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# Studies on seed viability and its effects on germination, growth and graft-take in medicinal fruit plant of Jamun

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**Abstract**
Jamun is an important medicinal plant used in various traditional systems of medicine. An investigation was carried out on seed viability and its effects on germination, growth, root and graft-take in medicinal plant of Jamun. Among different days, seeds sowed at zero days after extraction got early initiation, 50% germination (15.74 and 22.55), Number of leaves (20.33) and stem diameter (5.37mm). whereas three days after extraction seeds recorded significantly maximum germination percentage (100%), germination index (2.45) extent of Polyembryony (3.59), Plant height (20.22 cm), primary root length (26.07 cm), numbers of secondary roots (44.61), volume of roots (5.64 ml), rootstock vigour (594.22 g), vigour index (2022.70 cm) and Survival percentages (64.26%). However six days after extraction recorded highest height (7.41 cm) and Per cent graft success (70.40%). The germination percentage decreased with increased storage period. For viable seeds maximum germination percent growth, root, vigour and graft parameter was recorded three days after extraction and lowest was recorded twenty four days after extraction seeds.

**Keywords:** Medicinal Jamun, viability germination index, vigour index, graft survivability

## Introduction
Jamun (*Syzygium cuminii* Skeels) is also known as *Syzygium jamunum* and *Eugenia cumin.*( Nerale hannu, Jambul, Black Plum, Java Plum, Indian Blackberry, Jamblang) is one of the most popular indigenous minor fruit of our country. It is more popular as an avenue tree and for wind break. It has gained tremendous importance and recognition in recent past because of its hardy nature, incomparable medicinal and nutritional properties. It is widely used traditional system of medicine to treat diabetes, cancer, heart and liver trouble in India. Therefore, the Jamun fruits are having high value in terms of therapeutic and nutrition. The ripe fruits are used for health drinks, making preserves, squashes, jellies and wine (Warrier *et al.* 1996) [32]. The seed powder has antidiabetic properties and is a lotion for the cure of ringworm (Dastur, 1952) [11]. The purplish coloured fruit is full of medicinal values despite being tasty. Almost every part of the plant is useful but especially the bark, fruits, leaves and seeds are used for medicinal purposes (Sagrawat *et al.* 2006) [25]. Hence, refreshing and curative properties of Jamun make it one of the useful medicinal plants of India. The study of supplementation of Jamun seed powder @ 2g. Daily for three months, found reduced blood sugar level to 30mg per 100ml of blood (Shilpa and Krishnakumar, 2014) [26]. Seed viability and storability are predominantly dependent on seed moisture and storage temperatures. High seed moisture and storage temperature increase metabolism and microbial growth causing loss of viability.

The viability of Jamun seeds is very low because seeds are recalcitrant in nature (Singh, 1960) [28]. Germination percentage of Jamun seeds is only 20 to 50 per cent when sown within one month after extraction (Nachegowda *et al.* 2011) [20]. Percentatage of seed germination was highest when fresh seeds were subjected for germination compared to stored seeds, the viability of seed decreased gradually with the increase in storage period. Seedling growth, vigor and higher graft-take were found to be maximum in the fresh seeds, than in stored seeds (Nachegowda *et al.* 2011) [20] (Braz *et al.* 2012) [28]

Although nucellar embryony is observed in this crop, large scale variation in its fruit morphology, fruit quality, maturity and productivity have been reported owing to its cross-pollination nature and seed propagation. Thus, the methods of vegetative propagation, such as grafting become immensely important to obtain plants of true to type of desired mother plants.

And also increase the growth of the grafts and encourage early vigour of the grafts. Keeping all these above points in view, an investigation was carried out to study the response of Jamun seeds on viability and its effect on germination, growth, vigour and graft-take in Jamun.

