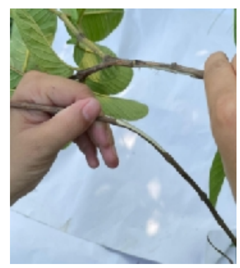
Guava (*Psidium guajava* L.) has occupied a unique position among all the fruit crops. It is known by various names such as guayabo, guara, arrayana, and luma in some regions. It is considered as a traditional plant owing to its cultivation for diverse properties in the field of medicine and possession of high nutritive value (Asif *et al.,* 2022). It belongs to family Myrtaceae and exhibits great economic importance globally due to its higher production and diversity in consumption (Pradhan *et al.,* 2021). Guava is a tree up to 10 m tall with a short and twisted stem with brown scales on its bark. It is a deep rooted depending on the type of soil and water table, giving it excellent anchorage. The tree is having a vigorous growth with fruit bearing in two to four years with its continuation for another 40 to 60 years (Irshad *et al.,* 2020). Guava possesses antiallergic, hepatoprotective, antimicrobial, antigenotoxic, antispasmodic, cardioactive, antidiabetic, anti-inflammatory properties. Beneficial pharmacological properties are acquired by the leaves and fruits of guava. The placement of guava fruit under ethno pharmaceutical drugs to cure throat inflammation and their activity against Salmonella, Serratia and Staphylococcus have been advocated by various researchers (Pelegrini *et al.,* 2011). Fruit Pulp contains gallic acid, chlorogenic acid, ellagic acid, catechin and rutin phenolic compounds. The correlation of antioxidant activity of the extract with phenolic compounds have also been assessed by various research workers (Kapoor *et al.,* 2020). Due to a rich source of magnesium guava fruit act as a nervous relaxant and relax muscles and nerves of the human body. A mineral namely folate promotes fertility in humans. Guava Juice is very effective in the treatment of dengue fever. Pink Guavas contain twice the amount lycopene present in tomatoes which protect the skin from UV rays and environmental pollution (Naaz, 2018). Vitamin-C in guava is essential for the synthesis and maintenance of collagen which is protective against skin wrinkles. Fruit of guava can be eaten raw and also in the form of slices as salad or desserts. Beverages are prepared from their pulp. Due to higher content of pectin in the skin of the fruit. It binds with sugar and fruit acid to form a gel and hence jelly is prepared from it. Various food items such as small cakes, puddings, jam, sauce, ice-cream, butter marmalade and pies can be prepared from the guava fruit. Puree, Juice, Concentrated nectar and syrup can also be prepared from it (Jyoti *et al.,* 2018). Seed multiplication results in genetic heterogeneity among the plants due to which seed propagation is not recommended. In order to increase the production chain vegetative propagation has been recommended by various research workers as it maintains genetic uniformity and preservation of identity of an elite cultivar in horticulture (Kumar *et al.*, 2020). Several researches on improvement on guava have been carried out to evaluate superior genotypes for large scale cultivation. The increasing demand of quality planting material of guava has been reported (Srivastava *et al.*, 2002). Propagation of guava can be through budding, air layering, stooling and inarching. Inarching is the oldest technique employed in guava propagation (Mukherjee and Majumdar 1983). It is a propagation method whereby two plants are united while growing on their own roots. In fruit and nut trees, young seedlings are usually planted beside an older tree and grafted into the trunk. It has been reported that the cultivar propagated by inarching grow faster than those propagated by stooling and air layering. Maximum success of 85 to 95 percent has been achieved during the rainy season in guava in the month of June-August (Gotur *et al*., 2017). The present study is based on the standardization of inarching time on vigour of guava.

MATERIALS AND METHODS

The present investigation entitled Standardization of time for inarching in guava cv. Allahabad Safeda was carried out during 2021-2022 at the guava block of orchard of Khalsa College, Amritsar. The research study consisted of 9 dates of inarching *i.e.* T_1 (May 1st), T_2 (May 15st), T_3 (June 1st), T_4 (June 15th), T_5 (July 1st), T_6 (July 15th), T_7 (August 1st), T_8 (August 15th), T_9 (September 1st). Vigorously growing healthy and disease free one-year-old seedling rootstocks of desi guava (50-60 cm) in height and 9-11mm thickness was used as a rootstock and the Alahabad Safeda cultivar of guava was chosen as scion for inarching. About 30-35 cm scion portion was retained above the point of inarching and it was detached from the mother plant at 60 DAG. Five plants from each replication and treatment were selected randomly and tagged for taking the observations at 90 DAG except survival percentage which was calculated at 60 DAG. Per cent graft take was calculated by the number of successful grafts at 90 DAG expressed in percentage. The number of days taken for complete healing of bud union after the date of inarching was considered as the time for healing of bud union. The graft survival percentage was calculated by counting the number of grafts surviving after 60 of inarching. Average number of primary branches and leaves were calculated by counting them. Length and diameter of new growth was measured with the help of a meter scale and digital vernier caliper at 90 DAG. Primary root length was measured from the point of their emergence to the apex with the help of measuring scale and the mean length of primary roots per graft was calculated at 90 DAT. 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 and ANOVA was set as per Gomez and Gomez (1984) for Factorial Randomized Complete Block Design.

