The Pharma Innovation Journal 2024; 13(5): 09-15

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
TPI 2024; 13(5): 09-15

www.thepharmajournal.com
Received: 22-02-2024
Accepted: 25-03-2024

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Influence of method of propagation, time and application of VA mycorrhizae on vegetative methods of propagation in Jamun

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Abstract
The vegetative propagation of jamun by hardwood cutting, air layering, patch budding and softwood grafting with application of VA mycorrhiza was carried in the months of November and February. VA mycorrhizae like *Acaulospora laevis* are known to produce growth regulating substances to enhances the plant growth. Inoculation of Mycorrhiza fungi shown increase in uptake mineral nutrients by plants. Hardwood cutting with VAM in February (12.13) took minimum number of days for initiation of new sprout. The highest number of sprouts were recorded with softwood grafting with VAM in February (2.50 (1.74)). The maximum number of leaves were produced in air layers with VAM in February (15.40 (3.98)). Among all the methods of vegetative propagation softwood grafting is most suitable for jamun. Softwood grafting with VAM is most successful method of propagation in November and February month.

Keywords: VA mycorrhiza, vegetative propagation, November, February

1. Introduction
Jamun (*Syzygium cuminii* (L.) Skeels) is an important, under exploited, indigenous fruit crop of our country, which belongs to Myrtaceae family. It is also known as Black plum, Java plum, Indian blackberry, Jambolan, etc. It has gained tremendous importance and recognition in recent past not only because of its hardy nature but also for its uncomparable medicinal and nutritional properties. It is widely grown in the larger parts of India from Indo- Gangetic plains in the north to Tamil Nadu in the south (Singh and Srivastava, 2000) [12]. It is of considerable importance in agro and social forestry and widely distributed in Indian tropical and subtropical forests.

The fruits are good sources of sugars, protein, vitamin A and vitamin C and minerals like iron, sodium, potassium, magnesium and calcium. The fruits are tasty pleasantly flavored and very much liked by children as well as elders. Besides being preferred for dessert purpose, fruits are used in the preparation of delicious beverages, jelly, jam, squash, wine, vinegar, etc. The vinegar prepared out of juice extracted from slightly unripe fruits is stomachic, carminative and diuretic, apart from having cooling and digestive properties (Thaper, 1958) [13]. The fruit syrup is a remedy for diarrhoea. The seed powder has antidiabetic properties and is a lotion for the cure of ringworm (Dastur, 1952) [4]. The seeds of fruit contain jamboline and jambosine that slow down the rate of sugar released into the blood and increases the insulin levels in the body. Regular consumption of jamun prevents hardening of arteries which leads to atherosclerosis, prevents strokes and cardiac arrests. Being low in calories and high on fibre, makes jamun an ideal fruit in weight loss diets. Leaves powder has antibacterial properties and is used as a tooth powder for strengthening teeth and gums. Leaves form palatable fodder for cattle, sheep and goats. The wood provides excellent fuel wood with high calorific value (4834 cal) without acid fumes.

Relatively long pre-bearing periods and lack of recognized standard varieties are the major hurdles for expansion of area under this crop. In the recent years, efforts are being made for identifying superior germplasm. 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, budding, air layering and cutting become immensely important to obtain plants of true to type of desired mother plants.

The increasing concern about the environment and socio-economic impact of chemical

agriculture has led many farmers and consumers to seek alternative practices for agricultural sustainability and marketability. Therefore, chemical free traditional farming technology (organic, panchagavya and VA Mycorrhiza-*Acaulospora laevis*) are gaining a new momentum not only in India, but also all over the world. These systems offer a means to address self-reliance, rural upliftment and conservation of natural resources. There is a need to identify and standardize location specific propagation methods and right type of propagation environment for higher propagation efficiency so the study is carried on Influence of method of propagation, time and application of VA Mycorrhiza on vegetative methods of propagation in Jamun

2. Material and Methods

An investigation on vegetative methods of propagation in Jamun (*Syzygium cuminii* (L.) Skeels) was carried out.