**Material and methods**

An investigation was carried out on Jamun viability studies in the in the Department of fruit science, College of Horticulture, Mudigere, University of Agricultural and Horticultural Sciences, Shivamogga during 2013-2014. Fully matured fruits of polyembryonic local/ wild Jamun variety were selected. Seeds required for the experiment were extracted from the disease free fully ripened fruits. Completely randomized block design with three replications and nine treatments (storage days) were employed *viz*., stones were sown at three days interval i.e. zero, three, six, nine, twelve, fifteen, eighteen, twenty one and twenty four days of old seeds. These seeds were sown on the same day and three days interval up to 24 days. Each time required number of seeds were sown in the polybags after taking weight and observation were recorded daily on initiation, 50 per cent, completion of germination, germination percentage, germination vigour index. At 90 DAS, growth, bio-mass, root parameters, Rootstock vigour and vigour index, monthly for growth parameters, three months after grafting (MAG) for graft success and six MAG for graft survival percentage and monthly interval for graft growth parameters were recorded.

For graft take uniform, healthy, disease and pests free viability treatment of uniform size six months old rootstocks were selected for softwood grafting. Two weeks prior to grafting day, mature (bulged tip) scions were cured by defoliating in order to activate the terminal buds of Bhardoli variety of Jamun from farmer field. The cured scions were collected and softwood grafting by wedge method was performed on the Jamun rootstocks. The scions were covered with poly tubes immediately after grafting. Watering was done using rosecan regularly. The sprouts that emerged from rootstocks were removed manually as and when they appeared.

The germination percentage and vigour index (GVI), vigour of root stock and survival percentage was computed using the formulas as bellow.

$$\text{Germination percentage} = \frac{\text{Number of stones germinated}}{\text{Number of stones sown}} \times 100$$

$$GVI = \frac{x_1}{d_1} + \frac{x_2}{d_2} + \frac{x_3}{d_3} + \ldots\ \ldots + \frac{x_n}{d_n}$$

Where $x_1$, $x_2$, $x_3$… $x_n$ are the number of seeds germinated on $d_1$, $d_2$, $d_3$… $d_n$ days taken for germination, respectively.

Vigour of the rootstocks = Dry weight of rootstock × germination percentage

Vigour index = Mean rootstock length × germination percentage

(Abdul Baki and Anderson, 1970).

$$\text{Survival (\%)} = \frac{\text{Number of grafts remained alive at the end of the experiment}}{\text{Number of successful grafts}} \times 100$$

**Results and discussion**

The germination characters *i.e.* initiation, 50 per cent germination and completion of germination was recorded minimum in zero, three and nine days old seeds (15.74, 22.55, 17.40, 28.21 and 63.92 days, whereas maximum number of days for germination was observed for twenty one and twenty four days old stones (36.18, 61.18 and 83.24 and 37.85, 62.60 and 84.28 days respectively). Germination percentage and germination vigor index was observed maximum in three days old seeds (100% and 2.45 respectively), whereas minimum was observed in 24 days old seeds (80.44% and 1.37 respectively).

In case of recalcitrant seeds like Jamun, seeds after reaching physiological maturity, bypass complete desiccation process so as to retain the viability of seeds and seeds acquire the ability to germinate prior to maturation drying. Usually, this potential to germinate is not expressed unless the fruit is removed from the plant (Hartmann *et al*. 1997) [16]. However, above 12 to 14 per cent seed moisture with relative humidity of 65 per cent or more, seeds stored at ambient condition become very much prone to fungal attack, which leads to loss of seed viability and vigour (Barton, 1980) [4]. The germination in recalcitrant seeds must proceed soon after maturity or the seed must be stored under conditions, which prevent drying. The biological basis for this inability in recalcitrant seeds to tolerant drying is not well understood (Berjak *et al*. (1989) [5].

The oxidative enzymes are essential for conversion of stored food reserves in seeds into simpler substances and for translocation of these simpler substances into the embryo for emergence of radical and plumule and thereby promoting the rapid germination (Bose, 1986) [7]. In Jamun seeds, faster germination may be due to increased the moisture in room temperature leads to increase the weight of seeds as it is wild. As the seeds weight was more, the endosperm weight would had been more which might have supplied all necessary nutrients and hormones for faster germination of stocks. The related observations were also reported by Bakshi, (1963) [3], Padma and Reddy, (1997) [22] and Venkat Rao, (2002) [31] in mango, Nachegouda *et al*. (2011) [20] Braz *et al*. 2012 [8]. In Jamun, Athani *et al*. 2006 [2] in wood apple. The fresh weight of the seed begins to increase as water uptake drives the emergence of the radicle. This process relies on the water potential of the cells in the seed and embryo.

