STANDARDIZATION OF PATCH BUDDING IN JACK FRUIT

(*Artocarpus heterophyllus* Lam.)

By

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THESIS

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DECLARATION

I, hereby declare that this thesis entitled **"STANDARDIZATION OF PATCH BUDDING IN JACK FRUIT (*Artocarpus heterophyllus* Lam.)"** is a bonafide record of research work done by me during the course of research and the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

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Certified that this thesis entitled **"STANDARDIZATION OF PATCH BUDDING IN JACK FRUIT (*Artocarpus heterophyllus* Lam.)"** is a record of research work done independently by Mrs.Fathimath Sherin Shasna K.K under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship or associateship to her.

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We, the undersigned members of the advisory committee of Mrs. Fathimath Sherin Shasna K. K, a candidate for the degree of **Master of Science in Horticulture** with major in Fruit Science, agree that the thesis entitled **"STANDARDIZATION OF PATCH BUDDING IN JACKFRUIT (*Artocarpus heterophyllus* Lam.)"** may be submitted by Fathimath Sherin Shasna K. K, in partial fulfilment of the requirement for the degree.

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LIST OF ABBREVIATIONS

%	per cent
@	at the rate of
°C	Degree Celsius
cv.	Cultivar
DAB	Days after budding
DAS	Days after sowing
et al	And others
fig.	Figure
FYM	Farmyard manure
g	Gram
hr	Hour
i.e.,	That is
KAU	Kerala Agricultural University
kg	Kilogram
KNO_3	Potassium nitrate
L	Litre
M-	- Molar
m	Meter
m^2	Squre meter
mg g^{-1}	- Milli gram per gram
SE(m)	Standard Error
Viz	Namely

Introduction

INTRODUCTION

Jackfruit tree, a member of Moraceae family originated in the rain forests of the Western Ghats. It is a versatile crop which has the potential to replace even rice. Tree can be grown well in marginal soils without any external inputs and has the ability to withstand climatic and soil stress. Hence, literally jackfruit can be considered as truly organic.

Even though the tree has multidimensional uses in food, fodder, fuel, timber and medicine, the tree is considered as one of the most under-utilized and neglected, under researched fruit tree. Jackfruit tree can impart crucial role in the food security and income generation of rural poor. Because of the immense health benefits, now jackfruit is gaining the attention of urban population. Recently the demand for elite planting material of jackfruit with superior quality like sweetness and firm fleshed nature and certain promising jack types like early bearing, seedless, gum less and cluster bearing have increased.

Because of the heterozygous nature of jackfruit seed, resulting progeny will be showing the type variation. Therefore vegetative propagation is the only method for getting true to type elite planting material. Among different methods of asexual propagation like cutting, layering, grafting and budding were found to be the most viable methods.

Approach grafting method is widely adopted for the vegetative propagation of jackfruit. But this method is cumbersome and labour intensive and we have to maintain progeny orchard. Since this method have many hurdles, other technique like softwood grafting, epicotyl grafting and budding technique are gaining importance.

Different types of budding adopted in jackfruit are chip budding, patch budding and shield budding. Among these, patch budding can be used as a viable alternative because it is simple and easy to perform and more number of scion buds could be obtained from a single bud stick. In order to perform budding, getting a rootstock with correct thickness is a problem faced by nursery men.

Hence, the present study entitled "Standardization of patch budding in jackfruit (*Artocarpus heterophyllus* Lam.) was undertaken with the following objectives:

1. To assess the influence of pre- sowing seed treatments on the waiting period of jackfruit seedlings to attain the proper girth for budding.
2. To study the impact of season on the success rate of patch budding.

Review of Literature

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2. REVIEW OF LITERATURE

For large scale production of high quality of planting materials, commercially adopted vegetative propagation method must be relatively simple and easy to perform, low cost with maximum success and the planting material should be vigorous in growth. Jackfruit is generally propagated through seed, being heterozygous nature, for maintaining varietal character of elite planting materials commercially adopted technique are vegetative propagation methods. Vegetative propagation in jackfruit are carried out using cutting, layering, grafting and budding. Approach grafting is the commercial method of vegetative propagation in jack fruit. The labour intensiveness, difficulties faced in maintaining progeny orchard etc. have made this technique less popular. In the recent times several other techniques like epicotyl grafting, soft wood grafting and patch budding are attempted though with varying success. Hence experiments were conducted to standardise patch budding technique in jack fruit and of review of work done in related aspects are presented hereunder.

2.1 Vegetative propagation techniques other than approach grafting in jackfruit

2.1.1 Budding

Budding has been found to be the best method for commercial multiplication of jack fruit. Budding is a kind of grafting, where only a single bud with a piece of bark is used as the scion material. The plant that grows after successful union of the stock and bud is known as budling. The degree of success depend upon many factors like time of budding or season prevailed during budding operation. Condition of budding including the age of rootstock, nature of bud stick whether it is in bark slipping, skill of the person performing budding, varietal compatibility etc. Weather is one of the important parameter which critically influence the healing process which ultimately decides the graft union. Teaotia *et al*. (1963) reported the superiority of budded plants over seedling of the same age in their growth habits.

Garner and Chaudhari (1976) found that patch budding was the most promising method for jack fruit propagation.

2.1.1.1 Vegetative propagation of jackfruit by budding

Garner and Chaudhari(1976) reported patch budding as the best method for jackfruit propagation which is in conformity with the finding of Moti *et.al*.(1976) that patch budded jack showed the highest success percentage over shield budding in the month of June.

2.1.1.2 Effect of season/time of grafting in fruit crops

Weather play a crucial role in determining the success rate of graft union. According to Hartmann and Kester (1979) temperature seem to have profound effect on the callus formation which leads to the speedy healing of bud union.

Khattak *et al.*(2002) reported that maximum sprouting per cent (81%) and survival rate (73.3%) for chip budded guava was obtained when budding operation was done on June 15^{th} , followed by July 15^{th} with 75.5 per cent of sprouting and a survival rate of 68.9 per cent respectively. But Aulakh (1998) reported that the maximum per.cent of successful plants (95.60%) and shoot length (46.60%) was obtained, when patch budding was done on 14^{th} June closely followed by budding on 29^{th}June in guava cv. Allahabad safeda.

Mehrotra and Gupta (1984) revealed that success rate was maximum (70.12%) on May month budded guava seedling of cv. Lucknow-49, which was on par with June and July budded plants. Similarly Rao *et al*. (1984) found that June budding resulting in higher success 74.0 per cent. Time of budding affected the success (Pandey and Prasad, 1980) in aonla.

Pandey *et al*. (1981) reported that May to August as the best time for propagation and the maximum growth of scion (71.90%) in ber. Budding in June resulted in 90 per cent success. Similar findings were observed by Dhar and Chaturvedi (1976), in propagation of ber through patch budding, which gave good result of 84.00 per cent to 96.70 per cent.

Singh and Pandey (1998) reported that the best time for patch budding in guava was July with a success rate of 65 per cent followed by August (55.70%).Budding carried out in February, March, April and June resulted in poor success. June, July budding significantly reduce the number of days taken for sprouting and time taken for attaining growth suitable for transplanting.

Patch budding done in June and July gave cent per cent success in bael followed by May. While comparing with the method of propagation, patch budding was superior over chip and T- budding. Moreover scion growth (42.09cm) was maximum on budlings of July (Singh *et al.,* 1976). A success rate of 66.60 per cent to 97.70 per cent was assured for patch budded bael during the period of May to August (Dhar and Chaturvedi, 1976).

In Aonla, patch budding was the best in June, July, August, being 100 per cent reported by Nand (1962).Among these months, patch budding performed on 2ndJuly took the maximum number of days (25.67 days) for bud sprouting whereas that done on 19th August took minimum days (5.67 days) for bud sprouting reported by Komanic (1964) in walnut. However, in guava April –June appeared to be better with lesser number of days for bud sprouting (19.85 to 37.5 days) investigated by Dhar and Chaturvedi(1976), which was in conformity with the findings of Singh and Pandey (1998).

Pathak and Srivastava (1973) reported that with a bud intake of 80 to 90 per cent and a budding success of 60.00 per cent to 70.0 per cent was obtained in July budded apple plants.

Gautam (1990) observed second highest success percentage by patch budding (35.00 per cent) followed by chip budding (20 percent) in walnut at Shimla.

Khattak *et al* (2002) also reported that maximum shoot length was obtained when budding done on middle of April 15 and September 15 showed the minimum shoot length.

Jose and Valsalakumari (1991) revealed that high percentage of survival and sprouting of epicotyl grafts of jack was obtained in the month of June.

Longer sprouts and maximum number of leaves were obtained from budlings of eight and ten months old rootstock respectively (Swamy, 1993).

Moti *et al.* (1976) obtained that June budding proved to be the best for bael, ber, jack fruit and mango whereas the May budding gave maximum success in Aonla. For a time period from May to August gave good response on patch budding in aonla (63.00 % to 98.80 %), bael (66.60 % to 97.70 %) and ber (84.00 to 96.70 %) whereas in guava April-June was favourable and success range varied from 71.60 per cent to 98.30 per cent during 1970 and 1971.

Tripathi and Kumar (2004) reported that , budding performed during last week of July in bael showed better response with respect to the following attributes like bud intake (70.00 per cent) bud sprout (62.20 per cent) and survival (62.20 per cent). July to September, budded plants showed maximum diameter (5.49 cm) and length (34.23 cm).

Investigation was carried out by Khattak *et al.* (2001) for finding out the effect of time of budding on propagation of guava cv. Allahabad safeda by T-grafting and chip budding. Budding was done at monthly interval from April 15th to September 15th.they noted that maximum sprouting (93.33 %) in T- budding on July 15th.but growth of shoots (24.00 cm) was maximum in chip budding after one year. Not only shoot growth but also the survival of budded plants (80.00 %) was high in case of chip budding.

Under Junagarh condition, grafted plants took minimum number of days (16 days) for early bud sprouting as compared with budded plants (18.27 days) in Jamun cv. Paras Local. From February to July, there was a reduction in number of days required for bud sprouting and among these minimum number of days where taken in June to July. Moreover, budding gave higher success than grafting with the best performance in June to July (Chovatia and Singh, 2000).

In pecan nut, Joolka and Rindhe (2000) discovered that June- July budding had the highest success (98.56 %) in chip budding. Optimum temperature and relative humidity prevailing during that period and the rapid sap flow in stock and scion during healing process were the main attributes deciding the success rate.

Study conducted by Ananda *et al* (1999) revealed that highest percentage of bud intake (96.25 per cent), linear growth (13.48 cm), and radial growth of scion (8.52 mm) and rootstock (9.83mm) was in the middle of February. While maximum number of lateral (1.0) were obtained at the middle of March, whereas highest number of saleable plants (94.14) was obtained during October in apple.

The investigation carried out Dwivedi *et al.* (2000) revealed that the 14 and 21 August have given the best response in terms of bud intake (81.60 %), sprouting (88.30 %) and linear growth (24.70 cm) in apricot under cold arid condition of Ladakh. But in kiwi, Chandel *et al.* (1998) found that higher bud intake (54.00 %), maximum mean sprouting (57.00 %) were recorded in July 15th budding and lowest bud intake(12.09 %) and sprouting (15.00 %) recorded when T-budding done on August 30th.

March, April and October months were reported to be the best time for budding in Kinnow mandarin. Patch budding done in March resulted in 95.00 per cent budding success whereas T budding method was superior in April (85.0 to 90.00 %) and October (80.0 to 95.0 %) in success (Bullar *et al.*, 1980).

Bagdanov (1976) revealed that the optimum results for apple were obtained when budding was carried out on 25th July and 15th August.

Standardization of method of vegetative propagation and season for bael was done at the Fruit Research Station, Basti by Singh *et al.* (1976). Results revealed cent per cent success in June and July by patch budding. Highest linear growth was recorded in July patch budded plants (42.90 cm). Better bud sprout and growth of sprouted buds could be obtained through favourable humid conditions have been emphasized by Hartmann and Kester (1986).

Singh and Srivastava (1979) studied the propagation of mango by different methods like budding, veneer grafting, air layering and inarching. July to August was congenial for mango propagation in Lucknow area, among these methods budding method showed least success percentage.

Investigation was carried out by Sharif *et al.* (2015) for determining best asexual propagation method and time in ber at Horticulture Research Institute AARI, Faisabad, Pakistan during 2010-2012. Experiments were carried out by two different methods *i.e.* T- budding and T- grafting during seven different month of year from February to August. Results revealed that T- grafting was superior than budding and first week of May gave maximum graft success (99.15 %), survival per cent (96.23 %) and minimum number of days for initiating new growth (14.33 days) but May budding took maximum number of days to sprout(56.00 days) and least success was reported in August budding (26.74 per cent).

Investigations carried out by Patel (2016) revealed that patch budding took significantly minimum number of days (8.90 days) for sprouting process, number of days required for leaf emergence (12.07 days) and maximum number of leaves per shoots (26.33) in aonla after 120 days.

Effect of season and growing environment on success rate of patch budding in tamarind was evaluated by Patel *et al.* (2016). Results revealed that June to August was congenial for performing patch budding while budding done in October month took maximum number of days for bud sprout (25.11 days). Growing environment and budding season have significant impact over sprouting percentage, total number of leaves per shoots, length of new shoots and stem girth. With respect to success rate of budding (18.35/25), sprouting percent (73.40 %) and number of leaves per new shoots after 90 days (9.02) and length of new shoots (25.18 cm). August was found to be the best season for performing patch budding in tamarind.

To assess the effect of budding season and method of budding over bud intake in nectarine on peach (*Prunus persica*) an experiment was conducted at fruit nursery, Department of Fruit Science, VCSG Uttarakhand University of Horticulture and Forestry, Bharsar, by Awasthi (2016). Shield budding done on 20th August took minimum number of days to bud sprout(167.04 days), longest length of bud sprout (77.78 cm) and also it gave the thickest sprout with an average diameter of 0.85 cm.

According to Archana *et al.* (2018), patch budding using two to four month old rootstock gave maximum budding success in jack fruit. While comparing the response of different age of rootstock, *i.e.*, two month old, four month old, six month old and eight month on NSP variety, which was used as scion material, gradual reduction in success rate was observed with respect to increase in age.Two month old rootstock gave 90 per cent bud intake where as eight month gave 76 per cent. It could be attributed to the latex yield of tree. Secondary metabolites like phenol interfere with auxin synthesis and callus induction which was in conformity with Priyanka *et al.* (2017).