(a) Preparation of rootstock

(b) Preparation of scion



(c) Cut surfaces of rootstock and scion facing each other

(d) Rootstock & scion tied with polythene

(e) Initiation of Sprouting

(f) Healing of graft union and formation of cambium layer

RESULTS AND DISCUSSION

Examination of data clearly depict that the plants inarched in the month of July-August sprouted earlier as compared to other months respectively. Minimum (21.50) days were taken by the plants inarched on July 15th which completed its sprouting in 62.96 days (Table 1). The plants inarched in the month of May exceeded the days to sprouting countable as 25.50. For sprouting of grafts optimum environmental conditions play a pivotal role in increasing the photosynthetic rate which results in more production of assimilates responsible for improvement in the graft growth and development (Sivudhu *et al.,* 2014). The earlier sprouting of the bud during July-August can be attributed to the prevalence of moderate temperature and high humidity of rainy season which formed the graft union too early thus subsequently advanced the sprouting of shoots. During the month of May, the day temperature is increased and night temperature is decreased with low humidity, the propagated plants take more time to form union and thereby there is a delay in the sprouting of shoots (Singh and Singh 2007). The results are in conformity with the findings of Singh *et al.* (2005) who had observed no graft success during the summer months. Kumar *et al*. (2020) revealed that the inarching performed in the month of July recorded the highest success which justifies the present results.

The results in Table 1 indicates that the highest bud take (91.64%) was noticed during inarching on July 15th with the lowest (67.50%) in May 1st inarched plants at 90 DAT. The highest graft take might be due to the favourable climatic conditions with high temperature and relative humidity as the prevalence of higher humidity around the stock-scion union prevent the desiccation of active scion tissue (Gotur *et al.,* 2017). During monsoon season cambial cells are activated by temperature and relative humidity. The callus on cambial region consists of thin-walled turgid cells which easily get desiccated which is protected by relative humidity (Hartmann *et al.*, 1979). The findings of Harshvardhan and Rajashrkhar (2012) in jackfruit, Syamal *et al*. (2013) in bael, Beer *et al*. (2013); Shyamal *et al*. (2012), Munthaj (2014) in guava; Shinde (2010) in jamun are similar to the present results.

It was observed that minimum time (21.74 days) for graft healing was recorded in the plants inarched on July 15th while the inarched plants on May 1st took more (27.00) days in graft healing(Table 1). According to the earlier studies the adhesion between grafts, callus formation, the establishment of new vascular tissue and the formation of a functional vascular system led to the graft healing (Pina *et al.*, 2012). The environmental conditions in terms of high humidity at the time of healing affects all the stages of healing. Hence the monsoon season inarched plants resulted in quicker graft healing. Kumar *et al.* (2020) revealed that the inarching performed in the month of July resulted in the earlier healing of graft union in jackfruit and Gotur *et al*. (2017) in guava which is in accordance with the present findings. Hartmann *et al*. (2015) reported quicker healing of graft in the plants propagated through inarching when performed during the monsoon season.

Examination of the data in Table 1 shows that maximum graft survival (88.89%) was reported from the inarched plants on July 15th with the minimum (65.15%) was in the plants inarched on May 1st. It was noticed that an upward trend in survival percentage was in the hotter months of July-August with higher humidity which can be attributed to the optimum temperature and high humidity resulting in the successful stock-scion union, early callus formation and initiation of subsequent growth (Gotur *et al.,* 2017). The lowest survival of the grafts was reported in the months with lower humidity which might be due to the reduction in division of cambial cells, their differentiation and consequent development of healing of stock-scion union as a result of decreased synthesis of endogenous auxins and mobilization of preserved food materials due to the reduced activity of hydrolyzing enzymes (Nanda and Anand 1970). The present results are in line with the findings of Kumar *et al*. (2020) in jackfruit, Shirol *et al*. (2005) in Khirni, Bhuva *et al*. (1990) in sapota. According to Hartmann *et al.* (2015) inarching of monsoon season results in the maximum survival of the grafts. Langpoklakpam *et al*. (2017) observed that the months of July-August were the finest for maximum survival of inarched plants in Sohiong (*Prunus nepalensis* L.).