In the present study, of all storage period produced more than one seedling per seed, the extent of polyembryony was high in six and three days old seeds (4.11 and 3.59 seedlings respectively), whereas it was low in 24 and 21 days old stones (2.16 and 2.92 seedlings respectively. This could be due to the fact that in the polyembryonic variation in sprouts is due to the failure of few embryos to germinate. Thus, it can be assumed that variation in Polyembryony is due to temporary aberration mediated through other extraneous factors Hemalata *et al.* (2000) [17]. And Gorakh Singh and Reddy (1990) [15], Venkat Roa (2002) [31] extent of polyembryony in jamu, was also studied in the present investigations

The quick development and functioning of root system is critical to the establishment of Jamun rootstocks. In the present investigation also, the root parameters, such as length of primary root, number of lateral roots and volume of roots observed at 90 DAS, revealed positive effect of all the storage periods. Among these, three, six and zero days old seeds found to be the most efficient in increasing primary root length and production of secondary roots (25.67 cm and 44.61 roots respectively), whereas 21 and 24 days stocks produced minimum primary root length and secondary roots (15.98 cm and 37.67 roots respectively). This is could be attributed that

amount of food material such as protein, CHO, starch content stored in Jamun seeds, that will enhances root parameters and also modification in the root geometry, might be having morphogenetic effects mediated by IAA and gibberellins (Allen *et al*. 1980) [1].

During 90 days after sowing the highest stock height, stock diameter and numbers of leaves was observed by three days old seeds (20.22 cm, 5.03 mm and 20.00 respectively), which was on par with six days old seeds, whereas lowest stock height, Stock diameter and number of leaves was observed by 24 days old seeds (15.93 cm, 2.90 mm and 14.33 respectively. Production of more number of leaves under certain storage days may be related to vigorous growth, which in turn facilitates better harvest of sunshine by the plants to produce more number of leaves. This is evident from the vegetative parameters, which were recorded after germination (Table 1), which have showed a decline trend with advancement of the storage. It is confirmed that as seeds deteriorate, they first loose vigour, then the capacity for normal germination and finally viability (Hartmann *et al*. (1997) [16] and Barman *et al.* (2006) [6] in rangpur, Swamy *et al*. (1999) [30] this is also evident from the results of present investigation.

Vigour of stock was recorded highest in three days old seeds and lowest in 24 days old seeds (594.22 g and 333.27 g respectively). Whereas vigour index observed in both 90 DAS (Days after sowing), was highest in three and six days old seeds (1637.71 and 1582.51 cm) and lowest in 24 days old seeds (1035.61 cm). This might be due to vigour of the stock and height of rootstock, which influence on the growth. However low vigour may be due to dwarf nature and slow growth and also climate fluctuation as observed by Giri, and Choudhari, (1966) [13] Reddy and Gorakh Singh, (1993) [24] and Venkat Roa (2002) [31] in mango. PGPR might had effected on plant growth directly by providing metabolites which promote plant growth without any interactions with native soil micro flora.

The highest graft success and graft survival percentage was observed with three and six DAE. Among the different storage periods three and six DAE rootstocks recorded significantly higher graft success and survival (64.26% and 70.40%, respectively), whereas least per cent was observed in 24 days old seeds (20.48 and 17.48 %, respectively). This variation in graft success and survival depending upon the rootstock and age of the scion may be related to the change in the translocation pattern of photosynthates and assimilation through the phloem which in turn affected the growth of rootstocks due to effect on root growth and absorption of various nutrients and water as reported by by Padma and Reddy (1995); Barman *et al*. (2006) [6] in Rangpur Lime; Gagandeep and Malhi (2006 [12] and Niranjan *et al*. (2013) [21] in mango and Michael and William in pecan (2014).

