The Pharma Innovation Journal 2021; 10(4): 1105-1109

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(4): 1105-1109

www.thepharmajournal.com
Received: 13-02-2021
Accepted: 16-03-2021

Nikshita R Patel
Department of Fruit Science, ASPEE College of Horticulture and Forestry Navsari Agricultural University, Navsari, Gujarat, India

YN Tandel
Department of Fruit Science, ASPEE College of Horticulture and Forestry Navsari Agricultural University, Navsari, Gujarat, India

Sejal B Patel
Department of Fruit Science, ASPEE College of Horticulture and Forestry Navsari Agricultural University, Navsari, Gujarat, India

Corresponding Author:
Nikshita R Patel
Department of Fruit Science, ASPEE College of Horticulture and Forestry Navsari Agricultural University, Navsari, Gujarat, India

Effect of seed scarification and priming treatments on seedling growth, survival and vigour index of sapota

Nikshita R Patel, YN Tandel and Sejal B Patel

Abstract
The sapota seed is difficult to germinate in compare to other fruit crops due to the hard seed coat so with a view to study was conducted under agri-shade net house at Regional Horticultural Research Station, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari (Gujarat). The effect of seed scarification (without and with scarification) and priming treatments (GA_3 200 ppm, thiourea 1%, cow urine 10%, cow dung slurry, potassium nitrate 2% and water soaking for 24 hours) on seedling growth, survival and vigour index were evaluated and data were analysed by using completely randomized design with factorial concept with twelve treatment combinations and three replications. The study showed that the maximum growth parameters *viz.*, number of leaves, seedling height and stem diameter at 5, 7 and 9 MAS; biomass of seedlings *viz.*, fresh and dry weight of shoot and root at 9 MAS; survival percentage and seedling vigour index Ⅰ and Ⅱ with minimum mortality were recorded in those seeds sown without scarification as compared to scarified seeds. Out of seed priming treatments, cow dung slurry was found to be superior for all above attributes which was at par with cow urine 10% and GA_3 200 ppm. Owing to the results obtained during study, it is inferred that the sapota seeds be sown without scarification or else sown after soaking in cow dung slurry or cow urine for 24 hrs to get higher growth, survival and vigour index of sapota seedlings.

Keywords: Sapota, scarification, priming treatments, growth, survival, vigour index

Introduction
Manilkara achras (Mill.) Fosberg, denominating a popular evergreen and everfruiting tropical fruit tree commonly referred to as sapota or *chiku* in many places of India. This exotic tree introduced from tropical America and belongs to family Sapotaceae. In India, it is cultivated for delicious fruits, timber and latex. The fruit is an ellipsoid berry, rough rusty, 5-10 cm in diameter and weight is about 75 to 150 g. The flesh is soft, mellowing with colour ranges from pale yellow to an earthy brown which contains zero to 12 black shining seeds. Seeds are hard and easily separable from the pulp.

Sapota can be propagated both by seed as well as vegetative methods *viz.*, inarching and softwood grafting. In early days, it was propagated through seed but it has certain disadvantages, such as variability, slow and uneven growth, long juvenile or pre-bearing age taking about 8 to 10 years to fruits and growing to a huge size (Cheema *et al.*, 1954) [7]. However, seed propagation is mainly used for the creation of variability, developing hybrids, selection of superior types and raising rootstock, they should not be used for home plantings. So, it is utmost important to get the maximum germination of seed and subsequent seedling growth. Seeds remain viable for a short period and have a high moisture content, which puts them in the category of recalcitrant seed (Ellis, 1984) [13]. The seed viability of sapota reported as 16 days (Duarte and Cruz, 2007) [11]. Seedling emergence is rather slow and uneven, possibly due to the hard seed coat. These problems pose difficulty in raising of sapota seedlings in larger numbers. There is a possibility of increasing seed germination and subsequent growth of seedlings in many crops including sapota by using scarification treatment, growth regulators, organics and chemicals through their significant effects on germination and further growth. Keeping these facts in mind, the study was framed.