Data interpretation showed maximum (3.47) primary branches in the plants inarched on 15th July while the lowest (2.39) primary branches were recorded in (May 1st) inarched plants. Rapid graft union formation and optimal environmental conditions with temperature and relative humidity might be responsible for the plant activity, which resulted in early graft union healing, an increase in the number of sprouts and also an increased meristematic activity during July-August (Hartmann and Kester 1997). These results are in agreement with the findings of Kumar *et al.* (2020) in jackfruit and Muniyappan *et al*. (2019) in jamun. Hartman and Kester (2015) reported maximum vegetative growth and the plants in arched during the monsoon season (Shirol *et al*. (2005).

Maximum length (44.83 cm) of the primary branch was recorded in inarching interval of July 15th. The smallest primary branch of length 37.40 cm at 90 DAT. Vegetative growth characteristics in terms of leaf production, leaf size and shoot length affects the length of the branch. Graft age in monsoon temperature at optimum temperature with high humidity levels prompts active cell activity. It facilitates early graft union repair resulting into good growth of meristamatic cells along with better photosynthesis and lower respiration acting positively on rootstock and scion resulting into their growth of branches as well (Rani *et al.,* 2015). Singh and Sengupta (1996) reported the longest sprout length (27.34 cm) with July grafting. Kumar *et al.* (2020) in jackfruit and Gotur *et al.* (2017) in guava noticed that inarching during July produced the maximum length of primary branches. Hartmann *et al*. (2015) reported maximum vegetative growth the plants inarched during the monsoon season (Shirol *et al.,* 2005) also reported the same in Khirnee.

Maximum length of new growth (3.66 cm) was observed when inarching was performed on July 15th (Table 2). The shortest length of new growth (1.91 cm) was recorded in May 1st inarched plants. The reason for the more growth in shoot length in the months of July and August can be attributed to the optimum temperature, sufficient sunlight, high humidity and water availability resulting in the higher rate of photosynthesis and the formation of more assimilates led to an increased cell division with improved growth and development of the shoot (Patil *et al.*, 2009). The research findings of Singh and Sengupta (1996) reporting the longest sprout length (27.34 cm) with July grafting are similar to the present findings. Kumar *et al.* (2020) in jackfruit and Gotur *et al*. (2017) in guava noticed that inarching during July produced the maximum length of new shoots. Hartmann *et al.* (2015) reported maximum vegetative growth in the plants inarched during the monsoon season.

Examination of the data in Table 2 clearly shows that at 90 DAT maximum diameter of new growth (6.33 mm) was recorded in T_6 (July 15th) while the lowest (5.71 mm)diameter was recorded in the plants inarched on May 1st. Congenial environmental conditions during monsoons at the time of inarching accelerated the cell division and growth of the shoots which affected the thickness of the growth as well which might be the reason for the increased diameter of the new formed shoots of inarched guava plants (Rani *et al.*, 2015). The findings of the study were previously reported by Mulla *et al*. (2011) in jamun, Patil *et al.* (2009) in sapota, Islam and Rahim (2010) in mango.

Maximum (27.90) leaves were recorded in the plants inarched on July 15th while lesser leaves (20.19) were produced in the plants inarched on May 1st. Increased leaf production can be attributed to the photosynthetic accumulation in freshly inarched plants due to adsorption of nutrients increased by leaf cells. Water is one of the driving forces for cell elongation and multiplication and grafting during the summer and early monsoon seasons resulted in favorable soil moisture, humidity and temperature which had a positive impact on the number of leaves of the scion. Lesser leaf production in May is owing to insufficient climatic circumstances, leaving the plant less exposed to favorable conditions for physiological development (Muniyappan *et al*., 2019). The present results are in consistence with the findings of Kumar *et al*. (2020) in jackfruit and Sivudu *et al*. (2014) in mango. Gotur *et al*. (2017) also advocated maximum leaf production in inarched plants of guava in the month of July Shirol *et al*. (2005) in sapota also reported the same.