Archana *et al.* (2018) studied the effect of season of patch budding on budding and sprouting success. Among 12 different months starting from January 2015 to December 2015, June budding resulted in maximum bud in take (94.00 %) and sprouting percent (95.74 %) followed by August, September with a budding success of 94 per cent and a sprouting success of 89.36 per cent and 74.47 per cent respectively while October grafting resulted in least budding success (30.00 %) and budding in January (37.20 %) November (52.17 %) resulted least sprouting success. With respect to the length of sprout, budding carried out in the month of April showed maximum length (24.96 cm) and minimum growth was observed in October budded plants (12.27 cm). Observations were taken 120 days after budding. October budding also resulted in minimum number of leaves per budded plants at 60th and 120th days after budding respectively (4.87, 7.00). With these they concluded that season have pronounced effect on budding success in jackfruit. June to September was found to be congenial for patch budding while minimum sprouting success was found in October and November month budded plants under Bengaluru condition.

Nataraj (2013) studied the influence of age of rootstock and month of patch budding in gumless jack under Mudigere condition. Rootstocks with one, two, three, four, five and six month were budded in selected months. Budding was carried in four months i.e. September, October, November and December. December was found to be the best month for budding with respect to different growth parameters like sprouting percent, number of sprouts per plants, length of budlings, girth of budlings and final establishment percentage.

According to Ghosh (2008) varietal compatibility decided the success rate of budding. Among the ten different cultivar of ber, Illachi and Gola showed the best compatibility with local rootstock with cent percentage success. He also reported that the best season for performing budding under West Bengal condition was from May to September for in situ budding. It showed cent percentage success but poly bags raised seedling responded best in the month of May to June with a success rate of 75 percent to 85 percent.

Teaotia *et al.* (1963) reported that in jack fruit, cent percentage success was observed when budding operation was carried in the middle of June under Utter Pradesh condition.

2.1.1.3 Method of budding

According to Teaotia *et al.* (1963) patch budding technique was superior over modified forket method of budding while doing budding in mango by using two different varieties (Langra and Dashehari) as scions, he found that March was the best season for budding in mango.

Singh *et al.* (1978) compared method of budding over the success in guava. Success rate was significantly higher in patch budding (68.8 %) while chip budding resulted in 24.5 per cent.

They also compared two different methods of budding. Results revealed that patch budding was superior over modified forkert budding, when budding operation carried on monthly interval from February to September. June was observed to be the best time for budding. Similarly, Singh *et al.* (1979) observed 48.4 percent success in patch budded Jamun while modified forket budding showed 44.3 per cent success.

Pandey *et al.* (1981) found that patch budding technique was best in ber over T, chip, and ring budding. Budding was carried in the second week of each month beginning from May to October. Similar result was obtained by Singh *et al.* (1982) in jack fruit. Budding was carried at monthly interval starting from February to September. Highest bud intake was recorded from June and July with 90 to 81.6 per cent respectively.

According to Konhar *et al.* (1990) among different budding methods (shield budding, patch budding, chip budding) success rate was superior in June and August patch budded jack fruit (80 %) while shield budded and fluted budded plant failed in bud intake.

According to Nath *et a l.* (2000) in ber cv. Gola, percentage of sprouting and shoot lengths were better on patch budded plants than I budded plants. Results revealed that patch budding was superior over modified forket budding with respect to bud intake and bud break. Budding done on August 14th gave cent percentage success.

Mawani and Singh (1992) revealed that interactive effects between methods and time of budding showed significance and highest budding success (71.11 %) was obtained in patch budding done in the middle of June.

2.2 Effect of seed treatments on germination

Rootstock is mainly produced by seeds. Healthy rootstock may attribute to many factors such as response of fruit tree to the environmental stress, survival of graft and final establishment in the field and to some extend it contribute to tree productivity, seedling with growth parameters such as proper height and girth could reduce the time period required to attain the graftable stage. Proper alignment of cambial tissues of rootstock and scion results in maximum bud intake. With the objective to obtain compatible size of rootstock within a short time, seeds extracted from ripened jack fruits were treated with different chemicals.

2.2.1 Effect of gibberellic acid (GA)on germination and seedling growth

GA has antagonistic effect on germination inhibitors (Brain and Hemming 1955; Wareing *et al.*, 1968) and endogenous gibberellins were reported to increase due to soaking (Mathur *et al.,* 1971). GA helps in synthesis of ᾱ- amylase which converts the starch into simple sugars. These sugars provide energy that is required for various metabolic and physiological activities. GA_3 treatment apart from improving germination also increased the subsequent growth of seedling. This may be attributed to cell multiplication and elongation of cells in the cambium tissue of internodal region by GA apparently activating the metabolic processes or nullifying the effect of an inhibitor on growth (Barton, 1958).

According to Parmar (2014) seed priming of custard apple with different chemicals like gibberellic acid(100 ppm,200 ppm), potassium nitrate(1 %,2 %), thiourea (500 ppm, 1000 ppm), fresh cow dung and urine slurry (1:2 ratio) and hot water treatments revealed that soaking the seed with 200ppm of gibberellic acid for 12 hours recorded the minimum days taken for germination(24.00 days) and maximum germination per cent (63.99 %). Growth parameters such as seedling length (5.30 cm) number of leaves per plant (3.67), root length (2.08 cm) and number of primary roots (3.67) recorded were maximum under this treatment.

Al-Hawezy (2013) studied the role of different concentration of gibberellic acid on the germination and seedling growth of Loquat. He reported that different concentration of GA_3 (200 ppm, 250 ppm and 300 ppm) have significantly improved germination percentage. 250 ppm GA_3 gave the best response on shoot and root length of young seedling and vigour index ranging from 8.21cm,

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10.15cm and 1726.425 while comparing with control. Soaking period did not affect significantly on loquat seed germination ratio during 1st and 3st week.

Harshavardhan and Rajasekhar (2012) studied the effect of presowing seed treatments on seedling growth of jackfruit. They reported that growth parameter such like seedling height (72.1 cm), seedling girth (0.78 cm), absolute growth rate (0.62 cm/day) were maximum on ripened seed treated with 200 ppm of gibberellic acid for 24 hours. Number of days taken for attaining graftable size were minimum (52.3 days) in this treatment.

Dhaka and Pal (2009) studied the effect of gibberellic acid on seed germination of lime and found that soaking the lime seed in 500 ppm of gibberellic acid for 40 hours resulted better germination, growth and survival.

While dipping the seed of *Tithonia rotundifolia* Blake using different concentration of GA_3 (100 ppm, 300 ppm, and 500ppm for different time period of 72 and 96 hours) Patel and Mankad (2014) found that 500 ppm of GA_3 for 96 hours resulted in rapid germination (94 %) which was 12 per cent more than the control.

Marostega *et al.* (2017) evaluated pre sowing treatment for overcoming the seed dormancy of ten passion fruit species. As a final observation, *Passiflora suberosa* showed a germination percentage of 86 per cent whereas *Passiflora morifolia* and *Passiflora tenuifolia* recorded 68 and 54 per cent germination respectively.

Sheoran *et al.* (2018a) observed the effect of scarification treatments on growth parameters of ber seedling. Among the different scarification treatments, soaking in 250 ppm of gibberellic acid for 24 hours resulted into higher plant height (97.1 cm),seedling diameter (4.77 cm), inter nodal length (31.3 mm), number of leaves per plants(116.3), leaf area (6.29 cm^2) at 120 days after sowing.

Kalyani *et al.* (2014) reported highest percentage of germination (83.79 %, 80.30 %) by treating the seed with 1000 ppm and 500 ppm of gibberellic acid respectively in guava.

Samir *et al.*(2015) reported that soaking of khirni (*Manilkara hexandra*) in 200 ppm of GA_3 resulted in better germination.

Experiments by Patel (2017) revealed that except leaf area maximum germination per cent (66.33 %), minimum number of days for 50 per cent germination, growth parameter like shoot length (41.33 cm), collar diameter (9.02 mm) number of leaves (17.90) was obtained by soaking the mango seed in 100 ppm of gibberellic acid.

Kumar *et al.* (2011) revealed that papaya fresh seeds, the standard germination percentage was accelerated from 67.14 (control) to 71.51 per cent with 1000 ppm of GA_3 followed by one molar KNO_3 (70.37 % germination).

Khopkar *et.al.* (2014) studied the effect of presowing treatments on seed germination of pummelo, soaking of fresh seed in 50 ppm of GA_3 for 24 hours resulted higher percentage of germination (76.67 %), maximum number of leaves (35.54) and a plant height(36.42 cm). But Khan *et al.*(2002) found that gibberellic acid have no significant effect on germination percentage and only had a marginal effect on rate of germination of both grape fruit and kinnow mandarin. Control took one or two days delay in germination and also took longer time to complete germination.

Soaking seeds in gibberellic acid 200 ppm for 24 hours recorded tallest seedlings with more absolute growth rate and less number of days taken to attain graftable size. Soaking seed in potassium nitrate (0.5 %) for 24 hours recorded maximum leaf area per seedling (2526 cm^2).

Jack fruit seeds were treated with different chemicals, ferulic acid (10^{-3}M), maleic hydrazide (1000 ppm), thiourea (1 per cent) potassium orthophosphate (1 %) and gibberellic acid (100 ppm) for 24 hours before sowing. The highest percentage of germination (98.0 %) and coefficient of germination velocity (28.00) were obtained on seeds soaked in gibberellic acid (Maiti., 2003)

Singh (2002) found that soaking the jackfruit seed in 100 ppm of gibberellic acid for 12 hours recorded highest percentage of germination (95.33

%) and maximum shoot length (26.78 cm) and seed took minimum number of days for germination (13 days).

Maiti (2003) reported that the second tallest jack fruit seedling (24.90 cm) was obtained on soaking seeds in 200 ppm of gibberellic acid.

Ratan and Reddy (2004) tried different concentration of gibberellic acid (200 ppm, 400 ppm, and 600 ppm gibberellic acid for 12 hours) on custard apple seed. Analysis of growth parameters of treated seed resulted seedling revealed that 400 ppm of gibberellic acid resulted in highest seed germination percentage (69 %), plant height (25.33 cm) and root length (12.23 cm). Minimum number of days (16 days) were taken by 600 ppm of gibberellic acid irrespective to the time period taken for pre-soaking and maximum stem girth (2.86 cm) was obtained by soaking in 200 ppm gibberellic acid for 24 hours.

Ahmad (2010) investigated the response of two varieties (Bruno and Hayward) of kiwi seeds with four different concentration of gibberellic acid (1000, 1500 ppm for 20 hours followed by stratification at 4.4°C for 6,8 and 10 weeks). Irrespective of the varieties, 2000 ppm of gibberellic acid resulted in maximum percentage of seed germination (67.25 and 53.00 % for Bruno and Hayward respectively).

Babu *et al.* (2008) found that gibberellic acid treated seed of papaya showed the highest percentage of germination and tallest plants and reduction in number of days taken for germination. Gibberellic acid (100 ppm) treated papaya seed recorded a germination percentage of 66.17 per cent compared with control (42.40 %). Untreated seeds took 31.86 days while the treated seed took only 29.73 days for germination.

Munde and Gajbhiye (2010) reported that 200 ppm of gibberellic acid treated mango stones produced maximum seedling height and more number of leaves.

2.2.2 Effect of potassium nitrate on germination and seedling growth

After soaking the ber seed with different concentration of potassium nitrate (1.0 %, 2.0 %) for 12 and 24 hours, among the different combination, soaking the seed for 2 percent for one day showed maximum germination (13.3 %).

Harshavardhan and Rajasekhar (2012) reported that application of potassium nitrate at 0.5 per cent for one day on ripened jackfruit seeds recorded maximum leaf area per seedling (2526 cm^2).

According to Farajollahi *et al.* (2014), 0.1 percent of potassium nitrate was found effective for seed germination (90 %) of a desert plant species *Calotropis persica* (Grand.).

According to Patel *et al.*(2016), among seed priming chemicals like thiourea (1000 ppm, 1500 ppm, and 2000 ppm), ethrel (1000 ppm, 1500ppm and 2000ppm) and potassium nitrate (1 %, 1.5 % and 2 %), Custard apple seed showed higher germination per cent (78.67 %) and minimum number of days (21 days) taken for germination, seedling height(5.96, 9.13 and 14.60 cm), seedling girth (0.26,0.34 and 0.46 cm), number of leaves (4.03, 6.60 and 6.60)and leaf area (3.71, 7.13 and 12.03 cm^2) at 60, 90 and 120 days after sowing by treating with 1.5 per cent of potassium nitrate.

Sheroran *et al.*(2018b) observed soaking the seed of ber in 1 per cent of potassium nitrate for 24 hours resulted seedling height (86.4 cm) seedling diameter (4.14 cm) number of leaves (100.3), inter nodal length (29.3), leaf area (5.47 cm^2).

Mane *et al.* (2018) studied the effect of presowing treatments on shoot growth of custard apple by adopting eight different treatments. Results revealed that soaking the seed in 0.1 per cent of KNO_3 resulted in maximum seedling height (16.87cm), stem diameter (0.30), 11.0 leaves per seedling, 28.55 cm^2 of leaf area, 1.61 g of fresh weight of seedling, 0.58 g of dry weight of seedling, when observation was taken 90 days after sowing.

Rajamanickam and Balakrishnan (2004) studied the effect of different seed treatments for improving the growth and vigour of Indian gooseberry seedlings. Fresh and one year old aonla seed were soaked in hot water, cold water, 0.5 per cent of sulphuric acid , 200 ppm of gibberellic acid, 0.5 per cent potassium nitrate , combination of 0.5 per cent potassium nitrate and 200 ppm gibberellic acid and 1 per cent thiourea and treated seeds were sown in sand medium. Among these, 200 ppm of gibberellic acid soaked fresh and one year old seed resulted tallest plants with a shoot length of 8.92 cm and 6.58 cm respectively. Soaking the fresh seed in 0.5 per cent potassium nitrate resulted highest root length (3.26 cm) were as in one year old seed combination of gibberellic acid and potassium nitrate resulted in maximum root length (2.94 cm).

Aatla and Srihari (2013) observed mango kernel pre-treated with 0.5 per cent of potassium nitrate recorded highest germination percentage (64 %), maximum seedling girth (7.10 mm), number of leaves (10.90), leaf length (15.83 cm), leaf width (8.00 cm), root characters like root length (23.40 cm), root spread (8.66 cm), root to shoot ratio (0.807). But the better growth parameters such as seedling height (24.13cm) and inter nodal length (3.66 cm) was recorded in extracted kernel treated with 500 ppm of gibberellic acid.

2.2.3 Effect potassium chloride on germination and seedling growth

Vanangamudi and Vanangamadi, (2003) revealed that presowing of tamarind seed in 3 per cent of potassium chloride helped to improve the chlorophyll content and soluble proteins.

2.2.4 Effect of water (hydropriming) on germination and seedling growth

Soaking the seed in water at room temperature hasten the germination process by removing the mechanical barriers like softening the seed coat and removing the inhibitors and enhancing the germination speed (Hartmann and Kester, 1979).