Material and methods
Experimental detail
The investigation was carried out at Regional Horticultural Research Station, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari (Gujarat) during the year 2017-18. It was laid out in Completely Randomized Design with factorial concept having

twelve treatment combinations, comprising of two levels of seed scarification (S) *viz.*, without scarification (S_0) and scarification (S_1); and six levels of seed priming treatments (I) *viz.*, GA_3 200 ppm (I_1), thiourea 1% (I_2), cow urine 10% (I_3), cow dung slurry (I_4), potassium nitrate 2% (I_5) and water soaking (I_6) for 24 hrs. The treatments were repeated thrice.
Fully mature fruits of sapota cv. Kalipatti were harvested and kept for ripening at room temperature. The required experimental seeds were extracted manually from the fully ripened fruits. Seeds with uniform size were selected and washed thoroughly with water to remove remaining adhered pulp and dead floating seeds. Then seeds were dried in shade to remove excess water and further subjected to different treatments. Out of whole seed material, the half of seeds lot were scarified by shaking the seeds with the grits in a plastic bottle for 30 seconds and followed by priming treatments for 24 hrs. While the unscarified seeds were directly soaked in respective priming treatments for 24 hrs. All the treated seeds were sown in polythene bags of size 7"×8" filled with red soil and well-rotted FYM (3:1). Watering was done immediately after sowing of seeds in polythene bags using watering rose and maintained the moisture level. Subsequently, bags were watered as and when required.

Growth parameters
Number of leaves/seedling
The total number of fully grown leaves per seedling was counted from five selected seedlings and computed the mean. It was recorded at 5, 7 and 9 months after sowing (MAS) as a number of leaves per seedling.

Seedling height (cm)
The height of five selected seedlings was measured from the base of seedlings to the growing tip with the help of meter-scale at 5, 7 and 9 MAS.

Stem diameter (mm)
Stem diameter of five selected seedlings was measured separately with the help of digital Vernier calliper at 3 cm height from the base. It was recorded at 5, 7 and 9 MAS as a stem diameter of seedlings in millimeter.

Biomass
Fresh weight of shoot (g) and root (g)
Five tagged seedlings from each treatment were uprooted at 9 MAS and washed carefully to remove the soil adhering to their roots and shoots followed by shade drying to remove excess water. Then the fresh weight of five shoots and roots in each treatment was measured on an electronic balance and recorded after computing the mean in gram.

Dry weight of shoot (g) and root (g)
The fresh weighed shoots and roots were chopped and kept in brown paper bags, properly labelled then oven dried at 60 ºC temperature till a constant weight which was measured with the help of electronic balance and the average value was computed.

Survival and mortality percentage
The survival and mortality percentage of each treatment was recorded at 9 MAS and calculated with the below mentioned formulas.

$$\text{Survival (\%)} = \frac{\text{Number of seedlings survived}}{\text{Number of seeds germinated}} \times 100$$

$$\text{Mortality (\%)} = \frac{\text{Number of seedlings died}}{\text{Total number of seedlings emerged}} \times 100$$

Seedling Vigour Index (SVI)
Vigour index determines the state of the health of seedlings and ultimately the state of the biomass production of the plant. It was calculated at 9 MAS based on the following formula given by Abdul-Baki and Anderson (1973) [1].

SVI - I (cm) = Per cent germination × Length of seedling (cm)
SVI - II (g) = Per cent germination × Dry weight of seedling (g)

The statistical analysis of data was carried out as per the method prescribed by Panse and Sukhatme (1985) [17].

Results and Discussion
Effect on seedling growth parameters and biomass
Effect of seed scarification
It showed significant effect of seed scarification and priming treatments on growth parameters and biomass of seedlings (Table 1 and 2). The maximum number of leaves (2.80, 10.60 and 13.50), seedling height (8.22, 10.76 and 13.04 cm) and stem diameter (2.42, 2.59 and 3.41 mm) at 5, 7 and 9 MAS, respectively and fresh weight of shoot and root (3.83 and 0.610 g, respectively) and dry weight of shoot and root (1.32 and 0.247 g, respectively) at 9 MAS were recorded in without scarification (S_0) treatment as compared to scarification treatment (S_1). The results are in accordance with the findings of Duarte and Suchini (2001) [12] in sapota with respect to seedling height and stem diameter; and Boora (2016) [5] found seed scarification reduced seedling height in ber as compared to control *i.e.* without scarification. Yisau *et al.* (2015) [22] reported scarification significantly influenced on the seedling height and total seedling fresh weight but not dry matter in *Albizia zygia*. Similar trend was also observed by Saied (2008) [20] in *Ziziphus spina-christi*.