Experimental design: Factorial CRD
Factor I**:** Method of propagation
Factor II**:** Month for propagation
No. of replications**:** 3
No. of treatments: 16

2.1 Material used for Hardwood cuttings

Hardwood cuttings from matured one year old shoots of Jamun were used for study. The cuttings were taken from matured shoots containing having length of 20-25cm with 6 nodes. The leaves of cuttings were removed, trimmed at both ends just above and below the nodes. A slant cut was given at the basal end to expose maximum absorbing surface for inducing effective rooting. The terminal open ends of cuttings were smeared with Blitox to avoid infection and drying. In the normal potting mixture consisting of Soil, Sand and FYM in 2:1:1 proportion and this mixture was filled to polybag. The inoculation of VAM was done at 5 gram per poly bag and 1/3 portion of cutting was inserted into the media. The rooting media around the base of the cutting was gently pressed to hold the cutting in right place, to eliminate air pockets and make sure that the base of the cutting was in good contact with the moist rooting media. The cuttings were watered at regular interval for maintaining moisture at optimum level.

2.2 Material used for air layering

For the experiment, tree of uniform vigour and size were selected. Tree with matured about one year old healthy branches of pencil thickness were selected for air layering. Transparent polythene (200 gauge) was used as wrapper. The size of the polythene wrapper was 25×20 cm. 1 kg sphagnum moss soaked into water for half an hour i.e. soaked till wet sphagnum moss was ready to use and while carrying out of air layering VAM (*Acaulospora laevis*) was inoculated to media at five gram per air layer. One year old branches about lead pencil thickness were selected. A ring of bark about 2.5-3.0 cm. in length was removed from selected shoot just below the bud without injuring the under lying wood and the respective rooting media was applied evenly around the cut portion then wrapped with polythene film and then tied with the help of gunny thread. After 90 days of air layering of the shoots, branches were ready for detachment. These were detached by making a cut just below the lower end of the ringed surface with a sharp scatter. The polythene covers were removed gently and the successful air layers were planted in well-prepared polybag as per the layout plan.

2.3 Material used for Patch budding

Seeds were sown in the poly bags of 8 × 12 cm size containing potting mixture of soil, sand and FYM in the ratio of 1:1:1. The poly bags of respective treatments were labelled and kept apart enough from each other. The poly bags were watered daily and weeding and other cultural operations were done as and when required.The scions from healthy and high yielding mother plants were used. Well matured, pencil thickness, scions free from pest and diseases were selected for patch budding. The scion shoots were collected in the morning hours from 8.30 A.M. to 9.30 A.M. on the day of budding. The scion shoots were separated from the selected mother trees with sharp secature, wrapped in moist cloth and carried in polythene cover to the site of budding. Budding was performed on the day of separation of budding sticks from mother tree. The disease free seedlings rootstock raised in polythene bags were selected and a patch of bark measuring about 0.8 to 1.0 cm horizontally and 2.0 to 2.5 cm vertically from the rootstocks having pencil thickness was removed at a height of 15 cm above the ground level. Immediately similar size bark with active scion bud was taken from the scion bud stick and placed on the stock and tied with polythene strip and watering was done at regular intervals. In the normal potting mixture consisting of soil, Sand and FYM in 2:1:1 proportion mixture was filled to poly bag. The inoculation of VAM was done at 5 gram per poly bag. After proper union of bud and rootstocks approximately one month after budding, polythene strip was removed to examine for success. If buds are green in colour then the top growth on the rootstock was decapitated with the help of a secature by leaving 10 cm distance above the budding. The sprouts above and below the bud union from the rootstocks were removed manually as and when they appeared. Necessary plant protection measures were taken whenever required.