Jamwal *et al.* (2013) studied the effect of different seed treatment on seed germination of ber. Pre-soaking of seed in water for 24, 48 and 72 hours and keeping them in gunny bags for two, four and six days along with three sowing times *i.e.*,15th March, 15th April, 15th May. As a final observation soaking the seed in 72 hours followed by keeping in gunny bags resulted 70 per cent germination after 30 days of sowing however, after two month of sowing, maximum germination (76.67 %) was reported in seed which was subjected to pre-soaking in water 48 hours followed by keeping gunny bags for 6 days. They concluded that germination percentage and duration of soaking has positive correlation. Extended pre-soaking (beyond 72 hours) resulted blocking of oxygen supply during some critical metabolic process of germination (Kajal, 1982).

Adeniji *et al.* (2014) evaluated the effect of water soaking on the seed of sugar apple. Soaking the seed for 6, 12, and 24 hours at 30^0C, revealed that as the soaking period extended from six to twelve hours the germination percentage was increased from 6.60 per cent to 53.33 per cent and thereafter declined to 46.60 per cent with the further increase in soaking time (24 hours).

Sheoran *et al.* (2018 a) reported that soaking ber seeds in water for one or two days resulted in 2.6 percentage increase in rate of germination.

Pre-soaking of custard apple seed in cold water showed following growth parameter such as plant height (16.13 cm), stem diameter (0.28cm), leaves per seedling (10.33), fresh weight of seedling1.31 g (Mane *et al.*, 2018).

According to Patil *et al.* (2018) water soaking of jamun seed in 24 hours resulted early emergence of seedling (7.13 DAS) and showed maximum germination percentage (95.73 %), number of leaves (20.73) with stem diameter (3.57 mm).

Maiti (2003) recorded the smallest time period required for maximum germination (10.66 days) and highest germination value (24.38 %) and stem girth (2.63 cm) were obtained on soaking the jack fruit seed in water for 24 hours.

Materials and Methods

3. MATERIALS AND METHODS

The present study entitled 'Standardization of patch budding in jackfruit (*Artocarpus heterophyllus* Lam.) was conducted during the period from June 2018 to November 2019 at Department of Pomology and Floriculture, College of Agriculture, Padannakkad, Kasaragod. The experiment was carried out with main objective of finding the influence of presowing seed treatments on the waiting period to attain buddable sized seedling and to assess the impact of season on the success rate of patch budding. The details of materials used and technique adopted during the investigation are presented below:

3.1 GEOGRAPHICAL LOCATION AND CLIMATE

The study was conducted in the Instructional Farm of College of Agriculture, Padannakkad situated in the northern part of Kerala at an elevation 20 m above mean sea levels, at 12^0 20' 30'' north latitude and 75^0 04' 15'' east

The monthly meteorological data pertaining average rainfall, mean maximum and minimum temperature and relative humidity during the period from 2018 June to 2019 November was recorded and presented in Appendix II.

3.2. PREPARATORY OPERATIONS

3.2.1. Collection of jack seeds

Locally available ripened jackfruit seeds were taken for raising rootstock. Big sized seeds have the ability to produce vigorous seedling (seeds weighing 5 to 8g) were used for raising rootstocks. Seeds were extracted from healthy ripened fruits followed by washing and removal of slimy coating and adhering pulp.

3.2.2 Raising of rootstocks

For patch budding seeds were sown during the month of March. Fresh seeds were sown in polythene bags of 15 × 20 cm^2 size of 300 gauge thickness. The bag were filled with a pot mixture of FYM, sand,soil in a ratio of 1:1:1

3.2.3 Care of rootstock

Seeds sown polybags were watered regularly. During initial period, the polybags were kept under shade to avoid direct solar radiation. Germination of seeds started from 15 days to 20 days after sowing and continued for 30 to 40 days. After one month, seedlings kept under open condition with regular application of water at two days interval.

3.2.4 Selection of rootstock

Vigorously growing uniform seedling of pencil thickness were selected for performing budding operation.

3.2.5 Selection of scion

Scion were selected from healthy and high yielding mother plants were used. One season old having dormant bud of pencil thickness, free from pest and disease were selected for patch budding.

3.2.6 Collection of scion

The scion shoots were collected directly without curing from selected healthy jackfruit tree in the morning hours on the day of budding. Scion shoots were detached from the mother tree with a sharp secateur, wrapped in moist newspaper to get rid of the latex and kept in polythene bags and carried to the site of budding. Budding was carried on the day of separation of budding sticks from mother tree.

3.2.7 Patch budding procedure

The disease free pencil thickness rootstocks raised in polybag were selected and the bark measuring about 0.9 to 1 cm horizontally and 2.0 to 2.5 cm vertically resembling a patch from the rootstock were removed at a height of 15 cm above the ground level. Similar size bark with active scion bud was taken from the scion stick and placed on the stock and tied with a polyethene strips and the budded plants were kept under direct sunlight followed by watering at regular interval.

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Budding operation was carried at monthly interval from July to November (Plate 1).

3.2.8 Aftercare of the budlings

The success of budding was indicated by the presence of green colour of bud wood, which indicated the proper bud union approximately one month after budding. Polythene strips were removed to examine the success rate. Still the bud wood remain green in colour, the rootstock was decapitated just above the graft union by leaving a one node distance. The budlings were kept under open condition for further growth of buds.

The sprout above and below the bud union from the rootstock were removed manually whenever they appeared.

3.3 EXPERIMENT 1: PRESOWING TREATMENTS ON MATURE AND RIPENED JACK FRUIT SEEDS.

Design: CRD

Varieties used: Local

Number of treatments: 7

Number of replication: 3

Number of seeds per treatments: 30

3.3.1 Treatments details

The experiment was carried out to find the effect of presowing treatments on the waiting period of seedlings for attaining buddable size. Mature and ripened jackfruits from a single tree were used to extract the seeds. Seeds were soaked for 24 hours in various concentration of chemicals. Details of the treatments are given below:

T_1-Soaking the seeds with 100 ppm of GA_3

T_2- Soaking the seeds with 200 ppm of GA_3

T_3-Soaking the seed in 0.5 % of KCl

T_4-Soaking the seed in 1% of KCl

T_5-Soaking the seed in 1% of KNO_3

T_6-Soaking the seeds in tap water

T_7-Direct sowing (control)

3.3.2 Preparation of the solution of chemicals and plant growth regulators

The solution of gibberellic acid of 100 ppm and 200 ppm was prepared by weighing 100 mg and 200 mg of gibberellic acid separately with the help of digital balance. After dissolving each in 95 per cent 10 ml alcohol, the solutions were made up to 1litre by adding distilled water.

Preparation of chemical solutions of 0.5 % and 1 % of KCl, 1 % of KNO_3 are given below

(a) 0.5 % of KCl- 5g of KCl was taken and dissolved in 1000 ml of distilled water.
(b) 1 % of KCl- 10 g of KCL was dissolved in 1000 ml of distilled water.
(c) 1 % of KNO_3- 10g of KNO_3 was dissolved in 1000 ml of distilled water

3.3.3 Seed extraction

Seeds was collected from a uniform size fully ripened and healthy fruits of a single jackfruit tree. Extracted seeds were washed properly under running water followed by water soaking to remove light weighted nonviable seeds. Seeds settled at the bottom are taken out and kept for shade drying for one hour. Seeds were subjected to different seed treatments for 24 hours.

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1 - Seed collected for seed treatment

2 - Presowing seed treatment with different chemical solution

Plate 1 - Seeds subjected to different presowing treatments

3.3.4 Seed treatments:

Seeds were treated with aqueous solution of gibberellic acids, potassium chloride, potassium nitrate and water as per the details of the treatments given above.

3.3.5 Sowing of seeds

All the untreated and treated seeds were sown in polybags of 15×20 cm^2 size of 300 gauge thickness. The bags were filled with potting mixture composed of FYM, sand, and soil in a ratio of 1:1:1. Single seed was sown in each poly bags followed by irrigation and kept under open condition.

3.3.6 Observations recorded

Mean value of five randomly selected plants in each treatment per replication was taken. Parameters recorded under present investigation are as follows:

3.3.6.1 Days taken for first germination

Observation were recorded from the date of sowing to first emergence of seeds. Seeds were sown on 5th May 2019. Visibility of cotyledonary leaves considered as germinated seeds.

3.3.6.2 Days taken for 50% germination

Number of days taken for 50 % emergence of seeds were recorded.

3.3.6.3 Germination percentage

Number of germinated seeds out of total sown seeds were recorded at 30 days after sowing and expressed in percentage

$$\text{Germination percentage (\%)} = \frac{\text{Total number of seed germinated}}{\text{Total number of seed sown}} \times 100$$

3.3.6.4 Germination rate

Germination rate was calculated according to the daily germination percentage data, based on the following formula (Mohammadi, 2009).

$$GR = \frac{\sum n}{Dn}$$

Where, GR = germination rate, n = number of seeds germinated on a specific day, and D = number of days from the start of experiment.

3.3.6.5 Number of leaves per seedling

The number of leaves per seedling of three plants in each treatment was counted at 60 and 90 DAS

3.3.6.6 Height of the shoot (cm)

The height of three plants per each treatment was recorded using centimetre scale at 60, and 90 DAS

3.3.6.7 Girth of the stem (cm)

Stem diameter of the three plants from each treatment was measured by using a thread at 60 and 90 DAS.

3.3.6.8 Fresh weight of plant (g)

Fresh weight of three randomly selected plants in each treatment was measured in grams with the help of digital balance at 90 DAS.

3.3.6.9 Dry weight of plant (g)

Dry weight of three randomly selected plants in each treatments was taken by chopping the plants followed by oven drying at 60 ± 2^0C temperature till a constant weight. This was followed by weighing using an electronic balance and average value was computed.

3.3.6.10 Leaf length and Leaf breadth (cm)

Length and breadth of five physiologically matured leaves of each treatment was recorded at 60, and 90 days intervals by using a centimeter scale.

3.3.6.11 Leaf area (cm^2)

Leaf area was computed by linear measurement method. Length and breadth of the leaf was multiplied with the leaf area constant which has been already calculated for different crops.

3.3.6.12 Seedling vigour index

Seedling Vigour Index (SVI) was determined by dividing the product of percentage of seed germination and average seedling length with 100 (Chon and Kim., 2002)

3.4 EXPERIMENT-2: IMPACT OF SEASON ON THE SUCCESS OF PATCH BUDDING

Location : College of Agriculture, Padannakkad, Kasargod

Design : CRD

Rootstock : local (6 month old rootstock)

Number of treatments: 6

Replication : 3 (10 plants per each replication)

Treatments details

T_1- patch budding in June

T_2- patch budding in July

T_3-patch budding in August

T_4- patch budding in September

T_5- patch budding in October

T_6- patch budding in November

3.4.1 Observations recorded

Visual observation was made on the budlings .after on month of sprouting. Periodically observation was recorded at $30^{th,}$ 60^{th}, 90^{th} days after sprouting on growth parameters like length of sprout, number of leaves on the budded shoots. The observation on percentage of success and days to sprout were recorded during the initial stages of sprouting and the percentage of survival was recorded after 90 days after budding. For taking observation, budlings showing uniform growth were selected from each treatments

3.4.1.1 Percentage of budding success/bud take percent

Percentage of bud intake was recorded eight days after budding.bud that retained green colour were recorded as successful graft union.

$$\text{Per cent of budding success (\%)} = \frac{\text{Number of plants with bud union success} \times 100}{\text{Total number of budded plants}}$$

3.4.1.2 Percentage of sprouting success

The per cent sprouting success were recorded based on the successful bud growth for each selected plants

$$\text{Per cent of sprouting success(\%)} = \frac{\text{Number of sprouted plants} \times 100}{\text{Total number of budded plants}}$$

3.4.1.3 Percentage of survival

Percentage of survival was recorded on 90 days after sprouting by using the formula

Percentage survival =

$$\frac{\text{Total number of successful budlings - Number of dead budlings}}{\text{Total number of successful budlings}}$$

3.4.1.4 Length of bud sprout (cm)

Length of bud sprout was recorded as shoot length after one month of sprouting at 60^{th}, 90^{th}, and 120^{th} days after budding using a centimetre scale. A point at the base of new sprout was marked by using a ball point pen in the selected plants and monthly growth rate from the point marked was recorded as length of sprout.

3.4.1.5 Number of leaves per budded plant

Number of leaves per budded plant was recorded at 60^{th}, $90^{th,}$ and 120^{th} days after budding from each selected plants up to 90 days.

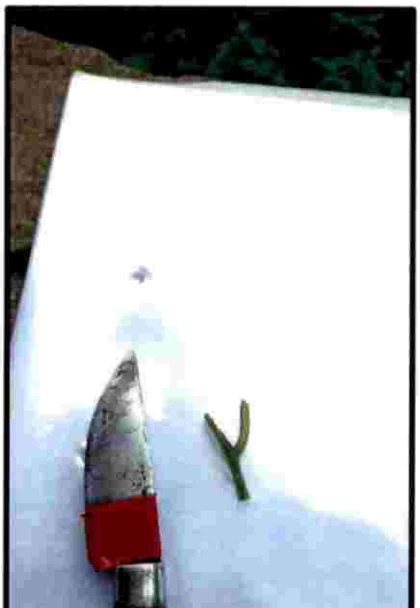
3.5 Statistical analysis

The data collected as per the observation were subjected to statistical analysis to find the significance difference between the treatments and analysis was done using the OPSTAT software (Sheoran *et al*., 1998)

Materials used for patch

scion

Extraction of bud

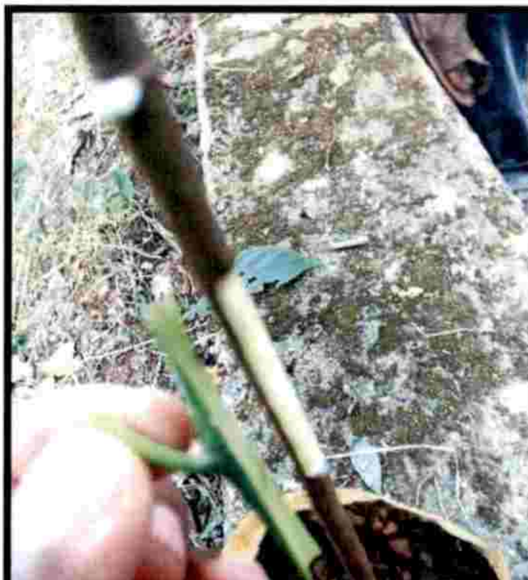


Extracted bud

Plate 2 – Removal of bud from budwood

Rootstock nursery

Rootstock



Keeping budwood on rootstock

Plate 3- Preparation of rootstock for performing patch budding

Results

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4. RESULTS

The present investigation entitled 'Standardization of patch budding in jackfruit (*Artocarpus heterophyllus* Lam.) wasconducted at College of Agriculture, Padannakkad, Kasaragod. The study comprised of two experiments. The results obtained during the course of investigation have been described in this chapter under appropriate headings. The observations are summarized in the form of tables (1 to 11) and illustrated through figures from 4.1 to 4.11.