Effect of seed priming treatments
In case of seed priming treatments, the maximum number of leaves (3.08, 11.43 and 14.08), seedling height (8.52, 11.48 and 13.62 cm) and stem diameter (2.50, 2.71 and 3.50 mm) at 5, 7 and 9 MAS, respectively and fresh weight of shoot and root (4.13 and 0.653 g, respectively) and dry weight of shoot and root (1.41 and 0.269 g, respectively) at 9 MAS were recorded in pre-soaking treatment of cow dung slurry (I_4) which was at par with cow urine 10% (I_3) and GA_3 200 ppm (I_1) for 24 hrs.
Cow dung slurry consists of undigested fibre, epithelial cells, pigments, salts, rich in minerals, N, P, K, Ca, Mg, S and other micronutrients which may be contributed for vigorous growth of the seedling, which increased number of leaves, height and stem diameter of the seedling and ultimately enhance the biomass production. These results are analogous with the earlier findings of Prajapati (2013) [18] in *khirni* and Ashiya Naguri and Tank (2015) [2] in mango.
Cow urine 10% (I_3) was found best next to cow dung slurry treatment (I_4) in case of growth parameters and biomass. The probable reason for the enhancement of vegetative growth and biomass of seedling with cow urine which might have resulted in more production of photosynthates and their translocation through phloem to the whole plant and increase in the overall assimilation and distribution of materials within the plants. Such effect is in accordance with the findings of Desai *et al.* (2017) [9] in papaya.
GA_3 200 ppm (I_1) also influenced on the production of more

number of leaves which might be due to more synthesis of nucleoprotein and the activity of GA_3 at apical meristem that responsible for increasing leaf initiation (Sheoran *et al.*, 2019) [21]. The increase in seedling height may be attributed to the cell multiplication and elongation in the cambium tissue of the internodal region because gibberellic acid apparently activates the metabolic processes or nullifies the effect of growth inhibitor (Donoho and Walker, 1957) [10]. Stem diameter was also increased due to higher cell division and elongation at the stem portion (Sheoran *et al.*, 2019) [21]. These all above growth parameters leads to increase in biomass of sapota seedlings. The similar results coincided with the findings of Pampanna *et al.* (1995) [16] in sapota and Ratna Rai *et al.* (2018) [19], Bajaniya *et al.* (2018) [3] and Bajaniya *et al.* (2019) [4] in *khirni*.

Table 1: Effect of seed scarification and priming treatments on seedling growth of sapota

Treatments	Number of leaves/seedling			Seedling height (cm)			Stem diameter (mm)		
	5 MAS	7 MAS	9 MAS	5 MAS	7 MAS	9 MAS	5 MAS	7 MAS	9 MAS
Seed scarification (S)									
S_0: Without scarification	2.80	10.60	13.50	8.22	10.76	13.04	2.42	2.59	3.41
S_1: With scarification	2.56	10.04	12.32	7.79	10.29	12.39	2.31	2.49	3.26
S.Em.±	0.04	0.15	0.17	0.13	0.14	0.16	0.03	0.03	0.04
C.D. at 5%	0.13	0.43	0.51	0.38	0.41	0.47	0.09	0.09	0.11
Seed priming treatments (I)									
I_1: GA_3 200 ppm	2.89	10.80	13.37	8.08	10.85	12.98	2.42	2.57	3.39
I_2: Thiourea 1%	2.50	9.73	12.03	7.83	10.13	12.02	2.31	2.46	3.24
I_3: Cow urine 10%	2.97	10.92	13.57	8.33	11.02	13.25	2.45	2.61	3.41
I_4: Cow dung slurry	3.08	11.43	14.08	8.52	11.48	13.62	2.50	2.71	3.50
I_5: Potassium nitrate 2%	2.67	9.96	12.58	7.87	10.18	12.45	2.32	2.50	3.28
I_6: Water soaking	2.00	9.09	11.84	7.38	9.48	11.97	2.16	2.39	3.19
S.Em.±	0.07	0.26	0.30	0.22	0.24	0.28	0.06	0.05	0.07
C.D. at 5%	0.22	0.75	0.88	0.64	0.71	0.81	0.16	0.15	0.19
Interaction effect (S × I)									
S.Em.±	0.11	0.36	0.43	0.32	0.34	0.39	0.08	0.08	0.10
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS
C.V. %	6.84	6.09	5.74	6.85	5.66	5.38	5.71	5.23	4.96

