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Effect of seed treatment and foliar spray of chemical substances on seedling growth of jamun (*Syzygium cuminii* L.)

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Abstract
An experiment was carried out to study the effect of seed treatment and foliar spray of chemical substances on seedling growth of jamun at Regional Horticultural Research Station, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari during 2016-2017. Among the seed treatments, GA_3 @ 200 mg l^{-1} for 10 min (S_4) recorded the maximum seedling height (82.60 cm), number of leaves (42.63), stem diameter (7.90 mm), number of shoots/seedling (2.95), leaf area (86.30 cm^2), root: shoot ratio (3.21), primary root length (43.04 cm), number of secondary roots (46.36), fresh and dry weight of seedling (104.20 and 40.63 g), fresh and dry weight of root (23.93 and 10.16 g) and minimum days to reach graftable size (151.12). Among the foliar spray of chemical substances, the maximum seedling height (92.26 cm), number of leaves (49.90), stem diameter (8.00 mm), number of shoots/seedling (3.30), leaf area (87.84 cm^2), root: shoot ratio (3.35), primary root length (45.77 cm), number of secondary roots (49.37), fresh and dry weight of seedling (114.60 and 44.76 g), fresh and dry weight of root (24.69 and 10.39 g) and minimum days to reach graftable size (136.70) was recorded in GA_3 @ 200 mg l^{-1} (F_2). In interaction (S_4F_2) jamun seedlings raised from seeds treated with GA_3 @ 200 mg l^{-1} for 10 min and sprayed with GA_3 @ 200 mg l^{-1} recorded maximum seedling height (95.89 cm), number of leaves (52.53), stem diameter (8.63 mm), number of shoots/seedling (3.60), root: shoot ratio (3.64), number of secondary roots (54.11), fresh and dry weight of seedling (126.65 and 49.39 g), fresh and dry weight of root (28.31 and 12.18 g) and minimum days to reach graftable size (128.47).

Keywords: Foliar spray, jamun, seedling growth, seed treatment

Introduction
Jamun (*Syzygium cuminii* L.) is an important, under-exploited, indigenous fruit crop of our country. It belongs to family myrtaceae. In India many tropical fruit tree species, most of which are not commercially cultivated, are highly popular as they not only provide a significant source of livelihood support to the rural people but also has a cultural and social value. Such underutilized fruits have been long sustained due to their importance for their nutritional value and as a source of rural and tribal household income. Jamun is one of such underutilized fruit species of great importance in India. The fruits are good sources of iron, minerals, sugars and proteins. The powdered seeds have also a reputation of being useful in the treatment of diabetes. Lack of improved varieties, long gestation period that the plants obtained from seeds take for fruiting are main responsible factors for not cultivating this crop on orchard scale despite its high potential as a dry land horticulture fruit crop and its multifarious uses. Recently there is awareness for growing this crop in orchard scale and hence demand for elite plant.

Though, jamun can be propagated by seeds as well as by vegetative means (grafting and budding), large variation is found in the orchard raised from the seeds. Moreover, seedling trees start bearing only after 9-10 years. Therefore, to avoid late bearing and to maintain and preserve the genetic uniformity vegetative propagation should be preferred over seed propagation. To carryout propagation by vegetative methods, raising of healthy and vigorous seedling/rootstock is very important. The jamun seeds are recalcitrant in nature and availability is also restricted to one season. Therefore, the seeds available during that particular season need to be utilised properly for raising rootstock. Since these seeds are properly utilized and used in multiplication of rootstocks for grafting, raising of rootstocks and proper use of rootstocks is equally important.

The time required to grow jamun seedlings to a suitable size for grafting may be as long as one year. Therefore, shortening this time is considered very important and it can be achieved by enhancing the seedling growth. Seed treatment and foliar spray of growth regulators and nutrients are known to enhance the growth of seedlings of various fruit crops. With this background, the present experiment was planned to find the effect of seed treatment and foliar spray of chemical substances on seedling growth of jamun to reduce the time required to reach graftable size of jamun seedlings.

Material and methods

The experiment was laid out in completely randomised block design with factorial concept with thirty treatment combinations, each repeated three times. The treatments comprised of six seed treatments *viz.* control (S_1), water soaking for 24 hrs (S_2), hot water (100 ^{0}C) for 5 sec (S_3), GA_3 @ 200 mg l^{-1} for 10 min (S_4), KNO_3 @ 0.5% for 10 min (S_5) and thiourea @ 0.5% for 10 min (S_6) and foliar spray of five different chemical substances *viz*. control (F_1), GA_3 @ 200 mg l^{-1} (F_2), NAA @ 200 mg l^{-1} (F_3), urea @ 1% (F_4) and 19:19:19 @ 1% (F_5). Seeds required for the experiment were extracted from the disease free fully ripened fruits of jamun cv. Local by washing with water. The freshly extracted seeds were subjected to seed treatments and were sown during last week of June in polythene bags of size 9" x 7" filled with potting mixture. Watering was done immediately after sowing and at regular intervals. Later two months old jamun seedlings were sprayed with different chemical substances twice at monthly interval.