2.4 Material used for Softwood grafting

Seeds were sown in the poly bags of 8 × 12 cm size containing potting mixture of soil, sand and FYM in the ratio of 2:1:1. The poly bags of respective treatments were labelled and kept apart enough from each other. The poly bags were watered daily and weeding and other cultural operations were done as and when required. As per the experimental treatments, the scion shoots were collected from mother trees in the early morning hours (7.00 to 8.30 A.M.) on the day of grafting. Immediately after separation of the scions from the mother trees, they were wrapped in moist gunny bag. The stock seedlings were decapitated leaving about 15 to 20 cm stem. The top was split by grafting knife to a length of about 5 cm. Scion shoot having nearly same diameter and of desired length was mended to about 4 to 4.5 cm in wedge keeping bark on both sides and fitted in slit of rootstock and secured firmly by polythene strip. The inoculation of VA Mycorrhiza was done at 5 gram per poly bag. Grafted plants were kept under shade net condition and grafts were sprayed with 0.2 percent captan at 15 days interval to prevent fungal infections. The side shoots sprouted on the seedlings stock were nipped frequently. After sprouting of grafts polythene bags were kept in open sunlight.

3. Result

3.1 Influence of propagation method, time and application

of VA Mycorrhiza on number of days taken for initiation of new sprouts

The data on number of days taken for initiation of new sprouts as influenced by different propagation methods and month of propagation from zero days after propagation are presented in Table 1.

The data revealed that, there was significant differences between different methods of propagation irrespective of month of propagation. Hardwood cutting with VAM took minimum number of days for initiation of new sprouts (12.43). Significantly maximum number of days taken for initiation of new sprout (32.30) was recorded with patch budding.

There was no significant differences between the month of propagation irrespective of method of propagations. The interaction effects between the different methods of propagation and month of propagation were found to be significant. Significantly hardwood cutting with VAM in February took minimum number of days for initiation of new sprout (12.13). Maximum number of days taken for initiation of new sprout was recorded with patch budding in November (33.46) which was found on par with air layers in November (33.06), patch budding with VAM in November (32.46) and air layers with VAM in November (29.86).

3.2 Influence of propagation method, time and application of VA Mycorrhiza on number of sprouts at different intervals

The data on number of sprouts as influenced by different methods of propagation, month of propagation and their interaction are presented in Table 2.

Among the methods of propagation, hardwood cutting with VAM recorded maximum number of sprouts (2.33) at 30 days followed by hardwood cutting (1.90). Softwood grafting with VAM recorded maximum number of sprouts (2.00 (1.58)) followed by air layers with VAM (1.76 (1.50)) at 60 DAP. At 90 DAP maximum number of sprouts (2.25 (1.65)) were recorded with softwood grafting with VAM which was found on par with air layers with VAM (2.01 (1.57)), air layers (1.93 (1.55)) followed by softwood grafting (1.78 (1.52)). Least number of sprouts (1.00) were recorded in patch budding and patch budding with VAM at 30 DAP. Minimum number of sprouts (1.03 (1.23), and 1.06 (1.25), respectively) was recorded with Patch budding at 60 and 90 DAP, respectively.

The number of sprouts were found to be non-significant between the months of propagation at 30 and 60 DAP respectively. However at 90 DAP maximum number of sprouts (1.13 (1.23)) were produced in November and least number of sprouts (0.98 (1.17)) were produced in February month.

Interaction studies between the method of propagation and month of propagation showed significant differences among the treatments on the number of sprouts. The significantly highest number of sprouts (2.86) were recorded with hardwood cutting with VAM in November at 30 DAP followed by hardwood cutting in November (2.20). At 60 DAP highest number of sprouts (2.06 (1.60)) were recorded with softwood grafting with VAM in February which was found on par with softwood grafting with VAM (1.93 (1.55)) in November. At 90 DAP highest number of sprouts (2.50 (1.74)) were recorded with softwood grafting with VAM in February which was found on par with air layers in February (2.06 (1.60)) followed by air layers with VAM in February (2.03 (1.58)).

Least number of sprouts (1.00) were recorded with patch budding and patch budding with VAM in November and February, respectively at 30 DAP. Least number of sprouts (1.00 (1.22)) were recorded with patch budding in February at 60 and 90 DAP.