Table 2: Effect of seed scarification and priming treatments on biomass of sapota seedlings

Treatments	Biomass (g)			
	Fresh weight		Dry weight	
	Shoot (g)	Root (g)	Shoot (g)	Root (g)
Seed scarification (S)				
S_0: Without scarification	3.83	0.610	1.32	0.247
S_1: With scarification	3.44	0.547	1.21	0.228
S.Em.±	0.06	0.009	0.02	0.003
C.D. at 5%	0.17	0.025	0.06	0.009
Seed priming treatments (I)				
I_1: GA_3 200 ppm	3.90	0.614	1.36	0.252
I_2: Thiourea 1%	3.31	0.524	1.18	0.218
I_3: Cow urine 10%	3.91	0.631	1.38	0.257
I_4: Cow dung slurry	4.13	0.653	1.41	0.269
I_5: Potassium nitrate 2%	3.41	0.545	1.22	0.236
I_6: Water soaking	3.12	0.503	1.02	0.193
S.Em.±	0.10	0.015	0.03	0.005
C.D. at 5%	0.29	0.044	0.10	0.016
Interaction effect (S × I)				
S.Em.±	0.14	0.021	0.05	0.007
C.D. at 5%	NS	NS	NS	NS
C.V. %	6.82	6.39	6.53	5.80

Effect on survival and mortality percentage

Effect of seed scarification

Seed scarification and priming treatments had significant difference on survival and mortality percentage (Table 3). Seeds sown without scarification (S_0) treatment exhibited significantly the maximum survival (66.03%) and minimum mortality (24.09%) as compared to scarification (62.93 and 27.07%, respectively) treatment (S_1) at 9 MAS. Brijwal and Kumar (2013) [6] in guava seedling reported the maximum survival percentage. The probable reason for that might be the early germination of seeds which helps in successful acclimatization of seedlings and vigour of seedlings ultimately leads to better growth thus high survival.

Effect of seed priming treatments

An effect of different seed priming treatments on survival and mortality percentage at 9 MAS was influenced significantly and recorded the maximum survival (71.46%) in seeds soaked in cow dung slurry (I_4) which was at par with cow urine 10% (I_3) and GA_3 200 ppm (I_1) treatments. The mortality of seedlings was also obtained lesser (18.72%) in pre-soaking treatment of cow dung slurry (I_4) and cow urine 10% (I_3) for 24 hrs, while the minimum survival (57.74%) and maximum mortality (32.58%) were noted under water soaking (I_6)

treatment.

This might be due to the overall performance in relation to growth parameters were good in the same treatments. Falguni Patel (2015) [14] mentioned that presence of essential plant nutrients, beneficial microbes and plant protection substances in cow dung slurry which ultimately increased the survival and decreased mortality percentage. Cow dung treated seeds were the most effective for improving survival and decreasing mortality percentage. It might be due to the presence of N, P, K, S and other micronutrients could have been cause for increase vigour of seedlings, which increase survival and decrease mortality. Similar results were also reported by Prajapati (2013) [18] in *khirni* and Ashiya Naguri and Tank (2015) [2] in mango.