The observations on seedling height (cm), number of leaves, stem diameter (mm), number of shoots/seedling, leaf area (cm^2), root: shoot ratio, primary root length (cm), number of secondary roots, fresh and dry weight of seedling (g), fresh and dry weight of root (g) at 180 DAS and days to reach graftable size (stem diameter of 7 mm) were recorded. The data generated from the studies were subjected to analysis by using standard method suggested by Panse and Sukhatme (1967) [8].

Result and discussion

Shoot parameters

Jamun seeds treated with GA_3 @ 200 mg l^{-1} for 10 min (S_4) gave maximum seedling height (82.60 cm), number of leaves per seedling (42.63), stem diameter (7.90 mm), number of shoots per seedling (2.95), leaf area (86.30 cm^2), fresh weight of seedling (104.20 g) and dry weight of seedling (40.63 g) as compared to other treatments at 180 days after sowing. Minimum days to reach graftable size (151.12 days) was also reported in same treatment S_4. The increase in seedling height with GA_3 treatment was due to the fact that this hormone increased osmotic uptake of nutrients, causing cell elongation and thus increased height of the plant and stem diameter also increased due to greater cell division and elongation at the stem portion. The increased in number of leaves and leaf area might be due to activity of GA_3 at the apical meristem resulting in more synthesis of nucleoprotein responsible for increasing leaf initiation and area (Sen and Ghunti, 1976) [12], whereas increased in fresh and dry weight of stem and leaves were due to fact that GA_3 improves the rate of photosynthesis and cause greater accumulation of photosynthates and also due to higher shoot length, root length, number of leaves and number of lateral root under this treatment. All of these may have led to the overall assimilation and redistribution of photosynthates within the plant, thereby promoting growth and development. Such effect is in accordance with the finding of Babu *et al*. (2010) [1] in papaya and Prajapati Dixita (2013) [10] in jackfruit.

Among foliar spray chemical substances, the maximum seedling height (92.26 cm), number of leaves (49.90), stem diameter (8.00 mm), number of shoots per seedling (3.30), leaf area (87.84 cm^2), fresh weight of seedling (114.60 g) and dry weight of seedling (44.76 g) at 180 days after sowing was noted in F_2 (GA_3 @ 200 mg l^{-1} at 60 and 90 days after sowing) and minimum days to reach graftable size (136.70 days) was also reported in same treatment F_2.

It is interesting to note that, there was an increased in plant height in GA_3 treated seedlings compared to all other treatments. It might be due to fact that GA_3 had role in cell enlargement and division, increase in intercellular spaces in the mesocarpic cells and higher translocation of photosynthates and mineral nutrients to the plants. (Krishnamoorthy, 1993) [4]. The increased in seedling height and girth by application of gibberellic acid was also reported by earlier workers Parameswari and Srimathi (2008) [9] in tamarind and Surakshita *et al*. (2014) [14] in jamun.

The production of more number of leaves in gibberellic acid treatment may be due to GA_3 which induced vigorous growth by more number of branches which in turn facilitates better harvest of sunshine by the plants to produce more number of leaves. These results obtained on this aspect are in agreement with Marler and Mickelbert (1992) [5] in carambola.

GA_3 improves the internal physiology of plant in terms of better supply of water, nutrient and other bio compounds vital for their proper growth and development which in turn helps to produce more leaf area per seedlings. This might be due to maximum height of seedling under this treatment. This also helps in invigoration of physiological process of plant and stimulatory effect of chemicals to form new leaves at faster rate. Similar results were reported by Marler and Mickelbert (1992) [5] in carambola, Kawthalkar and Kunte (1974) [3] in rangpur lime.

Maximum fresh weight and dry weight of seedling is due to the effect of GA_3 by mobilization of water and nutrients transported at higher rate which might have promoted more production of photosynthetic product and translocated them to various plant parts which might have resulted in better growth of the seedlings and hence more fresh and dry weight. The results are in confirmity with the findings of Misra and Jaiswal (2001) [6] in bael, Monselise and Halevy (1962) [7] in citrus.