3.3 Influence of propagation method, time and application of VA Mycorrhiza on number of leaves at different intervals

The data on number of new leaves as influenced by different methods of propagation, month of propagation and their interaction are presented in Table 3.

Among the different methods of propagation, the perusal of data on number of leaves indicate that, at 30 DAP the number of leaves recorded were maximum in softwood grafting with VAM (8.71) which was statistically on par with air layers with VAM (7.80) followed by softwood grafting (7.63). At 60 DAP the number of leaves recorded were maximum in softwood grafting with VAM (11.86 (3.50)) which was statistically on par with air layers with VAM (11.43 (3.45)) followed by softwood grafting (9.70 (3.18)). Maximum number of leaves were recorded in air layers with VAM (14.60 (3.88)) followed by air layers with VAM (12.66 (3.62)) at 90 DAP.

Among the different methods of propagation, at 30 DAP the minimum number of leaves were recorded with hardwood cutting (1.46). No rooting of cuttings were noticed in hardwood cutting alone as well as with VAM, hence no number of leaves were recorded in these two treatments. At 60 and 90 DAP the minimum number of leaves were recorded with patch budding (5.53 (2.45)) and (7.93 (2.90)), respectively.

There were no significant differences between number of leaves at 30 and 60 DAP in month of propagation. There were significant differences between month of propagation at 90 DAP. Maximum number of leaves were recorded in February (9.00 (2.81)) and least number of leaves were recorded in November (8.00 (2.67)).

The interaction between the method of propagation and month of propagation significantly influenced the number of leaves. At 30 DAP maximum number of leaves were produced in softwood grafting with VAM in February (8.90) which was on par with softwood grafting with VAM in November (8.53), air layers with VAM in November (8.33) followed by softwood grafting in November (7.80). At 60 DAP maximum number of leaves were produced in softwood grafting with VAM in November (12.20 (3.55)) which was found on par with air layers with VAM in February (11.66 (3.48)), softwood grafting with VAM in February (11.53 (3.46)), air layers with VAM in November (11.20 (3.41)) followed by air layers in February (10.00 (3.23)). At 90 DAP the maximum number of leaves were produced in air layers with VAM in February (15.40 (3.98)) which was on par with air layers with VAM in November (13.80 (3.78)) followed by air layers in February (13.73 (3.76)).

The minimum number of leaves (1.26) were produced in hardwood cutting in November at 30 DAP. The minimum number of leaves (5.06 (2.35)) and (7.40 (2.80)), respectively were produced with patch budding in November at 60 and 90 DAP, respectively.

3.4 influence of method of propagation, time and

application of VA Mycorrhiza on number of branches

The data on number of branches as influenced by different method of propagation, month of propagation and their interaction are presented in Table 4.

Among the different methods of propagation, the perusal of data on number of branches indicate that, at 30 DAP significantly maximum number of branches (1.93 (1.55)) were recorded in air layers with VAM. Significantly maximum number of branches (2.06 (1.59)) were recorded with softwood grafting with VAM followed by air layers with VAM (1.86 (1.53)) at 60 DAP. Significantly maximum number of branches were recorded in softwood grafting with VAM (2.40 (1.73)) followed by softwood grafting (2.03 (1.63)) at 90 DAP. No rooting of cuttings were noticed in hardwood cutting alone as well as with VAM, hence no number of branches were recorded in these two treatments. Least number of branches were recorded in air layers (1.36 (1.36)) at 30 DAP. Minimum number of branches (0.50 (0.96)) were recorded with patch budding and patch budding with VAM at 60 and 90 DAP, respectively.

There were significant differences between number of branches in November and February. At 30 DAP significantly maximum number of branches were recorded in November (0.45 (0.91)). At 60 and 90 DAP significantly maximum number of branches were recorded in February (1.20 (1.25)) and (1.17 (1.26)), respectively. Significantly minimum number of branches (0.36 (0.88)) were recorded in February at 30 DAP. At 60 and 90 DAP minimum number of branches were recorded in November (0.88 (1.10)) and 1.05 (1.15)), respectively.