4.1 EXPERIMENT 1: PRESOWING TREATMENTS ON MATURE AND RIPENED JACK FRUIT SEEDS

4.1.1 Days taken for first germination

Number of days taken for germination was recorded on the basis of the visibility of sprouts just above the rooting media. The data are presented in Table 1.The days taken for germination was significally varied in different presowing seed treatments. Among different treatment T_5 (soaking seeds with 1% KNO_3 for 24 hours) took minimum number of days required for germination(17 days) which was on par with T_1 (17.33 days) and maximum number of days(26.70 days)required for sprouting was obtained in direct sowing without any pre-treatments (control).

4.1.2 Days taken for 50 per cent germination

Days taken for 50 per cent germination significantly varied among treatments. T_5 (seed soaking in 1% KNO_3) significantly reduced the time to 23.47 days and this was followed by T_1 (25.33 days). Maximum number of days required for attaining 50 per cent germination was recorded in control (33.83 days).

4.1.3 Germination percentage

Seed germination percentage was worked out and presented in Table 2. Germination percentage significantly varied due to different presowing seed treatments. Among treatments, T_1 significantly enhanced the germination percentage (65.13 %) which was on par with the treatment T_2 (63.82 %) and T_5 (62.55 %) and minimum percentage was observed with the control (53.39 %).

4.1.4 Germination rate

Seed germination rate was worked out and presented in Table 2. Germination rate varied significally among different presowing seed treatments. The maximum germination rate was observed in T_1 (0.59) which was on par with T_5 (0.57) and T_2 (0.53) and minimum germination rate was observed with the control (0.29).

4.1.5 Number of leaves per seedling

Number of leaves per seedlings was recorded at 60 and 90 days after sowing (Table 3).Treatments were significantly different after 60 days of sprouting. Maximum number of leaves were found in T_5 (4.17), which was on par with T_4 (3.6). On later stage (90 DAS) the treatments differences were insignificant.

4.1.6 Height of shoot (cm)

Height of the shoots was recorded at 60 and 90 days after sowing and average data is presented in Table 4. Treatments were significantly different and maximum shoot length was observed in T_1 (28.20 cm) and minimum sprout length was observed in control (21.50 cm).At later stage (90 days after) the treatments were significantly different and the maximum shoot length was observed in T_1 (46.11 cm) which is on par with T_2 (43.11 cm) and minimum height was recorded in control (30.70 cm).

4.1.7 Girth of plant (cm)

Girth of plant was recorded at 60 DAS and 90 DAS and average value observed is presented in Table 5. After 60 DAS the maximum girth (2.09 cm) was observed in T_1 which is on par with T_2 (2.04 cm) and T_5 (1.96 cm). At 90 DAS, maximum girth of shoot was observed in T_1 (2.61 cm) which was on par with T_2 (2.58 cm).

4.1.8 Length (cm), Breadth (cm) and leaf area (cm^2)

The length, breadth and leaf area was calculated after 90 DAS and the average value are given in Table 6. There were no significant differences among treatments. Maximum leaf area was observed with T_5 (83.49 cm^2).

4.1.9 Fresh weight (g) and dry weight (g)

Fresh weight and dry weight of seedlings were recorded at 90 DAS and the average value is presented in Table 7. There were significant differences among the treatments. Maximum fresh weight was obtained in T_5 (16.71 g). Dry weight was taken after 90 DAS, by keeping the whole plant in hot air oven at 62°C for 4 days. The treatments were significantly different and maximum dry weight was obtained in T_5 (5.34 g) which was on par with T_1 (4.94 g). Minimum dry weight was obtained in the T_6 (3.37 g).

4.1.10 Seedling vigour index

Seedling vigour index was calculated at 60 DAS and 90 DAS and the average values are presented in Table 8. The treatments were significantly different. The maximum seedling vigour was obtained in T_1 (2319.33, 3788.15) which was on par with T_2 (2129.80, 3503.94) followed by T_5 (2029.56, 3075.45) and the minimum value was obtained with the control (1386.22, 1976.37).

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Table 1: Effect of presowing treatments on number of days from sowing to seed germination and days taken for 50 per cent germination

Treatments	Days taken for sprouting	Days taken for 50 per cent germination
T_1- Soaking the seed in GA_3 100 ppm for 24 hours	17.33	25.33
T_2- Soaking the seed in GA_3 200 ppm for 24 hours	21.00	27.13
T_3- Soaking the seed in 0.5 % KCl for 24 hours	23.33	29.43
T_4- Soaking the seed in 1% KCl for 24 hours	23.10	29.43
T_5- Soaking the seed in KNO_3 1 % for 24 hours	17.00	23.47
T_6- Soaking the seed in water for 24 hours	24.33	30.83
T_7- Control (direct sowing)	26.70	33.83
SE(m)	**0.37**	**0.28**
CD(0.05)	**1.14**	**0.86**

Table 2: Effect of presowing treatments on germination percentage and germination rate

Treatments	Germination percentage (%)	Germination rate
T_1- Soaking the seed in GA_3 100 ppm for 24 hours	82.22 (65.13)*	0.59
T_2- Soaking the seed in GA_3 200 ppm for 24 hours	80.56 (63.82)	0.53
T_3- Soaking the seed in 0.5 % KCl for 24 hours	71.11 (57.49)	0.41
T_4- Soaking the seed in 1 % KCl for 24 hours	74.56 (59.69)	0.43
T_5- Soaking the seed in KNO_3 1 % for 24 hours	78.44 (62.55)	0.57
T_6- Soaking the seed in water for 24 hours	71.11 (57.49)	0.42
T_7- Control (direct sowing)	64.45 (53.39)	0.29
SE(m)	**1.62**	**0.03**
CD(0.05)	**4.97**	**0.10**

***Figures in parentheses are arcsine transformed values**

Table 3: Effect of presowing treatments on number of leaves per seedling on 60, 90 days after sowing.

Treatments	60 DAS	90 DAS
T_1- Soaking the seed in GA_3 100 ppm for 24 hours	2.83	6.44
T_2- Soaking the seed in GA_3 200 ppm for 24 hours	3.07	5.22
T_3- Soaking the seed in 0.5% KCl for 24 hours	3.30	5.56
T_4- Soaking the seed in 1%KCl for 24 hours	3.60	6.55
T_5- Soaking the seed in KNO_3 1 %for 24 hours	4.17	6.56
T_6- Soaking the seed in water for 24 hours	3.17	4.89
T_7- Control (direct sowing)	2.53	4.67
SE(m)	**0.24**	**0.72**
CD(0.05)	**0.73**	**NS**

Table 4: Effect of pre sowing treatments on height of plant at 60, 90 days after sowing.

Treatments	Height of plant after 60 DAS (cm)	Height of plant at 90 DAS (cm)
T_1- soaking the seed in GA_3 100 ppm for 24 hours	28.20	46.11
T_2- soaking the seed in GA_3 200 ppm for 24 hours	26.23	43.11
T_3- soaking the seed in 0.5 % KCl for 24 hours	22.48	33.68
T_4- soaking the seed in 1%KCl for 24 hours	23.71	36.28
T_5- soaking the seed in KNO_3 1 %for 24 hours	25.42	38.43
T_6- soaking the seed in water for 24 hours	24.32	33.48
T_7- control (direct sowing)	21.50	30.70
SE(m)	**0.64**	**1.10**
CD(0.05)	**1.95**	**3.36**

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Table 5: Effect of pre sowing treatments on girth of plant at 60, 90 days after sowing.

Treatments	Girth of plant after 60 DAS (cm)	Girth of plant at 90 DAS (cm)
T_1- Soaking the seed in GA_3 100 ppm for 24 hours	2.09	2.61
T_2- Soaking the seed in GA_3 200 ppm for 24 hours	2.04	2.58
T_3- Soaking the seed in 0.5 % KCl for 24 hours	1.82	2.31
T_4- Soaking the seed in 1 % KCl for 24 hours	1.80	2.33
T_5- Soaking the seed in KNO_3 1 % for 24 hours	1.96	2.45
T_6- Soaking the seed in water for 24 hours	1.67	2.02
T_7- Control (direct sowing)	1.30	1.83
SE(m)	**0.05**	**0.03**
CD(0.05)	**0.16**	**0.08**

Table 6: Effect of pre sowing treatments on length, breadth and leaf area of plant at 90 days after sowing.

Treatments	Length (cm)	Breadth (cm)	Leaf area (cm^2)
T_1- Soaking the seed in GA_3 100 ppm for 24 hours	14.99	7.33	77.16
T_2- Soaking the seed in GA_3 200 ppm for 24 hours	13.90	6.66	64.81
T_3- Soaking the seed in 0.5 % KCl for 24 hours	14.28	6.80	69.17
T_4- Soaking the seed in 1%KCl for 24 hours	15.67	7.16	78.40
T_5- Soaking the seed in KNO_3 1 %for 24	16.57	7.15	83.49
T_6- Soaking the seed in water for 24 hours	13.72	6.35	61.47
T_7- Control (direct sowing)	12.94	6.62	60.64
SE(m)	**1.30**	**0.41**	**9.33**
CD(0.05)	**NS**	**NS**	**NS**

Table 7: Effect of pre sowing treatments on fresh weight and dry weight of plant at 90 days after sowing

Treatments	Fresh weight (g)	Dry weight (g)
T_1- Soaking the seed in GA_3 100 ppm for 24 hours	15.81	4.94
T_2- Soaking the seed in GA_3 200 ppm for 24 hours	15.85	3.69
T_3- Soaking the seed in 0.5 % KCl for 24 hours	13.30	3.19
T_4- Soaking the seed in 1 %KCl for 24 hours	13.23	3.48
T_5- Soaking the seed in KNO_3 1 %for 24 hours	16.71	5.34
T_6- Soaking the seed in water for 24 hours	11.59	3.09
T_7- Control (direct sowing)	11.05	3.48
SE(m)	**0.42**	**0.14**
CD(0.05)	**1.28**	**0.42**

Table 8: Effect of pre sowing treatments on Seedling vigour index (I) at 60, 90 days after sowing

Treatments	Seedling vigour index(I)at 60 DAS	Seedling vigour index(I) at 90 DAS
T_1- Soaking the seed in GA_3 100 ppm for 24 hours	2,319.33	3,788.15
T_2- Soaking the seed in GA_3 200 ppm for 24 hours	2,129.86	3,503.94
T_3- Soaking the seed in 0.5 % KCl for 24 hours	1,650.31	2,463.78
T_4- Soaking the seed in 1% KCl for 24 hours	1,890.96	2,905.11
T_5- Soaking the seed in KNO_3 1 %for 24 hours	2,029.56	3,075.41
T_6- Soaking the seed in water for 24 hours	1,782.31	2,465.04
T_7- Control (direct sowing)	1,386.22	1,976.37
SE(m)	**75.96**	**148.45**
CD(0.05)	**232.632**	**454.63**

1- Seedling gowth after 30 DAS
2- Seedling growth after 90 DAS

Plate 4 – Growth of seed treated plants

4.2 EXPERIMENT 2: IMPACT OF SEASON ON THE SUCCESS OF PATCH BUDDING

4.2.1 Bud in take (per cent)

The seasonal effect of patch budding on bud intake was significally different among different treatments (Table 9). The maximum budding success was observed in July budded plants (60.65 %) followed by August (54.31 %), June (54.71 %) and September (35.05 %). Minimum bud in take was obtained in November budded plants (18.41 %).

4.2.2 Sprouting success percentage

The data pertaining to the seasonal effect of patch budding on sprouting success in jackfruit budded plants revealed (Table 9) significant difference among the treatments. The patch budding carried out in the month of July recorded the maximum sprouting success (68.81 %) followed by August budded plants (62.70 %) and the least sprouting success was found in November budded plants (26.03 %).

4.2.3 Successful budlings (%)

All sprouted plants survived after 90 days of budding. The data pertaining to the seasonal effect of patch budding on final successful budlings (Table 9) displayed significant differences among the treatments. July budded plants recorded the maximum number of successful budlings (68.81 %) and minimum number of final successful budlings was observed in November budded plants (26.03 %).

4.2.4 Length of bud sprout

Length of sprout was observed at 30 days interval at 30 DAB, 60 DAB, and 90 DAB (Table 10).There were no significant differences after 30 DAB. Maximum length of sprout was observed in July budded plants (3.55 cm) and minimum sprout length was observed in November budded plants (2.90 cm)

The seasonal effect of patch budding on sprout length of budded plants showed significant difference among the treatments at 60 DAB. Among the treatments July budded plants showed maximum sprout length (12.03 cm) which was on par with the June budded plants (10.70 cm) and August budded plants

(10.62 cm). At later stage, after 90 DAB, treatments were significantly different among themselves and maximum length of sprout was observed in July (21.14 cm) followed by August (17.59 cm) which was on par with the June budded plant (16.71 cm)

4.2.5 Number of leaves per budded plants

The impact of season over the number of leaves per plant (Table 11) was observed at 30 days interval and at 30 DAB, 60 DAB and 90 DAB was significantly different among treatments. Maximum number of leaves was observed in June budded plants (2.98, 4.40, and 9.30). Minimum number of leaves was observed in November budded plants (2.11, 4.30, and 4.75) all 30, 60.and 90 DAB respectively. Differences among treatments were insignificant at 60 DAB.