Rootstocks of three and zero days after extraction had significantly greater stem diameter (6.16 and 6.04 mm respectively) and graft sprout height was maximum in six and three days after extraction which was (7.41 and 7.30 cm) and minimum in 24 days after extraction *i.e*. ( 3.85mm and 4.41 cm) (Tables 2). This may be due to influence weather parameters, vigour of rootstocks and high vigour index confounded to high graft growth. This increase in the graft growth might be due to increased photosynthesis, which could be further related to more number of leaf sprouts Mulla *et al*. (2011) [18] and Ghoage *et al*. (2011) [14] in Jamun. The influence of weather parameters like humidity and temperature on bud survival and grafting has been observed by Patel and Amin (1976). In their experiment they found that temperature range of 23.15 and 25.87 $^0$C was the most favourable. Same results were found in present investigation also.

In this experiment it can be concluded that Jamun being recalcitrant, loose its viability quickly. The seeds could be stored at ambient condition for 24 days after extraction without much variation in germination growth, root and graft parameters.

**Table 1:** Response of Jamun seeds on viability and its effect on germination characters and Extent of polyembryony

| Treatments | Number of days taken for germination | | | Germination per cent | Germination index | Extent of polyembrony |
|---|---|---|---|---|---|---|
| | Initiation | 50% | Completion | | | |
| $T_1$-0 days | 15.74 | 22.55 | 72.81 | 93.40 | 2.26 | 3.41 |
| $T_2$-3 days | 17.40 | 28.21 | 68.59 | 100.00 | 2.45 | 3.59 |
| $T_3$-6 days | 20.96 | 33.45 | 64.82 | 98.44 | 2.41 | 4.11 |
| $T_4$-9 days | 24.15 | 41.92 | 63.92 | 96.00 | 2.23 | 3.15 |
| $T_5$-12 days | 27.77 | 48.04 | 71.07 | 92.96 | 2.19 | 2.49 |
| $T_6$-15 days | 31.52 | 51.11 | 74.43 | 90.41 | 2.02 | 2.54 |
| $T_7$-18days | 34.37 | 55.62 | 77.14 | 86.03 | 1.84 | 2.51 |
| $T_8$-21 days | 36.18 | 61.18 | 83.24 | 87.92 | 1.76 | 2.92 |
| $T_9$-24 days | 37.85 | 62.60 | 84.29 | 80.44 | 1.37 | 2.16 |
| S.Em± | 0.57 | 0.54 | 0.56 | 0.96 | 0.10 | 0.5 |
| C.D. at 5% | 1.70 | 1.67 | 1.67 | 2.85 | 0.29 | 1.27 |
| C.V. (%) | 3.62 | 2.08 | 1.32 | 1.81 | 8.20 | 24.9 |

**Table 2:** Effect of jamun seeds on viability and its effect on root, growth, vigour and graft parameters at 90 Days after sowing and 90 days after grafting parameters