The seeds treated with GA_3 200 ppm (I_1) also increased survival percentage of sapota seedlings. This result has been supported by Chiranjeevi *et al.* (2017) [8] in aonla. The pre-soaking of seeds with GA_3 at 200 ppm is well known for better germination, seedling growth and vigour. It is also highly suitable for commercial cultivation and their germination and seedling health. Similar results were also earlier reported by Bajaniya *et al.* (2019) [4] in *khirni* and Palepad *et al.* (2017) [15] in custard apple.

Effect on seedling vigour index

Effect of seed scarification

There was a significant difference between seed scarification and priming treatments on seedling vigour index Ⅰ and Ⅱ. Table 3 showed that the higher seedling vigour index (SVI) - Ⅰ and Ⅱ (1658.02 cm and 92.55 g, respectively) were recorded in without scarification (S_0) treatment as compared to scarification (1451.32 cm and 78.55 g, respectively) treatment (S_1).

Effect of seed priming treatments

Out of all seed priming treatments, the highest seedling vigour index (SVI) - Ⅰ and Ⅱ (1954.80 cm and 110.89 g, respectively) were registered in cow dung slurry (I_4) treatment which was at par with cow urine 10% (I_3) and GA_3 200 ppm (I_1) for 24 hrs. The water soaking treatment (I_6) noted the lowest SVI - Ⅰ and Ⅱ (1094.54 cm and 54.68 g, respectively) as compared to rest of the treatments.

It can be ascribed to the cumulative effect of germination percentage, seedling length and dry weight of seedling under the same treatments. Similar findings were observed with cow dung slurry treatment in mango (Ashiya Naguri and Tank, 2015) [2].

Enhanced seedling vigour index with cow urine 10% (I_3) might be due to the cow urine maintains high water content in the cell which leads to increase cell division and cell elongation and thereby increased the germination and overall growth of the seedlings which may help to increase seedling vigour. Similar results were obtained by Desai *et al.* (2017) [9] in papaya.

GA_3 initiate quick germination, more seedling height and number of leaves and more accumulation of dry matter which resulted in increase in vigour index. These findings are close agreement with Ratna Rai *et al.* (2018) [19] in *khirni* and Palepad *et al.* (2017) [15] in custard apple.

Table 3: Effect of seed scarification and priming treatments on survival, mortality and vigour indices of sapota seedling

Treatments	Survival (%)	Mortality (%)	Seedling Vigour Index (SVI) - Ⅰ (cm)	Seedling Vigour Index (SVI) - Ⅱ (g)
Seed scarification (S)				
S_0: Without scarification	66.03 (82.59)	24.09 (17.41)	1658.02	92.55
S_1: With scarification	62.93 (78.69)	27.07 (21.31)	1451.32	78.55
S.Em.±	0.93	0.45	33.48	1.88
C.D. at 5%	2.71	1.32	97.72	5.49
Seed priming treatments (I)				
I_1: GA_3 200 ppm	68.75 (86.79)	21.21 (13.21)	1796.98	102.01
I_2: Thiourea 1%	58.97 (73.41)	30.99 (26.59)	1342.89	70.33
I_3: Cow urine 10%	69.86 (88.06)	20.10 (11.94)	1809.94	104.09
I_4: Cow dung slurry	71.46 (89.54)	18.72 (10.46)	1954.80	110.89
I_5: Potassium nitrate %	60.09 (75.11)	29.87 (24.89)	1328.89	71.29
I_6: Water soaking	57.74 (70.94)	32.58 (29.07)	1094.54	54.68
S.Em.±	1.61	0.78	57.98	3.26
C.D. at 5%	4.70	2.29	169.25	9.51
Interaction effect (S × I)				
S.Em.±	2.28	1.11	82.00	4.61
C.D. at 5%	NS	NS	NS	NS
C.V. %	6.11	7.50	9.14	9.33

Note: Figure outside parenthesis indicates arcsine transformed value

Conclusions

As cow dung slurry and cow urine are the cheaper pre-soaking treatments and also easily available as compared to GA_3 and hence, it is concluded that to get higher growth, survival and vigour index of sapota seedlings, the sapota seeds be sown without scarification or else sown after soaking in cow dung slurry or cow urine for 24 hrs.

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