The minimum number of days to reach graftable size may be due to induced vigorous growth by gibberllic acid. The promotion of growth in terms of increased plant height, stem diameter and number of leaves caused the increased plasticity of the cell wall followed by hydrolysis of starch to sugars which lowers the water potential of cell resulting in the entry of water into the cell causing the cell elongation. This might have attributed to increase photosynthetic activity, accelerated translocation and efficiency of utilising photosynthetic products resulting in cell elongation and rapid cell division in growing portion (Sargent, 1965) [11].

Among the different treatment combinations, seed treatment *viz*., GA_3 @ 200 mg l^{-1} for 10 min and foliar spray of GA_3 @ 200 mg l^{-1} at 60 and 90 days after sowing (S_4F_2) had recorded maximum seedling height (95.89 cm), number of leaves per seedling (52.53), stem diameter (8.63 mm), number of shoots per seedling (3.60), fresh weight of seedling (114.60 g) and dry weight of seedling (44.76 g) at 180 days after seed sowing. Minimum days to reach graftable size (136.70 days)

was also reported in same treatment combination S_4F_2. The better results in respect to plant height, stem diameter, number of leaves and number of shoots was observed in S_4F_2 might have occurred due to cell division and cell elongation, which in turn would have increased the internodal length and overall vegetative growth as suggested by Shanmugavelu (1970) [13].
In the present study foliar spray of NAA @ 200 mg l^{-1} at 60 and 90 days after sowing was found toxic and due to that poor shoot and root growth was observed.

Root parameters
In case of seed treatment, the maximum primary root length (43.04 cm), number of secondary roots (46.36), fresh weight of root (23.93 g), dry weight of root (10.16 g) and root: shoot ratio (3.21) was found in seed treatment GA_3 @ 200 mg l^{-1} for 10 min (S_4) as compared to rest of seed treatments. This improvement in root parameters due to GA_3 treatment might have resulted into increased production of photosynthates and their translocation through phloem to the root zone might be responsible for increasing the root length (Vachhani *et al*., 2014) [15]. The seeds treated with GA_3 might be accelerates the translocation and assimilation of auxins, reasons for better root growth and vegetative characters of jamun seedling may be due to overall assimilation and redistribution of materials within plants which enhance the growth attributes. Moreover, GA_3 also induced the activity of gluconeogenic enzymes during early stages of seed germination and vigour characteristics that are reflect in terms of increased in primary root length, number of secondary roots, fresh weight and dry weight of root. These results are in close agreement with Brijwal and Kumar (2013) [2] in guava and Vasantha *et al*. (2014) in tamarind [16].
Regarding the effect of foliar spray of different chemical substances on root parameters, GA_3 @ 200 mg l^{-1} at 60 and 90 days after sowing resulted in maximum primary root length (45.77 cm), number of secondary roots (49.37), fresh weight of root (24.69 g), dry weight of root (10.39 g) and root: shoot ratio (3.35). However, minimum primary root length (32.27 cm), number of secondary roots (49.37), fresh weight of root (13.51 g), dry weight of root (5.66 g) and root: shoot ratio (2.59) was recorded in seedlings treated with NAA @ 200 mg l^{-1} at 60 and 90 days after sowing. GA_3 increases somatic uptake of nutrients, causing root cell elongation and thus increasing the root volume and taproot length resulted in increasing fresh weight and dry weight of root. The results obtained in the present studies are in agreement with that reported by Wagh *et al*. (1998) [18] and Virendra and Shafaat (1996) [17] in aonla.
The different root parameters of jamun seedling *viz*., primary root length (cm), number of secondary roots, fresh weight of root (g), dry weight of root (g) and root: shoot ratio was altered by interaction between different seed treatment and foliar spray of chemical substances. Root parameters were recorded at 180 days after seed sowing. The maximum number of secondary roots (54.11), fresh weight of root (28.31 g), dry weight of root (12.18 g) and root: shoot ratio (3.64). were noted in treatment S_4F_2 (seed treatment of GA_3 @ 200 mg l^{-1} for 10 min and foliar spray of GA_3 @ 200 mg l^{-1} at 60 and 90 days after sowing) compared to rest of the treatments. GA_3 might have promoted more root formation through root cell elongation and more nutrient uptake as suggested by Shanmugavelu (1970) [13].

Table 1: Effect of seed treatment and foliar spray of chemical substances on seedling height, number of leaves and stem diameter of jamun seedling at 180 days after sowing.