Table 9: Impact of season on the bud in take per cent and sprouting per cent and successful budling percentage

Treatments	Budding success percentage (%)	Sprouting success percentage (%)	Successful budlings percentage (%)
T_1 - Patch budding in June	50 (44.98)*	66.66 (54.71)	66.66 (54.71)
T_2 - Patch budding in July	76 (60.65)	86.96 (68.81)	86.96 (68.81)
T_3 - Patch budding in August	66 (54.31)	79 (62.70)	79 (62.70)
T_4 - Patch budding in September	33 (35.05)	47.33 (43.45)	47.33 (43.45)
T_5 - Patch budding in October	20 (26.55)	29.33 (32.72)	29.33 (37.72)
T_6 - Patch budding in November	10 (18.41)	19.33 (26.03)	19.33 (26.03)
SE(m)	**0.40**	**1.06**	**1.06**
CD (0.05)	**1.26**	**3.31**	**3.31**

***Figures in parentheses are arcsine transformed values**

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Table 10: Impact of season on the Length of sprout at 30, 60 and 90 days after budding

Treatments	Sprout length after 30 DAB (cm)	Sprout length after 60 DAB (cm)	Sprout length after 90 DAB (cm)
T_1 - Patch budding in June	3.74	10.70	16.71
T_2 - Patch budding in July	3.55	12.03	21.14
T_3 - Patch budding in August	3.28	10.62	17.59
T_4 - Patch budding in September	3.00	8.37	15.57
T_5 - Patch budding in October	2.93	6.57	10.70
T_6 - Patch budding in November	2.90	5.87	9.73
SE(m)	**0.42**	**0.85**	**0.64**
CD (0.05)	**NS**	**2.66**	**2.01**

Table 11: Impact of season on the number of leaves at 30, 60 and 90 days after budding

Treatments	Number of leaves on budlings after 30 DAB	Number of leaves on budlings after 60 DAB	Number of leaves on budlings after 90 DAB
T_1 - Patch budding in June	2.98	4.40	9.30
T_2 - Patch budding in July	2.21	4.63	6.41
T_3 - Patch budding in August	2.55	3.17	5.75
T_4 - Patch budding in September	2.31	4.07	5.27
T_5 - Patch budding in October	2.11	4.30	5.53
T_6 - Patch budding in November	2.11	4.30	4.75
SE(m)	**0.16**	**0.47**	**0.77**
CD (0.05)	**0.508**	**NS**	**2.41**

Patch budded jack fruit

Cutting the top portion above the patch budded region

Plant after 20 DAB

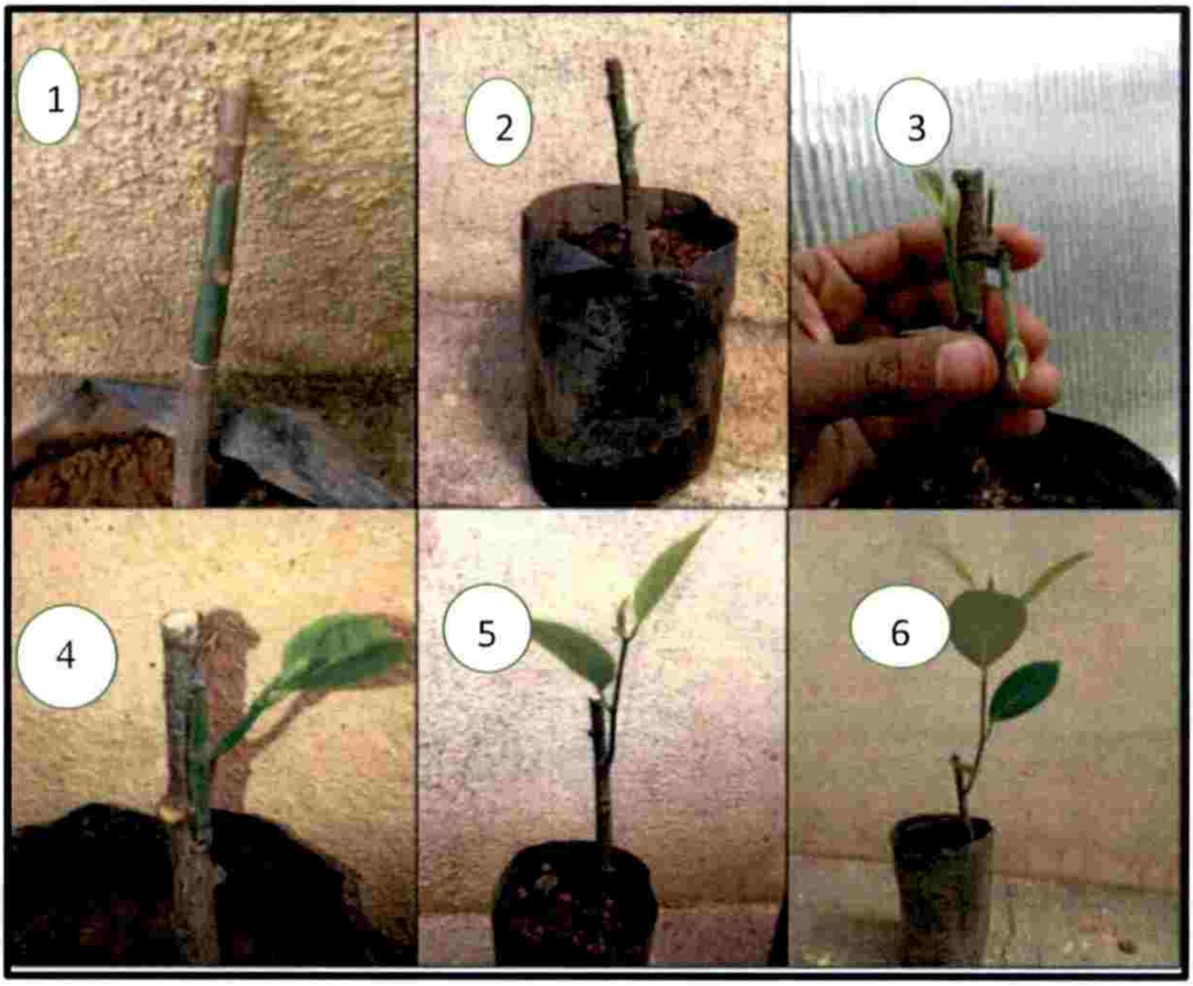
Plant after 30 DAB

Plate 5 - Aftercare of patch budded jack fruit tree

Plant after 60 DAB

Plants after 90 DAB

Plate 6-Different stages of patch budded jack fruit



Different growth stages of patch budded jack fruit plants

1 - Plants after 20 DAB

2, 3 - Plants after 30 DAB

4, 5 – Plants after 45 DAB

6 - Plants after 60 DAB

Plate 7- Sprouted budling at different time

Discussion

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5. DISCUSSION

The present investigation entitled 'standardization of patch budding in jackfruit (*Artocarpus heterophyllus* Lam.) was conducted at College of Agriculture, Padannakkad, Kasaragod.The study comprised of two experiments. Salient results obtained during the course of investigation have been discussed in this chapter under appropriate headings

5.1 EXPERIMENT 1: PRESOWING TREATMENTS ON MATURE AND RIPENED JACK FRUIT SEEDS.

5.1.1 Days taken for first germination

Days taken for germination significally varied in different presowing seed treatments. Among different treatment T_5 (soaking the matured and ripened seeds with 1% KNO_3 for 24 hours) took minimum number of days required for germination (17 days) which was on par with T_1 (17.33 days) and maximum number of days(26.70 days) required for sprouting was obtained in direct sowing (control).

According to Patel *et al.*(2016), Custard apple seed treated with 1.5 per cent potassium nitrate took minimum number of days (21 days) taken for germination.

Variation with respect to number of days required for potential germination might be due to the stimulatory effect of chemical on different process such as cell division, cell elongation and cell differentiation and ultimately on the emergence of seedlings.

Rajamanickan and Balakrishnan (2004) reported that soaking the fresh seed of aonla in 0.5 per cent KNO_3 resulted highest root length (3.26 cm).Similar result was obtained by Aatla and Srihari (2013) in mango. Kernels pre-treated with 0.5 per cent of KNO_3 had better root characters like root length (23.40 cm), root spread (8.66 cm) and root to shoot ratio (0.807). Hence, early establishment of roots might be one of the reason for the early emergence of jackfruit seedling.

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5.1.2 Days taken for 50 per cent germination

Days taken for 50% germination significantly varied among treatments,T_5 (seed soaking in 1 % KNO_3) significantly reduced the time duration to 23.47 days (30.62% reduction over control) and followed by T_1(25.33 days). Maximum number of days required for attaining 50 per cent germination was obtained in control (33.83 days).

5.1.3 Germination percentage

Germination percentage significantly varied due to different presowing seed treatments. Among treatments T_1 significantly enhanced the germination percentage (65.13 %) which was on par with the treatment T_2 (63.82 %) and T_5 (62.55 %) and minimum percentage was observed with the control (53.39 %).

Babu *et al.* (2008) reported the similar finding in papaya seed soaked in 100 ppm of gibberellic acid showed maximum percentage of germination (66.17 %).The highest percentage of germination (98.0 %) and coefficient of germination velocity (28.00) were obtained in seeds soaked in100 ppm gibberellic acid (Maiti *et al.*, 2003).

Singh (2002) also found that soaking the jack fruit seed in 100 ppm of gibberellic acid for 12 hours showed highest percentage of germination (95.33 %).According to Parmer *et al.* (2014) seed priming of custard apple with 200 ppm Gibberellic acid had maximum germination per cent (63.99 %). Samir *et al.* (2015) also reported that soaking of kirni (*Manilkara hexandra*) can be soaked in 200 ppm of GA_3 resulted better germination.

Sheoran *et al* (2019 b) soaking ber seed for 2 per cent of KNO_3 for one day showed maximum germination (13.3 %). Aatla and Srihari (2013) observed mango kernel pre-treated with 0.5 per cent of KNO_3 recorded highest germination percentage (64 %).

According to Farajollahi *et al.* (2014), 0.1 percent of KNO_3 was found effective for seed germination (90 %) of a desert plant species *Calotropis persica*

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(Grand.) because of the positive role of KNO_3 in balancing the hormone present in the seed resulted enhanced germination rate (50 %) over the control.

Bray *et al.* (1989) suggested that presowing treatments causes occurrence of certain metabolic repair during the imbibition, build-up of germination-enhancing metabolites (Basra *et al.*, 2005) and osmotic adjustment (Bradford, 1986), and, for seeds that are not redried after treatment, a simple reduction in imbibition lag time (Bradford, 1986). Salts like KNO_3 reduced water potential of the solutions in which seeds were steeped and depleted the water content of seeds. This made the seeds, to proceed to the first stage of germination, to rapidly imbibe water with no lag after sowing, (Heydecker *et al.* 1973).

Pre-soaking treatment of gibberellic acid might affect and alter the enzymatic reaction (protein synthesis, conversion of starch to sugar) involved in the germination process. Gibberellic acid induces *de-novo* synthesis of proteolytic enzyme like alpha amylase and ribonuclease. This amylase hydrolyse the starch in endosperm resulting the availability of essential sugars required for the initiation of growth process. Liberation of chemical energy help to activate embryo as well as suppression inhibitors along with the synthesis of RNA, ultimately resulting in higher germination (Copeland and McDonald., 1995).

5.1.4 Germination rate

Germination rate varied significantly among different pre sowing seed treatment. The maximum germination rate was observed in T_1 (0.59) which was on par with T_5 (0.57) and T_2 (0.53) and minimum germination rate was observed with the control (0.29).

In mango, Reshma and Simi (2019) reported the highest germination rate in kernels treated with 200 ppm of gibberellic acid followed by 100 ppm of gibberellic acid and KNO_3.

5.1.5 Number of leaves per seedling

Number of leaves per seedlings was recorded at 60th and 90th days after sprouting. Treatments were significantly different after 60th days of sprouting.

Fig.1. Effect of presowing treatments on number of days taken for first and fifty per cent germination

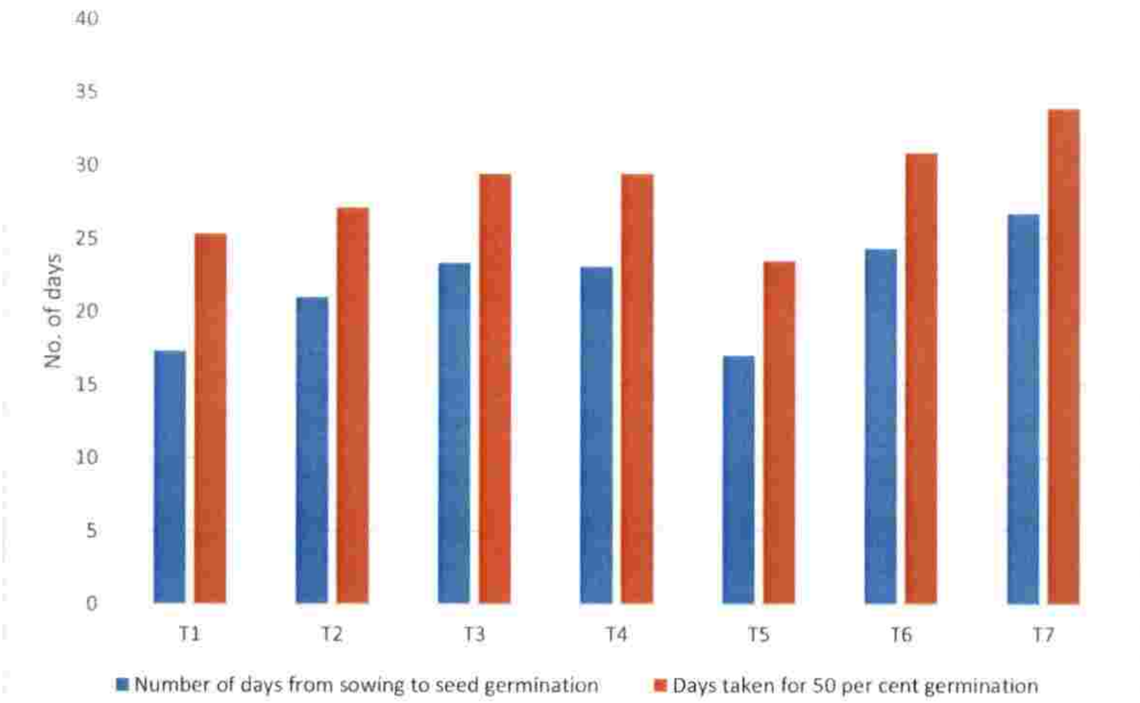
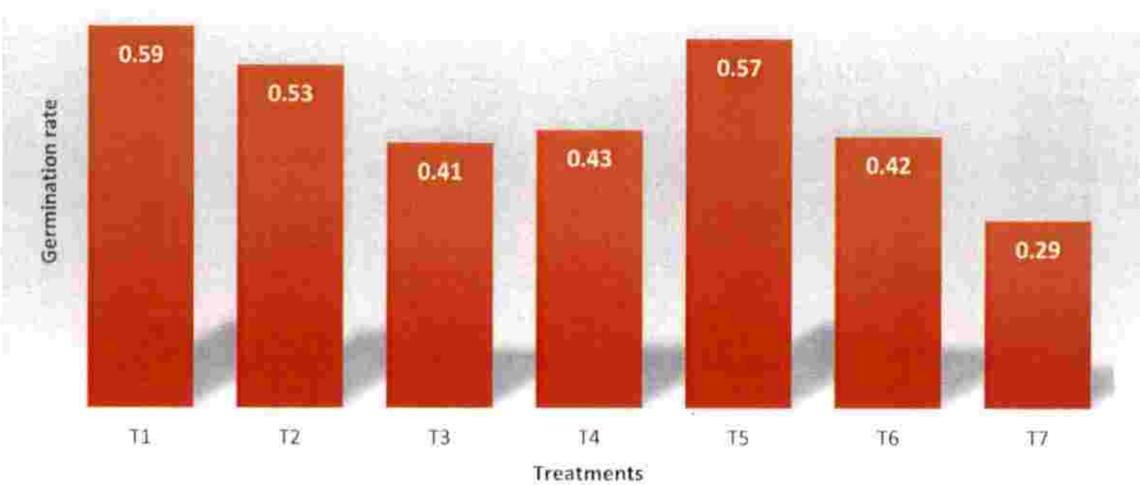


Fig.2. Effect of presowing seed treatments on germination rate of jack fruit seedling



Maximum number of leaves were found in T_5 (4.17), which was on par with T_4 (3.6). At later stage (90 DAS), the treatment differences were non-significant.