The interaction between the method of propagation and month of propagation significantly influenced the number of branches. Maximum number of branches were recorded in air layers with VAM in November (2.20 (1.64)) at 30 DAP. It was followed by air layers with VAM in February (1.66 (1.47)). At 60 DAP maximum number of branches were recorded in softwood grafting with VAM in February (2.51 (1.74)) followed by air layers with VAM in November (2.20 (1.64)). At 90 DAP maximum number of branches were recorded in softwood grafting with VAM in February (2.54 (1.79)) followed by air layers with VAM in November (2.26 (1.66)) which was found on par with softwood grafting with VAM in November (2.26 (1.66)). Air layers recorded minimum number of branches (1.26 (1.32)) in February at 30 DAP. Minimum number of branches (1.00 (1.22) were recorded with patch budding and patch budding with VAM in February at 60 and 90 DAP, respectively.

Table 1: Influence of method of propagation, time and application of VA Mycorrhiza on number of days taken for initiation of first sprout

Method of propagation (P)	Number of days taken for initiation of first sprout		
	M_1	M_2	Mean of propagation
P_1	14.86	16.60	15.73
P_2	12.73	12.13	12.43
P_3	33.06	28.86	30.96
P_4	29.86	27.53	28.70
P_5	33.46	31.13	32.30
P_6	32.46	28.06	30.26
P_7	17.26	25.53	21.40
P_8	15.86	20.86	18.36
Mean of month(M)	23.70	23.84	-
	S. Em±	CD@ 5%	-
Propagation (P)	1.12	3.26	-
Month (M)	0.56	1.63	-
Interaction (PxM)	1.59	4.61	-

Treatment details

P_1: Hardwood cutting, P_5: Patch budding
P_2: Hardwood cutting + VAM, P_6: Patch budding + VAM
P_3: Air layering, P_7: Softwood grafting
P_4: Air layering + VAM, P_8: Softwood grafting + VAM
M_1: November M_2: February
DAP: Days After Propagation

Table 2: Influence of propagation method, time and application of VA Mycorrhiza on number of sprouts at different intervals

Method of propagation (P)	Number of sprouts/ propagated plant								
	30 DAP			60 DAP			90 DAP		
	M_1	M_2	Mean of propagation	M_1	M_2	Mean of propagation	M_1	M_2	Mean of propagation
P_1	2.20	1.60	1.90	0.00 (0.70)*	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)
P_2	2.86	1.80	2.33	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)
P_3	1.40	1.10	1.20	1.66 (1.47)	1.46 (1.40)	1.56 (1.43)	1.80 (1.51)	2.06 (1.60)	1.93 (1.55)
P_4	1.86	1.20	1.43	1.86 (1.53)	1.66 (1.47)	1.76 (1.50)	2.00 (1.57)	2.03 (1.58)	2.01 (1.57)
P_5	1.00	1.00	1.00	1.06 (1.25)	1.00 (1.22)	1.03 (1.23)	1.13 (1.27)	1.00 (1.22)	1.06 (1.25)
P_6	1.00	1.00	1.00	1.23 (1.31)	1.16 (1.29)	1.20 (1.30)	1.43 (1.38)	1.26 (1.32)	1.35 (1.35)
P_7	1.33	1.33	1.33	1.53 (1.42)	1.76 (1.48)	1.70 (1.48)	1.59 (1.49)	1.97 (1.56)	1.78 (1.52)
P_8	1.73	1.93	1.83	1.93 (1.55)	2.06 (1.60)	2.00 (1.58)	2.00 (1.57)	2.50 (1.74)	2.25 (1.65)
Mean of month (M)	1.67	1.33	-	1.16 (1.24)	1.13 (1.24)	-	1.24 (1.27)	1.31 (1.29)	-
	S.Em±	CD@5%	-	S.Em±	CD@5%	-	S.Em±	CD@5%	-