Seed treatments	Seedling height (cm)						Number of leaves						Stem diameter (mm)					
	Foliar spray						Foliar spray						Foliar spray					
	F_1	F_2	F_3	F_4	F_5	Mean	F_1	F_2	F_3	F_4	F_5	Mean	F_1	F_2	F_3	F_4	F_5	Mean
S_1	71.52	89.94	41.25	86.55	91.93	76.24	32.87	46.73	15.53	43.33	44.60	36.61	7.07	7.50	6.94	7.13	7.41	7.21
S_2	78.47	93.03	43.89	87.13	84.85	77.47	38.87	51.40	16.13	46.73	47.80	40.19	7.11	7.65	7.05	7.54	7.61	7.39
S_3	78.71	93.37	44.35	81.57	91.29	77.86	39.13	50.67	18.20	44.27	47.20	39.89	7.16	7.57	7.10	7.41	7.55	7.36
S_4	84.09	95.89	47.78	90.57	94.67	82.60	44.73	52.53	20.67	47.53	47.67	42.63	7.51	8.63	7.20	8.03	8.16	7.90
S_5	81.16	92.53	43.05	87.70	89.71	78.83	46.13	50.07	19.67	44.87	48.40	41.83	7.21	8.44	7.10	8.27	8.38	7.88
S_6	85.01	88.81	44.26	87.02	86.81	78.38	44.53	48.00	19.67	46.40	47.93	41.31	7.12	8.23	7.09	8.03	8.19	7.73
Mean	79.83	92.26	44.10	86.76	89.88		41.04	49.90	18.31	45.52	47.26		7.20	8.00	7.08	7.73	7.88	
	S		F		SXF		S		F		SXF		S		F		SXF	
F test	*		*		*		*		*		*		*		*		*	
SEm. ±	0.95		0.86		2.11		0.61		0.56		1.28		0.07		0.06		0.15	
CD(5%)	2.67		2.44		5.98		1.73		1.58		3.62		0.19		0.17		0.41	
CV%					4.66						7.09						3.35	

Table 2: Effect of seed treatment and foliar spray of chemical substances on number of shoots, leaf area and root:shoot ratio of jamun seedling at 180 days after sowing.

Seed treatments	Number of shoots						Leaf area (cm^2)						Root:shoot ratio					
	Foliar spray						Foliar spray						Foliar spray					
	F_1	F_2	F_3	F_4	F_5	Mean	F_1	F_2	F_3	F_4	F_5	Mean	F_1	F_2	F_3	F_4	F_5	Mean
S_1	2.47	2.73	1.20	2.53	2.60	2.31	64.00	84.42	65.96	75.62	82.46	74.49	2.83	3.08	2.45	3.33	3.22	2.98
S_2	2.33	3.40	2.07	2.53	2.67	2.60	70.74	86.19	69.20	76.08	83.02	77.04	3.13	3.27	2.70	3.14	3.30	3.11
S_3	2.07	3.33	1.87	2.60	2.60	2.49	67.40	86.38	68.15	79.73	83.81	77.09	2.91	3.26	2.63	3.14	3.24	3.04
S_4	2.33	3.60	2.47	3.13	3.20	2.95	77.21	94.21	78.33	90.65	91.12	86.30	3.23	3.64	2.57	3.28	3.35	3.21
S_5	2.47	3.47	2.27	3.20	3.13	2.91	78.65	87.36	75.65	86.78	87.66	83.22	3.27	3.52	2.57	3.16	3.01	3.11
S_6	2.47	3.27	2.40	3.00	3.00	2.83	78.69	88.49	76.96	87.28	88.05	83.90	2.91	3.29	2.63	3.22	3.38	3.09
Mean	2.36	3.30	2.04	2.83	2.87		72.78	87.84	72.38	82.69	86.02		3.05	3.35	2.59	3.21	325	
	S		F		SXF		S		F		SXF		S		F		SXF	
F test	*		*		*		*		*		NS		*		*		*	
SEm. ±	0.04		0.04		0.10		1.19		1.08		2.65		0.04		0.04		0.09	
CD(5%)	0.13		0.16		0.28		3.35		3.06		-		0.12		0.11		0.26	
CV%					6.44						5.71						5.24	

Table 3: Effect of seed treatment and foliar spray of chemical substances on primary root length, number of secondary roots and fresh weight of jamun seedling at 180 days after sowing.