Harshavardhan and Rajasekhar (2012) reported that application of potassium nitrate at 0.5 per cent for one day on ripened jack fruit seeds recorded maximum number of leaves (28.2). Stimulatory action of KNO_3 might be due to the presence of NO_3, which promotes the leaf growth.

According to Patel *et al.* (2016), Custard apple seed showed higher number of leaves (4.03, 6.60, 6.60) at 60, 90 and 120 days after sowing by treating with 1.5 per cent of potassium nitrate. Aatla and Srihari (2013) also observed mango kernel pre-treated with 0.5 per cent of KNO_3 recorded highest number of leaves (10.90).

Vanangamudi, and Vanangamadi, (2003) revealed that presowing of tamarind seed in 3 per cent of potassium chloride helped to improve the chlorophyll content and soluble proteins.Increase in the photosynthetic rate might attribute to increase in number of leaves.

5.1.6 Height of shoot

Height of the shoots recorded at 60^{th}, 90^{th} days after sprouting were significantly different and maximum shoot length was observed in T_1 (28.20 cm) and minimum sprout length was observed in control (21.50 cm).at later stage (90 days after) the treatments were significantly different and the maximum shoot length was observed in T_1 (46.11 cm) which was on par with T_2 (43.11 cm) and minimum height was recorded in control (30.70 cm).

In jackfruit, Harshavardhan and Rajasekhar (2012) reported the maximum seedling length (72.1 cm) by treating with 200 ppm of gibberellic acid for one day. Maiti *et al.* (2002) reported the second tallest jack fruit seedling (24.90 cm) on soaking the seed in 200 ppm of gibberellic acid. Patil *et al.*(2018) reported the maximum height of jamun (82.60 cm) by treating 200 ppm of GA_3 for 10 minutes.

GA_3 activate the alpha amylase, which digest the available carbohydrate into simpler sugar resulting in increased plant height (Shant and Rao, 1973) and Gibberellic acid are well known for intermodal elongation. Increase in seedling length might be due the stimulation of osmotic uptake of nutrients, cell multiplication and cell elongation.

Influence of GA_3 and potassium nitrate on stem elongation is achieved by inducing cell wall extensibility, stimulating cell wall synthesis, reducing the rigidity of cell wall and increasing the rate of cell division and as well as increasing the synthesis of IAA leading to the rapid growth (Reshma and Simi, 2019)

5.1.7 Girth of plant

Girth of plant was recorded at 60 DAS, 90 DAS and average values observed are presented in Table 5. After 60 DAS the maximum girth (2.09 cm) was observed in T_1 which was on par with T_2 (2.04 cm) and T_5 (1.96 cm).At later stage (90 DAS), maximum girth of shoot was observed in T_1 (2.61 cm) which is on par with T_2 (2.58).

Ratan and Reddy (2004) reported that in custard apple seed, maximum stem girth (2.86 cm) was obtained by soaking in 200 ppm Gibberellic acid for 24 hour.

Root collar diameter and height of seedling and rapid growth rate are some of the desirable attributes taken into consideration while selecting a seedling as a rootstock. These growth attributes can decide the waiting period. Increase in stem girth helps in better alignment of cambial region of the rootstock and scion (Pina and Errea, 2005). Mng'omba *et al* (2010) found that rootstock with thicker root collar diameter had more number of leaves per graft. Thin rootstock will produce few number of leaves on grafts and so the net photosynthetic assimilate production will be low and ultimately result in low graft survival.

Fig.3. Effect of presowing treatments on girth of jack fruit seedling

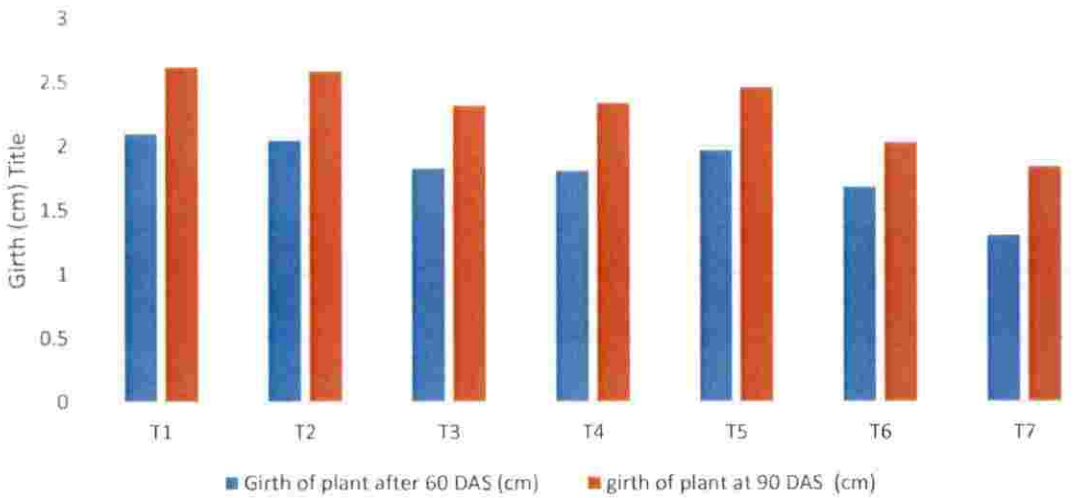
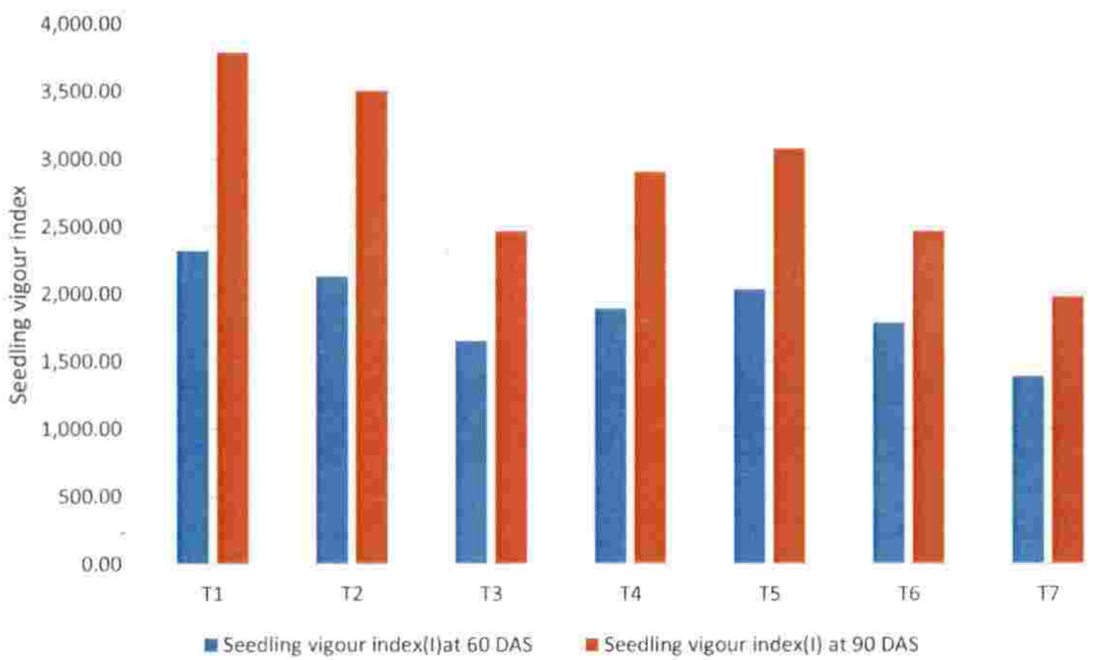


Fig.4. Effecct of presowing treatments on seedling vigour index at 60 and 90 days after sprouting



5.1.8 Length, Breadth and leaf area

There was no significant difference among treatments. However, T_5 recorded maximum leaf length and leaf area. Harshavardhan and Rajasekhar (2012) reported that application of potassium nitrate at 0.5 per cent for one day on ripened jack fruit seeds recorded maximum leaf area per seedling (2526 cm^2). Stimulatory action of KNO_3 might be due to the presence of NO_3, which promote the leaf growth.

5.1.9 Fresh weight and Dry weight

Fresh weight and dry weight were recorded at 90 DAS and there were significant difference between the treatments. Maximum fresh weight was obtained in T_5 (16.71 g). Dry weight was taken after 90 DAS, by keeping the whole plant in hot air oven at 62°C for 4 days. The treatments were significantly different and maximum dry weight was obtained in T_5 (5.34 g) which is on par with T_1 (4.94 g).Minimum dry weight was obtained in the T_6 (3.37 g). T_5 recorded more leaf number and leaf area, which might have increased the photosynthetic rate.

5.1.10 Seedling vigour index

Seedling vigour index was calculated at 60 DAS, 90 DAS and the average value is presented in Table 8. The treatments were significantly different. The maximum seedling vigour was obtained in T_1 (2319.33, 3788.15) which is on par with T_2 (2129.80, 3503.94) followed by T_5 (2029.56, 3075.45) and the minimum value was obtained with the control (1386.22, 1976.37). Increase in seedling vigour might be due the enhanced germination and early seedling emergence, better seedling growth and high seedling vigour.

5.2 EXPERIMENTS 2: IMPACT OF SEASON ON THE SUCCESS OF PATCH BUDDING

For maintaining the genetic uniformity and genetic conservation in jackfruit, vegetative propagation method is adopted. Approach grafting, soft wood grafting, epicotyl grafting, and patch budding are commonly adopted. Among this patch budding is gaining importance and widely practised in commercial nurseries.

Budding technique uses scion tissue in the form of a single viable bud. Factors like temperature, moisture, physiological stage of plant and craftsmanship influence the graft success.

Irrespective of the method of vegetative propagation, the success rate may vary with variety and geographical area and season wise standardization should be done and through this investigation was carried out to standardize the best season for adoption of patch budding. Some salient findings are discussed below.

5.2.1 Bud in take

The seasonal effect of patch budding on bud intake was significantly different among different treatments. The maximum budding success was observed in July budded plants (60.65 %) followed by August (54.31 %), June (54.71 %) and September (35.05 %). Minimum bud in take was obtained in November budded plants (18.41 %). But Nataraj (2013) got December as the best season for performing patch budding under Mudigere condition (High Range region).

Singh and Pandey (1998) reported that the best time for patch budding in guava was July with a success rate of 65.00 per cent followed by August (55.70 %).

Pathak and Srivastava (1973) revealed that with a bud intake of 80 to 90 per cent and a budding success of 60.00 per cent to 70.0 per cent was obtained in July budded apple.

Tripathi and Kumar (2004) also agreed that budding performed during last week of July in bael showed better response with respect to the following

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Fig.5. Impact of season on bud intake percentage and sprouting percentage in patch budded jack fruit

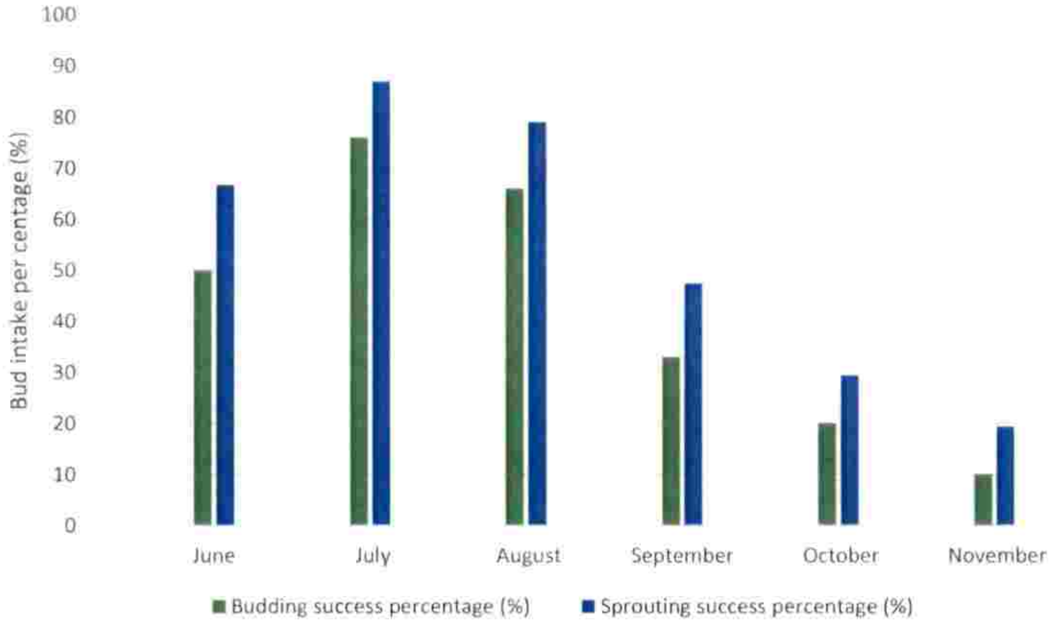
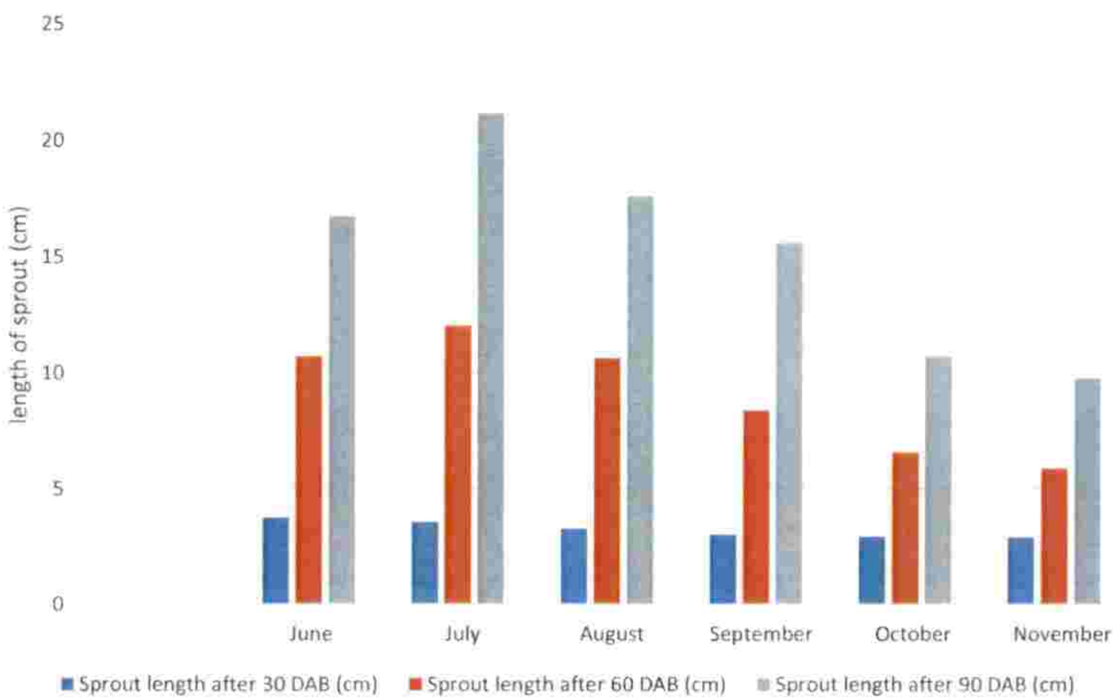


Fig. 6. Impact of season on length of sprout after 30, 60, and 90 days after sprouting



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attributes like bud intake (70.00 %) bud sprout (62.20 %) and survival (62.20 %). July to September, budded plants were showing maximum diameter (5.49 cm) and length (34.23 cm) bud sprouts observation was taken after 120 days under Hissar conditions.