Propagation (P)	0.05	0.20	-	0.05 (0.02)	0.16 (0.05)	-	0.10 (0.03)	0.30 (0.10)	-
Month (M)	0.02	0.10	-	0.02 (0.01)	0.08 (0.02)	-	0.05 (0.02)	0.16 (0.05)	-
Interaction (PxM)	0.08	0.28	-	0.07 (0.02)	0.23 (0.07)	-	0.15 (0.05)	0.46 (0.14)	-

Treatment details DAP: Days After Propagation ()* Values in the parenthesis are square root transformed values
P_1: Hardwood cutting, P_2: Hardwood cutting + VAM, P_3: Air layering, P_4: Air layering + VAM, M_1: November, P_5: Patch budding, P_6: Patch budding + VAM, P_7: Softwood grafting, P_8: Softwood grafting + VAM M_2: February

Table 3: Influence of propagation method, time and application of VA Mycorrhiza on number of leaves at different intervals

Method of propagation (P)	Number of leaves/ propagated plant								
	30 DAP			60 DAP			90 DAP		
	M_1	M_2	Mean of propagation	M_1	M_2	Mean of propagation	M_1	M_2	Mean of propagation
P_1	1.26	1.66	1.46	0.00 (0.70)*	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)
P_2	1.46	2.13	1.80	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)
P_3	6.80	6.93	6.86	8.93 (3.06)	10.00 (3.23)	9.46 (3.15)	11.60 (3.47)	13.73 (3.76)	12.66 (3.62)
P_4	8.33	7.26	7.80	11.20 (3.41)	11.66 (3.48)	11.43 (3.45)	13.80 (3.78)	15.40 (3.98)	14.60 (3.88)
P_5	2.33	2.93	2.63	5.06 (2.35)	6.00 (2.54)	5.53 (2.45)	7.40 (2.80)	8.46 (2.99)	7.93 (2.90)
P_6	3.20	3.53	3.36	5.60 (2.46)	6.73 (2.68)	6.16 (2.57)	8.53 (3.00)	11.06 (3.39)	9.80 (3.20)
P_7	7.80	7.46	7.63	9.73 (3.18)	9.66 (3.18)	9.70 (3.18)	11.33 (3.42)	9.93 (3.22)	10.63 (3.32)
P_8	8.53	8.90	8.71	12.20 (3.55)	11.53 (3.46)	11.86 (3.50)	11.40 (3.44)	13.46 (3.73)	12.43 (3.59)
Mean of month (M)	4.96	5.10	-	6.59 (2.43)	6.95 (2.50)	-	8.00 (2.67)	9.00 (2.81)	-
	S.Em±	CD@5%	-	S.Em±	CD@5%	-	S.Em±	CD@5%	-
Propagation (P)	0.19	0.55	-	0.46 (0.07)	1.35 (0.20)	-	0.38 (0.04)	1.12 (0.16)	-
Month (M)	0.09	0.27	-	0.23 (0.03)	0.67 (0.10)	-	0.19 (0.02)	0.56 (0.08)	-
Interaction (PxM)	0.27	0.78	-	0.65 (0.10)	1.90 (0.29)	-	0.55 (0.06)	1.59 (0.21)	-

Treatment details: DAP: Days After Propagation, ()* Values in the parenthesis are square root transformed values
P_1: Hardwood cutting, P_2: Hardwood cutting + VAM, P_3: Air layering, P_4: Air layering + VAM, M_1: November, P_5: Patch budding, P_6: Patch budding + VAM, P_7: Softwood grafting, P_8: Softwood grafting + VAM M_2: February

Table 4: Influence of propagation method, time and application of VA Mycorrhizae on number of branches at different interv