Maximum leaf area (41.86 cm^2) was recorded in inarched plants on (July 15th) while lesser leaf area (26.64 cm^2) was recorded in (May 1st) inarched plants. This might be due to the fact that inarching performed in congenial weather conditions during early monsoon season with proper soil moisture, higher humidity and temperature might had a positive impact on the number of leaves of the scion. The photosynthetic accumulation in freshly inarched plants due to the adsorption of nutrients increased by leaf cells might have increased the cell division and their multiplication which enhanced the leaf production with increased leaf area (Muniyappan *et al.,* 2019). The present results are in consonance with the findings of Kumar *et al*. (2020) in jackfruit and Sivudu *et al*. (2014) in mango.

The experimental results of the research study (Table 3) showed that the maximum number of primary roots (89.95) was measured in the inarching of July 15th while the lesser (55.62) primary roots were reported in May 1st inarched plants at 90 DAT. Increase in the number of primary roots of the inarched plants during rainy season might be due to the optimum temperature and humidity prevalence which prompted the hormonal content and co-factors responsible for the root production with adequate length.

The results showed that the maximum length of primary roots (21.20 cm) was measured in July 15th inarching interval with the smallest length (17.18 cm) of primary branch was reported in the plants inarched on 1st May at 90 DAT (Table 3). Increase in the root length of the inarched plants during rainy season might be due to the optimum temperature and humidity prevalence which prompted the hormonal content and co-factors responsible for the root production with adequate length. The present results are similar to Kumar *et al*., (2020) in jackfruit.

Table 1: Effect of time of inarching on success and survival in guava.

Treatments	Days to initiation of sprouting	Days to completion of sprouting	Inarching success(%)	Days to healing of graft union	Survival (%)
T_1 (May 1st)	25.50	67.56	67.50	27.00	65.15
T_2 (May 15th)	25.00	67.44	69.56	26.67	66.95
T_3 (June 1st)	24.83	66.10	70.18	25.48	68.67
T_4 (June 15th)	23.86	65.06	74.95	23.61	72.69
T_5 (July 1st)	23.18	64.12	84.63	22.70	81.60
T_6 (July 15th)	21.50	62.96	91.64	21.74	88.89
T_7 (August 1st)	22.30	63.83	87.36	22.20	83.50
T_8 (August 15th)	23.43	64.45	79.01	25.38	77.92
T_9 (September 1st)	24.60	65.49	71.93	26.53	69.62
C.D	**1.28**	**2.16**	**5.32**	**3.46**	**5.88**
Mean	**23.08**	**65.22**	**77.42**	**24.59**	**75.00**

Table 2: Effect of time of inarching on vegetative growth in guava.

Treatments	Number of primary branches	Length of primary branch (cm)	Length of new growth (cm)	Diameter of new growth (mm)	Total number of leaves
T_1 (May 1st)	2.39	37.40	1.91	5.71	20.19
T_2 (May 15th)	2.57	38.73	2.32	5.73	20.96
T_3 (June 1st)	2.62	40.18	2.65	5.81	23.18
T_4 (June 15th)	2.89	42.08	2.85	5.93	22.73
T_5 (July 1st)	3.16	42.67	3.53	6.18	24.38
T_6 (July 15th)	3.47	44.83	3.66	6.33	27.90
T_7 (August 1st)	3.39	43.25	3.58	6.21	25.85
T_8 (August 15th)	2.99	43.21	3.47	6.15	22.21
T_9 (September 1st)	2.76	43.07	2.90	6.10	22.03
C.D	**0.53**	**2.08**	**0.88**	**0.68**	**3.75**
Mean	**2.65**	**41.71**	**2.98**	**6.01**	**23.27**

Table 3: Effect of time of inarching on leaf area and root parameters in guava.

Treatments	Leaf area (cm^2)	Primary root length (cm)	Number of primary roots
T_1 (May 1st)	26.64	17.18	55.62
T_2 (May 15th)	27.72	17.81	58.25
T_3 (June 1st)	31.91	18.90	64.55
T_4 (June 15th)	35.16	18.92	70.15
T_5 (July 1st)	38.47	20.09	84.74
T_6 (July 15th)	41.86	21.20	89.75
T_7 (August 1st)	40.29	21.08	87.66
T_8 (August 15th)	35.84	19.96	77.62
T_9 (September 1st)	34.63	19.61	72.48
C.D	**3.78**	**2.76**	**4.75**
Mean	**34.72**	**19.41**	**73.42**

CONCLUSION

Based on the above findings, it can be concluded that inarching performed during July-August proved to be the best for survival percentage and vegetative growth of grafts. Hence it is the most appropriate interval for the superior plant production of guava cv. Allahabad Safeda commercially.

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Conflict of Interest. None.

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