Seed treatments	Primary root length (cm)						Number of secondary roots						Fresh weight of seedling (g)					
	Foliar spray						Foliar spray						Foliar spray					
	F_1	F_2	F_3	F_4	F_5	Mean	F_1	F_2	F_3	F_4	F_5	Mean	F_1	F_2	F_3	F_4	F_5	Mean
S_1	28.45	38.98	28.33	32.28	35.18	32.64	36.50	39.86	28.33	38.03	38.44	36.23	86.26	108.31	44.93	96.76	103.28	87.91
S_2	32.75	45.58	34.06	44.46	43.75	40.12	38.23	49.33	31.98	46.36	46.01	42.38	91.89	112.32	48.07	104.77	106.10	92.63
S_3	34.25	45.27	31.82	42.92	43.93	39.64	37.27	48.67	31.82	44.88	45.69	41.67	93.73	105.45	46.63	96.76	98.76	88.27
S_4	36.73	49.80	33.31	46.60	48.75	43.04	41.90	54.11	34.79	49.27	51.73	46.36	102.92	126.65	52.01	118.70	120.71	104.20
S_5	35.00	48.05	33.42	44.05	45.02	41.11	40.61	52.57	33.81	48.64	50.37	45.20	100.91	119.05	48.32	112.32	116.37	99.39
S_6	33.52	46.95	32.65	42.97	44.23	40.07	39.02	51.67	32.65	47.78	49.18	44.06	95.88	115.82	49.10	112.98	114.96	97.75
Mean	33.45	45.77	32.27	42.22	43.48		38.92	49.37	32.23	45.83	46.90		9526	114.60	48.18	107.05	110.03	
	S		F		SXF		S		F		SXF		S		F		SXF	
F test	*		*		NS		*		*		*		*		*		*	
SEm. ±	0.66		0.60		1.48		0.54		0.49		1.21		1.10		1.01		2.47	
CD(5%)	1.87		1.71		-		1.53		1.40		3.43		3.12		2.85		6.98	
CV%					6.50						4.92						4.49	

Table 4: Effect of seed treatment and foliar spray of chemical substances on dry weight of seedling, fresh weight of root and dry weight of root of jamun seedling at 180 days after sowing.

Seed treatments	Dry weight of seedling (g)						Fresh weight of root (g)						Dry weight of root (g)					
	Foliar spray						Foliar spray						Foliar spray					
	F_1	F_2	F_3	F_4	F_5	Mean	F_1	F_2	F_3	F_4	F_5	Mean	F_1	F_2	F_3	F_4	F_5	Mean
S_1	33.82	41.75	17.52	37.74	41.06	34.38	17.61	21.21	11.91	18.36	18.88	17.59	7.45	8.71	5.08	7.85	8.01	7.42
S_2	35.84	43.80	18.75	40.86	41.38	36.13	18.88	23.67	13.00	20.60	20.35	19.30	8.15	9.99	5.54	8.40	8.41	8.10
S_3	35.85	41.99	20.19	38.64	38.44	35.02	17.98	22.56	12.95	18.77	19.75	18.40	7.22	9.50	5.24	7.79	7.93	7.54
S_4	40.14	49.39	20.28	46.24	47.08	40.63	24.24	28.31	15.18	24.69	27.29	23.93	10.01	12.18	6.56	10.42	11.62	10.16
S_5	39.35	46.43	18.85	43.80	45.38	38.76	21.44	27.32	13.66	23.95	24.43	22.16	9.16	11.33	5.50	10.01	10.51	9.30
S_6	37.39	45.17	19.15	44.06	44.84	38.12	20.26	25.05	14.35	22.59	23.93	21.24	8.78	10.61	6.04	9.53	10.13	9.02
Mean	37.06	44.76	19.12	41.89	43.03		20.06	24.69	13.51	21.49	22.44		8.46	10.39	5.66	9.00	9.44	
	S		F		SXF		S		F		SXF		S		F		SXF	
F test	*		*		*		*		*		*		*		*		*	
SEm. ±	0.46		0.42		1.02		0.32		0.29		0.72		0.13		0.12		0.28	
CD(5%)	1.29		1.18		2.89		0.91		0.83		2.03		0.36		0.33		0.80	
CV%					4.75						6.07						5.72	

Table 5: Effect of seed treatment and foliar spray of chemical substances on days to reach graftable size of jamun seedling.

Seed treatments	Dry weight of seedling (g)					
	Foliar spray					
	F_1	F_2	F_3	F_4	F_5	Mean
S_1	178.87	148.07	187.81	167.33	163.40	169.09
S_2	178.80	141.00	179.40	155.67	156.80	162.33
S_3	179.47	142.27	179.87	158.73	159.93	164.05
S_4	175.47	128.47	176.75	140.80	134.13	151.12
S_5	176.93	130.33	176.20	141.80	134.80	152.01
S_6	178.40	130.07	179.73	148.80	146.33	156.67
Mean	177.99	136.70	179.96	152.19	149.23	
	S		F		SXF	
F test	*		*		*	
SEm. ±	1.53		1.40		3.43	
CD(5%)	4.34		3.96		9.70	
CV%					3.73	

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