Method of propagation (P)	Number of branches/ propagated plant								
	30 DAP			60 DAP			90 DAP		
	M_1	M_2	Mean of propagation	M_1	M_2	Mean of propagation	M_1	M_2	Mean of propagation
P_1	0.00 (0.70)*	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)
P_2	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)
P_3	1.46 (1.40)	1.26 (1.32)	1.36 (1.36)	1.93 (1.55)	1.33 (1.35)	1.63 (1.45)	1.86 (1.53)	1.40 (1.37)	1.63 (1.45)
P_4	2.20 (1.64)	1.66 (1.47)	1.93 (1.55)	2.20 (1.64)	1.53 (1.42)	1.86 (1.53)	2.26 (1.66)	1.60 (1.44)	1.93 (1.55)
P_5	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	1.00 (1.22)	0.50 (0.96)	0.00 (0.70)	1.00 (1.22)	0.50 (0.96)
P_6	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	1.00 (1.22)	0.50 (0.96)	0.00 (0.70)	1.00 (1.22)	0.50 (0.96)
P_7	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	1.33 (1.35)	2.20 (1.64)	1.76 (1.49)	2.06 (1.60)	2.00 (1.67)	2.03 (1.63)
P_8	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	1.60 (1.44)	2.51 (1.74)	2.06 (1.59)	2.26 (1.66)	2.54 (1.79)	2.40 (1.73)
Mean of month (M)	0.45 (0.91)	0.36 (0.88)	-	0.88 (1.10)	1.20 (1.25)	-	1.05 (1.15)	1.17 (1.26)	-
	S.Em±	CD@5%	-	S.Em±	CD@5%	-	S.Em±	CD@5%	-
Propagation (P)	0.04 (0.04)	0.13 (0.04)	-	0.05 (0.02)	0.16 (0.05)	-	0.09 (0.02)	0.27 (0.08)	-
Month (M)	0.02 (0.02)	0.06 (0.02)	-	0.03 (0.01)	0.08 (0.02)	-	0.04 (0.01)	0.13 (0.04)	-
Interaction (PxM)	0.06 (0.06)	0.19 (0.06)	-	0.08 (0.03)	0.23 (0.08)	-	0.13 (0.03)	0.38 (0.12)	-

Treatment details: DAP: Days After Propagation ()* Values in the parenthesis are square root transformed values
P_1: Hardwood cutting, P_2: Hardwood cutting + VAM, P_3: Air layering, P_4: Air layering + VAM, M_1: November, P_5: Patch budding, P_6: Patch budding + VAM, P_7: Softwood grafting, P_8: Softwood grafting + VAM M_2: February

4. Discussion

4.1 Number of days taken for initiation of new sprout

The data revealed that, there were significant differences between different methods of propagation irrespective of month of propagation. Significantly hardwood cutting with VAM took minimum number of days for initiation of new sprouts (12.43).

There were no significant differences between the month of propagation irrespective of method of propagation.

Interaction studies between method of propagation and month of propagation showed significant effect on the number of days taken for initiation of new sprouts. Hardwood cutting with VAM in February took minimum number of days for initiation of new sprout (12.13).

The hardwood cuttings with VAM in February took minimum number of days for initiation of new sprout. The congenial

weather conditions prevailed during period of propagation increased the cell activity resulted in early sprouting. Inoculation of VAM fungi increased cell multiplication and cell division which resulted in early sprouting. Similar findings were obtained by Scagel (2001) [11] in rose. These results are in accordance with results in pomegranate by Saroj *et al.* (2008) [10] and similar results were obtained in pomegranate by Ansari (2013).

4.2 Number of sprouts

In the present investigation the results pertaining to number of sprouts (2.33) was recorded maximum with hardwood cutting with VAM at 30 days. Softwood grafting with VAM recorded maximum number of sprouts (2.00 (1.58) and (2.25 (1.65)), respectively at 60 and 90 DAP, respectively.

The number of sprouts were found to be non-significant between the month of propagation at 30 and 60 DAP respectively. At 90 DAP maximum number of sprouts (1.31 (1.29)) were produced in November at 90 DAP.

Interaction studies between the method of propagation and month of propagation showed significant differences among the treatments with respect to number of sprouts. The significantly highest number of sprouts were recorded with hardwood cutting with VAM in November (2.86) at 30 DAP. This is due to higher accumulation of carbohydrates in hardwood cuttings with VAM, which readily served as a reservoir of food. Similar findings were obtained by Scagel (2001) [11] in rose and the highest number of sprouts were recorded with softwood grafting with VAM in February (2.06 (1.60) and (2.50 (1.74)) respectively at 60 and 90 DAP.