| Treatments | Root parameters | | | Growth parameters | | | Vigour parameters | | Graft parameters | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Primary root length (cm) 90 DAS | Number of secondary roots 90 DAS | Volume of roots ml) 90 DAS | Plant height (cm) | Number of leaves | stem diameter (mm) | Vigour of stock (g) | Vigour index (cm) | Graft height (cm) | Graft diameter (mm) | Graft success (%) | Graft survival (%) |
| | | | | 90 DAS | 90 DAS | 90 DAS | 90 DAS | 90 DAS | 90 DAG | 90 DAG | 90 DAG | 180 DAG |
| $T_1$-0 days | 25.12 | 42.02 | 4.23 | 19.85 | 20.33 | 5.37 | 514.93 | 1484.21 | 6.74 | 6.04 | 60.33 | 62.18 |
| $T_2$-3 days | 26.07 | 44.61 | 5.64 | 20.22 | 20.00 | 5.03 | 594.22 | 1637.71 | 7.30 | 6.16 | 65.44 | 64.26 |
| $T_3$-6 days | 25.93 | 43.50 | 4.60 | 20.00 | 19.00 | 4.81 | 546.62 | 1582.51 | 7.41 | 5.59 | 70.40 | 53.89 |
| $T_4$-9 days | 22.74 | 42.22 | 4.36 | 19.22 | 19.00 | 4.66 | 504.14 | 1516.33 | 6.04 | 5.09 | 55.92 | 45.48 |
| $T_5$-12 days | 21.51 | 42.07 | 4.00 | 18.70 | 17.00 | 4.38 | 500.43 | 1377.51 | 5.67 | 4.92 | 40.44 | 50.51 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $T_6$-15 days | 19.27 | 41.78 | 4.03 | 17.78 | 17.00 | 4.14 | 476.20 | 1317.47 | 5.41 | 4.63 | 45.55 | 34.88 |
| $T_7$-18 days | 17.94 | 40.07 | 4.18 | 17.45 | 16.00 | 3.17 | 444.72 | 1227.27 | 5.08 | 4.27 | 35.55 | 35.59 |
| $T_8$-21 days | 17.45 | 38.28 | 3.93 | 16.27 | 15.00 | 2.94 | 376.77 | 1209.34 | 4.88 | 4.48 | 30.29 | 26.62 |
| $T_9$-24 days | 15.98 | 37.67 | 3.53 | 15.93 | 14.33 | 2.90 | 333.27 | 1035.61 | 4.41 | 3.85 | 20.48 | 17.48 |
| S.Em± | 0.61 | 1.59 | 0.34 | 0.24 | 0.60 | 0.06 | 5.71 | 7.11 | 0.26 | 0.20 | 0.44 | 1.44 |
| C.D. at 5% | 1.82 | 4.73 | 1.01 | 0.70 | 1.80 | 0.20 | 16.96 | 21.13 | 0.76 | 0.60 | 1.30 | 4.28 |
| C.V. (%) | 4.98 | 6.67 | 13.72 | 2.22 | 6.87 | 2.8 | 2.07 | 0.89 | 7.53 | 6.04 | 1.60 | 5.74 |