Bagdanov (1976) reported that the optimum resulted for apple where obtained when budding was carried out on 25th July and 15th August.

Standardization of method of vegetative propagation and season for bael was done at the Fruit Research Station, Basti by Singh *et al.* (1976). Result revealed cent per cent success in June and July by patch budding.

Ahamad *et al.* (2017) found July as the most appropriate time for budding in peach with 93.33 per cent bud intake.

Percentage of bud in take depend upon many factors such as temperature, relative humidity, rate of sap flow between the root stock and scion and the time of budding. Among these factors temperature and humidity facilitate the union between the rootstock and scion (Ahamad *et al.*, 2012).

High humidity is good for callus formation, optimum temperature is good for new paranchymatous cell proliferation between the rootstock and scion.

Hussain *et al.* (2018) also reported maximum bud in take in the third week of July. Similarly Pathak and Srivastava (1973) obtained 80 per cent bud take in the month of July and August. Rapid sap flow in stock and scion facilitate for higher budding success.

Percentage of sprouting is not only influenced by single parameter but it is the overall effect of microclimate prevailing in that locality.

Baloda *et al.* (2016) also found that maximum bud intake success was found in fourth week of July. The higher success in July and August might be because of the optimum temperature and relative humidity prevailing during the period and sap flow in stock and scion, which might favoured the healing process and help in the establishment of continuity of cambium and vascular bundle for

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bud intake. Newly formed cells are thin and turgid, high relative humidity will help the thin and turgid cell from desiccation.

Aseef *et al.* (2018) reported that season, tree phenology and age of rootstock have crucial role deciding the success. Apart from the season the rain fall receiving in the month of July and August resulted in the activation of dormant bud sprouts. Lower success percentage obtained in November and October month can be correlated with the tree phenology. Jackfruit tree started to flower by the end December. The carbon assimilate will translocated to sink from the scion leading to the lower success rate.

5.2.2 Morphological characters

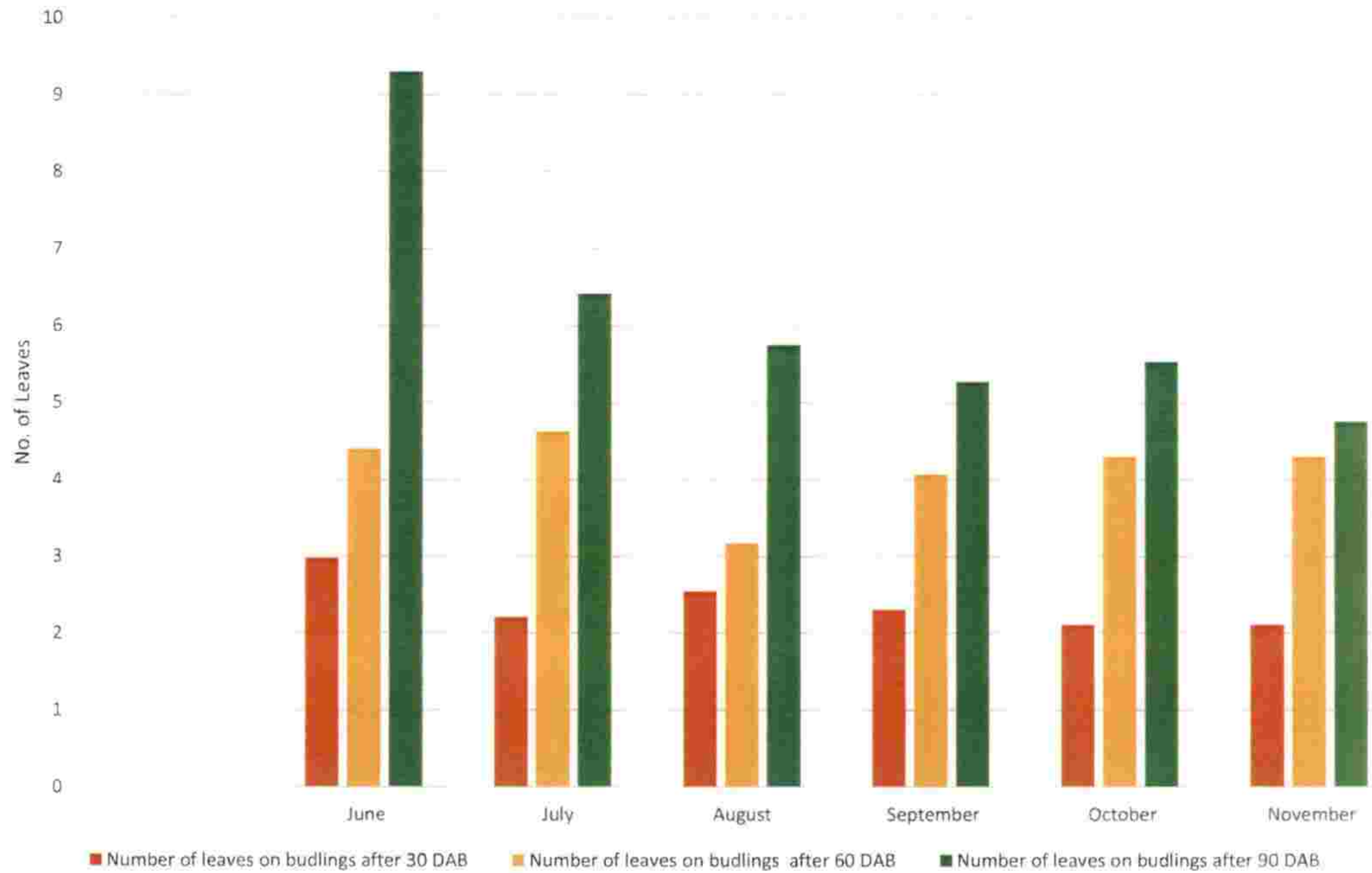
Length of sprout and number of leaves was observed at 30 days interval at 30 DAB, 60 DAB, and 90 DAB .There was no significant difference after 30 DAB in length of sprout. Later at 60 DAB. Among the treatments July budded plants showed maximum sprout length (12.03 cm) which was on par with the June budded plants sprout length (10.70 cm) and August budded plants (10.62 cm).

At 90 DAB, maximum length of sprout was observed in July (21.14 cm) followed by August (17.59 cm) which was on par with the June budded plant (16.71 cm). Maximum number of leaves was observed in June budded plants (2.98, 4.40, and 9.30). Minimum number of leaves was observed in November budded plants (2.11, 4.30, and 4.75). Number of leaves were non-significant after 60 DAB.

Baloda *et al.* (2016) also reported maximum shoot length (27.68 cm) when budding was done in fourth week of July. Archana *et al.* (2018) obtained maximum length of sprout in the month of April and June. But Kelesker *et al.* (1993) got higher sprout length in plant budded in the month of March to April. Maximum sprout length in June, July and August could be due to early sprouting, optimum temperature and relative humidity, which is required for the shoot growth and which leads to higher number of leaves per shoots.

Seedling with desirable like rapid growth, maximum root collar diameter and optimum height could reduce the waiting period rootstock. Most popular and

Fig. 7. Impact of season on number of leaves after 30, 60, and 90 days after sprouting



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viable vegetative propagation methods of jackfruit are approach grafting, epicotyl grafting, softwood grafting and patch budding. In grafting technique 15-20 cm long detached piece of shoot with few dormant buds are used as scion. In grafting not only rootstock but also scion can provide the required nutrient for newly developed tissues and prevent from drying. In case of patch budding a piece of bark from the stock is removed in the form of rectangle of 2.5 cm x 1.5 cm and a patch of similar size containing a viable bud is removed from the scion plant. So rootstock only can only provide the nourishment the new composite plants.

Fortification of seed by using chemicals and growth regulators can improve the growth characters like increasing the root collar diameter of resulting seedling to some extend ultimately helps to improve the budding success through proper alignment of scion and rootstock. Presowing of ripened and mature seed with 100 ppm or 200 ppm of gibberellic acid or with 1 per cent of KNO_3 showed similar significant impact over the growth parameters like number of days taken for germination, germination rate, germination percentage, girth of plant, number of leaves, seedling vigour index, etc

To obtain seedlings with good girth for budding, soaking seeds in gibberellic acid 100 ppm could be adopted. Temperature and humidity prevailing in July is ideal for performing patch budding in jack fruit on a six month old root stock under Kasaragod condition. July budded plants showed maximum bud intake, sprouting success, and sprout length, number of leaves.

Plate 8- field view patch budded jack fruit plants after one year

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Summary

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6. SUMMARY

Jackfruit is an obligate cross pollinated crop. Sexual method of propagation result in type variation. Cross pollination may leads to the production varikka on koozha type and vice versa.Vegetative propagation helps to maintain the genetic uniformity and large scale production of elite planting materials with desirable traits like precocity, sweetness, gumless nature, cluster bearing habit etc.

Approach grafting, soft wood grafting, epicotyl grafting and patch budding are the viable propagation method adopted in jack fruit tree. Among these methods, while comparing the facilities and methods, patch budding gained popularity in commercial nurseries. Response of patch budding may vary depending on many factors like climate, morpho-physiological characters of rootstock and scion and craftsmanship. Hence regional and varietal wise standardization of patch budding ought to be done.

Jack fruit tree availability is seasonal and recalcitrant nature of the seed make the storage difficult. Hence, within the limited period one should produce maximum rootstock required for performing vegetative propagation. The present investigation entitled 'Standardization of patch budding in jackfruit(*Artocarpus heterophyllus*Lam.) was undertaken at College of Agriculture, Padannakkad, Kasaragod during the period 2018 June to 2019 June .

To assess the effect of seed treatment on the seedling growth of jack fruit (for the reduction of number of days required for attaining buddable size), experiment was laid out in completely randomazied design replicated thrice with seven treatments. Seeds were subjected to different chemical treatment such as soaking 100 ppm, 200 ppm of gibberellic acid, 0.5 and 1 per cent potassium chloride, 1 per cent potassium nitrate, water for one day followed by immediate sowing.

Observations were taken on the parameters like number of days required for first germination, days taken for 50 % germination, germination percentage, germination rate, girth and number of leaves and height, seedling vigour index

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was observed at 60, 90 days after sprouting, length, breadth, and leaf area, fresh weight, and dry weight at 90 days interval.

T_5 (soaking the matured and ripened seeds with 1% KNO_3 for 24 hours) took minimum number of days required for germination (17 days) which was on par with T_1 (17.33 days) and maximum number of days (26.70 days) required for sprouting was obtained in direct sowing (control). T_5 (seed soaking in 1% KNO_3) significantly reduced the time duration to 23.47 days (30.62 % reduction over control) followed by T_1 (25.33 days). Germination percentage significantly varied due to different pre sowing seed treatments.Maximum germination percentage and germination rate was obtained T_1 (65.13 %, 0.59) which was on par with the treatment T_2 (63.82 %, 0.53) and T_5 (62.55 %, 0.57).

Variation with respect to number of days required for potential germination might be due to the stimulatory effect of chemical on different process such as cell division, cell elongation and cell differentiation and ultimately on the emergence of seedlings.

Maximum number of leaves were found in T_5 (4.17), which was on par with T_4 (3.6). At later stage, 90 DAS the treatment differences were non-significant. Maximum shoot length was observed in T_1 (28.20 cm) at 60 DAS and at later stage (90 days after) the treatments were significantly different and the maximum shoot length was observed in T_1 (46.11 cm) which is on par with T_2 (43.11 cm).

Maximum girth (2.09 cm) was observed in T_1 which was on par with T_2 (2.04 cm) and T_5 (1.96 cm). At later stage (90 DAS) Maximum girth of shoot was observed in T_1 (2.61 cm) which was on par with T_2 (2.58 cm).

Influence of GA_3 and potassium nitrate on stem elongation is achieved by inducing cell wall extensibility, stimulating cell wall synthesis, reducing the rigidity of cell wall and increasing the rate of cell division and as well as increasing the synthesis of IAA leading to the rapid growth. Maximum fresh weight and dry weight was obtained in T_5 (16.71 g, 5.34 g). Dryweight was on par with T_1

(4.94g).The maximum seedling vigour was obtained in T_1 (2319.33, 3788.15) which is on par with T_2 (2129.80, 3503.94) followed by T_5 (2029.56, 3075.45).

Results revealed that seed priming with this chemicals have significant effect on growth and vigour of the seedling. Maximum desirable attributes was observed in seed treated with 100 ppm of gibberellic acid and 1 per cent potassium nitrate. Treatment of these chemicals reduced the number of days taken for germination (17.33 days, 17 days respectively), days required for attaining 50 per cent germination (25.33 days, 23.47 days), germination percentage (65.13 %, 62.55 %), germination rate (0.56 and 0.57), girth of plant (2.09 cm, 1.96 cm respectively after 60 days).

To standardize the season for patch budding in jack fruit under Kasargod condition, patch budding was carried in monthly interval from June 2018 to November 2018 on a six month old rootstock. Experiment was laid out in completely randomized design, replicated thrice with six treatments.

The maximum budding success was observed in July budded plants (60.65 %) followed by August (54.31 %), June (54.71 %) and September (35.05 %). July budded plants showed maximum sprout length (12.03 cm,) which is on par with the June budded plants sprout length (10.70 cm) and August budded plants (10.62 cm). Later at 90 DAB, July (21.14 cm) followed by August (17.59 cm) which is on par with the June budded plant (16.71 cm).Maximum number of leaves was observed in June budded plants (2.98, 4.40, and 9.30).