The highest number of sprouts of the grafts might be due to favourable atmospheric conditions during that period especially optimum temperature coupled with proportionate humidity as experienced by Palande (2001) [7]. It may also attributed due to the effect of high temperature which was helped in more number of sprout because of fast establishment of vascular connection with rootstock and scion which has been also reported by Awasthi and Shukla (2003) [2]. VAM increased the efficiency of rootstock in nutrient absorption leading to increase in number of sprouts. The results are in accordance with findings of Johnson *et al* (1982) [6].

4.3 Number of leaves

Among the different methods of propagation, the perusal of data on number of leaves indicate that, the number of leaves recorded were maximum in softwood grafting with VAM (8.71 and 11.86 (3.50)), respectively at 30 and 60 DAP, respectively. Air layering with VAM recorded maximum number of leaves (12.66 (3.62)) at 90 DAP.

There were no significant differences between number of leaves at 30 and 60 DAP in month of propagation. At 90 DAP maximum number of leaves were recorded in February 9.00 (2.81).

The interaction between the method of propagation and month of propagation significantly influenced the number of leaves. At 30 DAP maximum number of leaves were produced in softwood grafting with VAM in February (8.90). At 60 DAP maximum number of leaves were produced in softwood grafting with VAM in November (12.20 (3.55)). More number of leaves per graft may also attributed due to reserved food material (Carbohydrate, Nitrogen) is comparatively more in sufficiently matured scion shoots. The quick and strong union formation, better nutrient uptake and ample growing period might have caused for higher number of leaves per plant. Similar findings were obtained by Patil *et al.* (1983) [8]. At 90 DAP the maximum number of leaves were produced in air layers with VAM in February (15.40 (3.98)). Gera *et al.* (2001) [5] postulated that the increase in number of leaves might be due to greater transpiration which may have possibly increased the flow of water and dissolved N to the roots of mycorrhizal treated air layers. These results are in conformity with the results in air layers of litchi by Anurag *et al*. (2013).

4.4 Number of branches

Among the different methods of propagation, the perusal of data on number of branches indicate that, at 30 DAP significantly maximum number of branches (1.93 (1.55)) were recorded in air layers with VAM. Significantly maximum number of branches (2.06 (1.59) and 2.34 (1.68), respectively) were recorded with softwood grafting with VAM at 60 and 90 DAP.

There were significant differences between number of branches in November and February. At 30 DAP significantly maximum number of branches were recorded in November (0.45 (0.91)). At 60 and 90 DAP significantly maximum number of branches were recorded in February (1.20 (1.25) and 1.17 (1.26)), respectively.

The interaction between the method of propagation and month of propagation significantly influenced the number of branches. Maximum number of branches were recorded in air layers with VAM in November (2.20 (1.64)) at 30 DAP. This might be due to air layers having better root system, they could absorb sufficient water, other nutrients and inoculation of VAM increases the absorption of nutrients leading to more number of branches. Similar findings were reported by Patil *et al.* (2003) in pomegranate. At 60 and 90 DAP maximum number of branches were recorded in softwood grafting with VAM in February (2.51 (1.74) and 2.54 (1.79)), respectively. "Bud break" stage was observed during the February This condition would have kept the plant tissue, especially cambium, in active stage that induces rapid callus development in softwood grafting resulting more number of sprouts were produced during this period lead to maximum number of branches. These results are in accordance with the results in jamun by Bharad (2011) [3].

5. Conclusion

Among all the methods of vegetative propagation softwood grafting is most suitable for jamun. Softwood grafting with VAM is most successful method of propagation in November and February months. Patch budding with VAM is ideal method of propagation in February. Propagation of jamun by airlayer with VAM showed success in February. Propagation of jamun by cutting was unsuccessful because of unfavourable environmental condition.

5. Reference

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