DAS- Days after Sowing,
DAG- Days after Grafting

## References


1. Allen MF, Moore TS, Christensen M. Phytohormone changes in *Bouteloua gracillis* infected by vesicular-arbuscular mycorrhizae. I. Cytokinin increase in the host plant. Canadian J Bot. 1980; 58:371-374
2. Athani SI, Sappandi S, Durgannavar MP, Kanamadi VC, Swamy GSK, Patil PB *et al*. Influence of different seeds treatments on seed viability, germination, seedling height, seedling girth and number of leaves in wood apple. Asian J Hort. 2006; 2(3):166-169.
3. Bakshi JC. Germination of mango stone in relation to the depth and time of sowing. Punjab J Hort. 1963; 3:199-204.
4. Barton LV. Seed viability during long term storage. Hort. Rev. 1980; 2:117-141.
5. Berjak PL, Farrant JM, Pammenter NK. The basis of recalcitrant seed behaviour. In Recent Advances in the Development and Germination of Seeds. Ed. Taylors an, RB, 1989, 89-108.
6. Barman P. Exploitation of Rangapur lime for soft wood grafting in citrus. *M.Sc. (Hort.) Thesis*, University of Agricultural Sciences, Dharwad, 2006.
7. Bose TK. Seed propagation. In Propagation of Tropical and Subtropical Horticultural Crops. Naya Prokash Private Limited, Kolkata, 1986, 1-18.
8. Braz J. Viability and vigor of Jamun (*Syzygium cumini*) seeds In Brazilian Journal of Botany, on line version São Paulo, 2012, 35(4).
   ISSN 1806-9959
9. Burdette SA. Evaluation of various scion and rootstock combination. Citrus J, 1997; **7**(5):19-22.
10. Chin HF, Robert EH. Recalcitrant crop seeds. Tropical Seeds. Tropical Press, Kaula Lumpur, 1980.
11. Dastur JP. Medicinal Plants of India and Pakistan. 2nd Edition DB. Taraperevala Sons, Bombay, 1952.
12. Gagandeep Kaur, Malhi CS. Effect of age of rootstock and growing medium on success of epicotyls grafting in mango. Indian J Hort. 2006; 63(3):244-247.
13. Giri A, Choudhari MV. Relation of mango stone weight to its germination and seedling vigour. Pakistan J Sci. 1966; 18:148-150.
14. Ghojage GSK, Swamy VC. Kanamadi RC. Jagdeesh P, Kumar Patil CP, Reddy BS. Effect of Season on Softwood Grafting In Jamun (*Syzygium Cumini*, Skeels.). Acta Hortic. 2011; 890:123-127
15. Gorakh Singh, Reddy YTN. A note on extent of Polyembryony in mango. Adv. Hort. For. 1990; 1:17-21.
16. Hartmann HT, Kester DE, Daview FTR, Creneves RL. Principles of propagation by seeds. In *Plant Propagation* - Principles and Practices. Prentice Hall of India Private Limited, New Delhi, 1997, 177-194.
17. Hemalata KM, Patil BN, Tidke S, Belorkar PV. Effect of stone weight on germination and extent of Polyembryony in polyembryonic mango varieties. J Soils Crops, 2000; 10(1):155.
18. Mulla SG, Angadi Karadi R, Patil VS, Mathad JC, Mummigatti UV. Studies on softwood grafting in Jamun (*Syzygium Cumini* Skeels.). Acta Hortic. 2011; 890:117-122.
    DOI: 10.17660/ActaHortic.2011.890.14
19. Nache Gowda M, Smitha N, Vinaya Kumar Reddy P, Studies on seed viability, germination and seedling growth of minor fruit plants. Acta Hortic. 2011; 890:135-138.
    DOI: 10.17660/ActaHortic.2011.890.17
20. NacheGowda, Kumar V, Vinaya Kumar Reddy P. Studies On Vegetative Propagation in Jamun (*Syzygium Cumini*). Acta Hortic. 2011; 890:107-110.
21. Niranjan Tripathy SM, Vikas G. Studies on growth and survival of stone grafts as influenced by age of seedling rootstock in mango (*Mangifera indica* L.) cv. Amrapali. J Applied Natural Sci. 2013; 6(2):716-719.
22. Padma M, Narayana RN. Effect of cracking and seed coat removal on seed germination of mango. J Res. Angurau. 1997; 26(2):17-21.
23. Patel BM, Amin RS. Investigation in to the best period for softwood Agrafting of mangoes *in-situ*. South Indian J Hort. 1981; 29:90-93.
24. Reddy YTN, Gorakh Singh Effect of rootstock on growth and yield of Alphonso mango (*Mangifera indica*). Ind. J Agri. Sci. 1993; 63(4):208-210.
25. Sagrawat H, Kharya M. Pharmacological potential of Eugenia jamuna: A Review. Pharmacogenesis Magazine. 2006; 2:96-104.
26. Shilpa KJ, Krishnakumar G. Nutritional, fermentation and pharmacological studies of Syzygium caryophyllatum (L.) Alston and Syzygium zeylanicum (L.) DC fruits. Cogent Food Agri. 2014; 1:1018694.
27. Singh UR, Pandey IC, Prasad RS. Propagation of Jamun by budding. The Punjab J Hort. 1979; 19(1 &2):74-75.
28. Singh RN. Cited from Majunder and Sharma. Hort. Adv. 1960, 1990; 4:48-60.
29. Sivasubramaniam K, Selvarani K. Viability and vigor of Jamun seeds Brazilian Journal of Botany. 2012; 35(4):397-400.
30. Swamy GSK, Patil PB, Athani SI, Prabhushankar DS. Effect of organic and inorganic substances on germination of Jamun (*Syzygium cumini*) seeds. Advances in Agric. Res. in India. 1999; 11:89-91.
31. Venkat Rao. Studies on nursery and production techniques in polyembroynic rootstocks of mango, *M.Sc. (Hort.) Thesis*, Uni. Agri. Sci. Bangalore, 2002.
32. Warrier P, Nambiar V, Ramankutty C. Indian Medical Plants, Orient Longman Ltd. Hyderabad. 1996; 5:225-228.