From observations maximum bud intake (60.65 %), sprouting success (68.81 %) and growth parameters such as length of sprout (2.90 cm, 12.03 cm, and 21.14 at 30, 60, and 90 DAB respectively), July is the best month for performing patch budding in Kasargod region and it can be extended upto September Beyond September, response of plant to patch budding was poor.

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STANDARDIZATION OF PATCH BUDDING IN JACK FRUIT
(*Artocarpus heterophyllus* Lam.)

By

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Abstract of the thesis

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ABSTRACT

The present investigation entitled 'Standardization of patch budding in jack fruit (*Artocarpus heterophyllus* Lam.) was undertaken at the College of Agriculture, Padannakkad, Kasaragod during the period 2018 June to 2019 June . The research work was carried out to assess the effect of seed treatments on the seedling growth to attain the buddable size and seasonal influence on the success of patch budding.

The first experiment was laid out in CRD with seven treatments and three replications. Seeds were subjected to different treatments such as gibberellic acid 100 ppm (T_1) and 200 ppm (T_2), potassium chloride 0.5 per cent (T_3) and 1 per cent (T_4), potassium nitrate 1 per cent (T_5) and water (T_6) for one day before sowing. In treatment T_7 (control), the seeds were sown without any treatment.

The treatment T_5 took minimum number of days for germination (17 days) which was on par with T_1 (17.33 days) and maximum number of days (26.70 days) required for sprouting was observed in control. T_5 recorded minimum days (23.47 days) to attain 50 per cent germination (30.62 % reduction over control) followed by T_1 (25.33 days). Maximum germination percentage and germination rate was obtained T_1 (82.22 %, 0.59) which was on par with the treatment T_2 (80.16 %, 0.53) and T_5 (78.44 %, 0.57).

Maximum number of leaves were produced in T_5 (4.17), which was on par with T_4 (3.6). Maximum shoot length was observed in T_1 (28.20 cm) at 60 DAS. At 90 DAS, the treatment T_1 (46.11 cm) recorded maximum shoot length which was on par with T_2 (43.11 cm). Maximum girth (2.09 cm) was observed in T_1 which was on par with T_2 (2.04 cm) and T_5 (1.96 cm) at 60 DAS. The maximum seedling vigour was obtained in T_1 (2319.33, 3788.15) which was on par with T_2 (2129.80, 3503.94) followed by T_5 (2029.56, 3075.45) at 60 and 90 DAS respectively.

Results of the study revealed that seed priming with chemicals have significant effect on growth and vigour of the seedling. Maximum desirable

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attributes were observed in seeds treated with 100 ppm of gibberellic acid and one per cent potassium nitrate. Treatment with these chemicals reduced the number of days taken for germination (17.33 days, 17 days respectively), days required for attaining 50 per cent germination (25.33 days, 23.47 days), and increased the germination percentage (82.22 %, 78.44 %), germination rate (0.56 and 0.57) and girth of plant (2.09 cm, 1.96 cm respectively after 60 days). Considering the cost of chemicals, one per cent potassium nitrate could be the best treatment.

To standardize the season for patch budding in jack fruit under Kasaragod condition, the experiment was laid out in CRD with six treatments. Patch budding was carried out at monthly intervals from June 2018 to November 2018 on a six month old root stock.

The maximum budding success was observed in July budded plants (76.00 %) followed by August (66 %), June (50 %) and September (33 %). July budded plants showed maximum sprout length (12.03 cm), which was on par with the June budded plants (10.70 cm).

From observations like maximum bud intake (76.00 %), sprouting success (86.96 %) and length of sprout (2.90 cm, 12.03 cm, and 21.14 at 30, 60, and 90 DAB respectively), it was found that July was the best month for performing patch budding in Kasargod region and it can be extended upto September. Beyond September response of plant to patch budding was poor.

The study could identify that soaking the seeds in one per cent KNO_3 can reduce the waiting period and July is the best month for performing patch budding in jack fruit under Kasaragod condition.

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DETAILS OF WEATHER DATA

DATE	TEMPERATURE (^0C)		HUMIDITY (%)		RAINFALL	SUNSHINE
	MAX	MIN	MAX	MIN		
01-06-2018	32	25.5	87	68	0	8.4
02-06-2018	32	26	92	70	0	2.7
03-06-2018	32.2	25	88	70	0	3
04-06-2018	31.5	23.5	100	96	92.4	0.2
05-06-2018	29	23.5	98	87	32.9	0.2
06-06-2018	29.5	25	96	82	17.5	8.3
07-06-2018	31.5	24.5	96	82	5.8	0.0
08-06-2018	30	24	98	89	145	0
09-06-2018	29	23.5	96	96	36.3	0
10-06-2018	27	23.9	88	72	120.6	0.9
11-06-2018	31	24.5	88	82	4	0.5
12-06-2018	31.2	26.5	85	79	5.2	1.8
13-06-2018	31	27	85	76	5.3	3
14-06-2018	31.5	25	89	96	7.4	0.0
15-06-2018	27	24	93	81	25.5	2.3
16-06-2018	30	25	96	70	5.6	6.2
17-06-2018	31.5	24.5	96	78	6.3	0.5
18-06-2018	30.5	23.5	92	81	24.2	5.3
19-06-2018	30.2	24.5	94	96	19.5	0
20-06-2018	29.5	23.5	100	100	51.9	0
21-06-2018	25.5	23.5	100	84	67.4	0
22-06-2018	27.5	23.5	93	90	5.9	0
23-06-2018	27.5	23.5	96	90	12.9	0
24-06-2018	26.5	22.5	96	81	16.6	0.5
25-06-2018	29.5	23	96	92	14.1	2.3
26-06-2018	29.5	22.5	96	78	32.8	1.9
27-06-2018	30.5	23	98	85	13	0
28-06-2018	30	23	100	92	71.5	0
29-06-2018	27.5	23	97	96	70.5	0
30-06-2018	25.5	23.5	93	75	15.2	6.2
01-07-2018	30.5	24	92	88	6.2	2.4
02-07-2018	30.5	25	92	81	2.8	5.1
03-07-2018	30.2	23.5	96	68	9.3	3.6
04-07-2018	31	24	92	79	13.2	3.5

05-07-2018	30.5	22	88	70	6.6	5.9
06-07-2018	31.5	24	96	75	12	0.3
07-07-2018	30.5	24	96	92	74.8	0
08-07-2018	29	22	96	85	35.2	0.4
09-07-2018	30	25.5	88	85	13.7	1.1
10-07-2018	30	24.5	96	87	19.4	0
11-07-2018	30.2	24.5	96	88	33.5	0
12-07-2018	29.5	23.5	98	75	61.3	1.9
13-07-2018	30.3	24	96	96	51	0
14-07-2018	27.5	24	98	75	48.5	2.9
15-07-2018	30.8	24	92	75	17.3	2.1
16-07-2018	30.8	24.5	94	87	32.2	0.0
17-07-2018	29.5	25	88	73	33.2	0.8
18-07-2018	30.5	23.5	96	92	42.2	0.7
19-07-2018	30	24.5	100	96	88.4	0.4
20-07-2018	29.5	24	96	92	96	0
21-07-2018	26.8	24	96	85	33.1	0
22-07-2018	29.8	24.5	95	77	14.2	3
23-07-2018	30	25	96	70	20.2	4.5
24-07-2018	31.5	25	96	75	6.4	2.5
25-07-2018	30	25	96	85	4.7	0.5
26-07-2018	28.5	24.8	98	78	48.3	1.3
27-07-2018	29.5	24.5	96	75	11.8	4
28-07-2018	30	25.8	94	75	4.4	4.7
29-07-2018	30.5	28.5	85	78	2.1	4
30-07-2018	31	27	96	85	1.4	2.8
31-07-2018	30	25	94	71	24.8	2.3
01-08-2018	30	25	96	81	7.5	0.6
02-08-2018	29	25	96	78	6	4.7
03-08-2018	31	23.5	98	82	86.3	0.6
04-08-2018	30	24	96	71	26.5	4.5
05-08-2018	30	24	96	75	0	7.8
06-08-2018	31.5	25	96	73	5.8	7.4
07-08-2018	30.5	24.5	92	84	14.3	0.8
08-08-2018	28.5	24	95	81	42.5	0.1
09-08-2018	29	24	96	78	5.2	2.0
10-08-2018	30	24	96	85	9.6	1.4
11-08-2018	30	23.5	96	85	36.6	0
12-08-2018	29.5	23	96	87	24	0

13-08-2018	28.5	23	95	79	41.2	0
14-08-2018	29	24.5	96	95	25.7	0
15-08-2018	26.5	24.8	93	92	85.8	0
16-08-2018	28.5	24.8	93	100	14	0
17-08-2018	28	24	96	80	54.3	0.2
18-08-2018	28	24.2	95	79	38.5	3.5
19-08-2018	29.5	24.5	96	78	21	0
20-08-2018	29.5	23	92	78	1.2	1.4
21-08-2018	29	23.5	96	78	9.1	6.5
22-08-2018	29	24.5	96	78	16.4	4.6
23-08-2018	29	23	93	72	14.5	3.7
24-08-2018	29.5	23	91	75	2.8	8.1
25-08-2018	30	23	90	80	5.3	8.4
26-08-2018	30	24	92	78	0	3.8
27-08-2018	30	24	96	81	10.9	0.6
28-08-2018	29	23.5	98	88	28.1	1.5
29-08-2018	29	23	96	77	51.4	2.2
30-08-2018	29	24.5	96	83	4.5	7
31-08-2018	29.5	24	92	78	3.6	4.9
01-09-2018	29.5	24	92	78	0	7.3
02-09-2018	30	23.5	91	75	0	5.4
03-09-2018	31	24	88	70	0	10.4
04-09-2018	30	23.5	88	72	0	10
05-09-2018	30	24	89	74	0	7.7
06-09-2018	30	23.5	92	74	0	9.2
07-09-2018	29.5	23.2	94	74	1	8.3
08-09-2018	29.5	23.5	91	69	4.2	7.9
09-09-2018	30	23	91	67	0	10.4
10-09-2018	30.5	22	91	69	0	10
11-09-2018	31	23.5	91	69	0	8.2
12-09-2018	31	24.5	92	71	0	9.6
13-09-2018	30.2	24.5	92	69	0	9.2
14-09-2018	30.5	23.5	86	67	0	9.2
15-09-2018	30.3	24	91	71	0	8.5
16-09-2018	30	25	84	69	0	9.6
17-09-2018	31	25.5	92	70	0	6.8
18-09-2018	30.7	24	91	66	0	8.9
19-09-2018	30.9	25.5	88	71	4.3	7
20-09-2018	30.6	23.8	85	69	0	9.2

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21-09-2018	30.5	24	88	64	0	9
22-09-2018	31	23.5	84	63	0	8.8
23-09-2018	31	26.5	84	69	0	9.4
24-09-2018	31.5	24.5	90	60	0	3.7
25-09-2018	31.5	25	88	61	0	7.2
26-09-2018	31.5	24	87	59	0	3.7
27-09-2018	31.8	25.5	84	69	0	5.4
28-09-2018	30.5	25	92	71	8.5	6.7
29-09-2018	30.7	25	92	75	0	5.5
30-09-2018	31	25.5	88	66	0	8.5
01-10-2018	32	25.2	91	70	5.1	8.6
02-10-2018	31.5	23.5	96	69	20.7	8
03-10-2018	31.5	26	88	79	0	5.8
04-10-2018	29	25.5	92	81	0.8	5.3
05-10-2018	30.5	25.5	88	75	6.4	1.3
06-10-2018	30	25	96	72	14.5	5.9
07-10-2018	31	26	92	64	4.8	7.6
08-10-2018	32	25	92	96	6.8	3.8
09-10-2018	29.8	24.5	96	70	47.7	2.4
10-10-2018	29.5	24.8	92	73	1.7	6.6
11-10-2018	31	26	91	69	0	8.3
12-10-2018	32	26	92	72	0	7.2
13-10-2018	31.5	25	93	72	0	5.3
14-10-2018	31.5	25	92	75	5.5	3.8
15-10-2018	30.5	25	92	74	1.2	4.5
16-10-2018	30.5	25.5	92	78	0	4.2
17-10-2018	29	24	88	71	15.7	9.6
18-10-2018	30	24.5	96	75	0.8	9.4
19-10-2018	30	25	92	70	1.8	5.7
20-10-2018	30	24	96	81	21.8	1.3
21-10-2018	28.9	23.9	88	69	0	9.3
22-10-2018	30.5	24	92	70	0	7.3
23-10-2018	30.5	24.5	91	63	0	9.5
24-10-2018	31.5	23.5	91	57	0	9.9
25-10-2018	32	23.5	88	59	0	9.7
26-10-2018	32	24	80	49	0	9.8
27-10-2018	33	24	91	56	0	9.9
28-10-2018	32.5	22.5	83	47	0	10.6
29-10-2018	33	22	91	54	0	10.5

30-10-2018	32.5	21	85	48	0	10.5
31-10-2018	32	21.5	88	53	0	10
01-11-2018	32	24	91	64	0	6.7
02-11-2018	31.5	25	92	58	0	8.5
03-11-2018	32.5	25	93	71	0	2.1
04-11-2018	31	25	92	63	8.2	9.3
05-11-2018	32	25	95	69	0	8.9
06-11-2018	31.5	25	90	58	0	9.8
07-11-2018	32.5	25	88	63	0	10.4
08-11-2018	32	23	87	54	0	8.6
09-11-2018	31.5	23	84	52	0	10.5
10-11-2018	32.5	24	87	61	0	10.1
11-11-2018	32	23	91	66	0	10.3
12-11-2018	31.5	23	87	60	0	8.7
13-11-2018	31.5	23.5	86	60	0	9.4
14-11-2018	32	21.5	91	56	0	10.1
15-11-2018	31.9	19.5	91	47	0	10.2
16-11-2018	32.5	23.5	83	63	0	7.7
17-11-2018	31.5	23.5	91	58	0	1.4
18-11-2018	32	25	88	63	0	8.8
19-11-2018	31.5	25.5	96	73	0	2.4
20-11-2018	30.9	24.5	92	68	0	2.3
21-11-2018	30.5	25.5	92	65	0	8.7
22-11-2018	32.5	25.5	88	60	0	5.9
23-11-2018	32.5	25	93	63	0	6.2
24-11-2018	32	24	94	69	6.8	6
25-11-2018	31.5	24	92	69	40	8.2
26-11-2018	31.5	24	96	66	0	8.6
27-11-2018	31.5	24	85	63	0	7.9
28-11-2018	32	21.5	87	46	0	9.9
29-11-2018	32	20.5	93	55	0	6.7
30-11-2018	32.5	25	88	66	0	5