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Effect of Seed Coat Removal Treatments on Seed Germination and Seedling Attributes in Mango Varieties

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ABSTRACT

A field experiment was carried out at the Indian Institute of Horticultural Research, Bengaluru during 2011–12 to study the effect of seed coat removal on seed germination and vigor of polyembryonic mango seedlings. In seed coat removal, the cultivar Muvandan recorded the maximum germination percent (85.4%), extent of polyembryony (2.76), and maximum number of leaves (10.3), whereas Bappakkai recorded maximum plant height (22.4 cm), stem girth (0.64 cm), leaf area (249.2 cm^2), fresh weight (18.5 g) and dry weight (8.4 g), vigor index-I (1831.5 cm), and vigor index-II (685.7 g). With respect to treatments, seed coat removal was superior in all of the parameters, namely, initiation of germination (16.7 days), germination percent (78.3%), extent of polyembryony (2.50), plant height (19.5 cm), stem girth (0.62 cm), number of leaves per plant (8.7), leaf area (288.3 cm^2), fresh weight (16.2 g) and dry weight (7.3 g), vigor index-I (1559.0 cm), and vigor index-II (581.8 g) compared to seed coat intact. There were no significant differences among the interactions of different treatments and cultivars.

KEYWORDS

Mango; seed coat removal; vigor; polyembryony

Introduction

Mango (*Mangifera indica*. L.) is the most important commercially grown fruit crop of India and is considered to be the national fruit. In mango, seed germination plays an important role in producing the rootstock seedlings required for production of grafts. The seeds have a hard seed coat, which inhibits the germination and extent of polyembryony. The effect of seed coat on germination, in general, is poorly understood, but the evidence points to a number of possibilities (Bewley and Black, 1982). The beneficial effect of seed coat removal on the germination of mango was reported by Simao (1960). However, the information on this aspect is meager, especially in polyembryonic varieties, where no such information is available. Hence, the seed coat removal study was undertaken to hasten the germination and various seedling attributes.

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Material and methods

The study was conducted on four polyembryonic mango cultivars at the Indian Institute of Horticultural Research during the month of July 2011. The experiment was laid out in a factorial randomized block design with four cultivars (Olour, Bappakkai, Vellaikolumban, and Muvandan) and two treatments (seed coat intact and seed coat removal) with three replications. Fruits from all of the cultivars were harvested when fruits started falling from the tree; when the pulp turned to a light yellow color, the fruits were kept for ripening at room temperature. Stones were extracted from fully ripened fruits and heavier stones weighing about 36 ± 1.2 g in Olour, 39 ± 1.1 g of Bappakai, 27 ± 0.75 g of Vellaikulamban, and 25 ± 1.0 g of Moovandan were selected for the experiment. Forty stones were maintained in each replication. The seed coat was removed by using secateurs and knives without damaging the embryo. The stones were raised in a nursery bed containing an equal proportion of sand, red earth, and farm yard manure (FYM) with the stalk end facing upwards in the beds at about 2–3 cm below the soil surface during the last week of July. Germination of stones started 15 days after sowing and continued till the 2nd week of Sept.

Observations were recorded daily for germination parameters and monthly for vegetative parameters, such as plant height, number of leaves, and stem girth, and results were presented at 145 days after sowing along with leaf area, fresh weight, dry weight, and seedling vigor. The seedling vigor was calculated based on the following formulas (Bewley and Black, 1982):

$$\text{Vigor index-I (cm)} = \text{Mean seedling length} \times \text{percent germination},$$

$$\text{Vigor index-II (g)} = \text{Dry weight of seedling} \times \text{percent germination}.$$

All of the data were statistically analyzed according to Panse and Sukhatme (1985) and the difference in the means were compared at 5% level of significance.

Results

Germination characters

Days to germination

The data (Table 1) showed that there was a significant difference among the cultivars and treatments. The days taken for initiation and 50% of germination was less in Olour and Bappakkai (16 and 24.5 days, respectively), whereas Vellaikolumban took a long period (22.8 and 35.3 days). Among the treatments, seed coat removal took less time (16.7 and 25.9 days, respectively) for initiation and 50% of germination while the maximum days were reported with treatment control (20.2 and 30.5 days, respectively).

Table 1. Germination characters of polyembryonic mango stones as influenced by different varieties and treatments.

	Days taken for																			
	Initiation of germination					50% of germination					Germination percentage					Extent of polyembryony				
	Cultivars[z]																			
Treatments[y]	V_1	V_2	V_3	V_4	Mean	V_1	V_2	V_3	V_4	Mean	V_1	V_2	V_3	V_4	Mean	V_1	V_2	V_3	V_4	Mean
T_1	17.6	25.0	17.3	21.0	20.2	30.0	38.6	25.6	28.0	30.5	56.6	41.6	72.5	77.5	62.0	1.86	1.80	2.13	2.53	2.08
T_2	14.3	20.6	15.3	16.6	16.7	25.0	32.0	23.3	23.3	25.9	77.5	53.3	89.1	93.3	78.3	2.33	2.20	2.46	3.00	2.50
Mean	16.0	22.8	16.3	18.8		27.5	35.3	24.5	25.6		67.0	47.5	80.8	85.4		2.10	2.00	2.30	2.76	
	Treatments		Varieties		T × V	Treatments		Varieties		T × V	Treatments		Varieties		T × V	Treatments		Varieties		T × V
F-test	*		*		NS	*		*		NS	*		*		NS	*		*		NS
S. Em ±	0.35		0.49		0.70	0.58		0.82		1.16	1.07		1.51		2.14	0.07		0.10		0.15
CD at (p = 0.05)	1.06		1.50		—	1.77		1.16		—	3.25		4.60		—	0.23		0.32		—

[z]Cultivars: V1—Olour; V2—Vellaikolumban; V3—Bappakkai; V4—Muvandan.
[y]Treatments: T_1—Seed coat intact; T_2—Seed coat removal.
*Significant at 5%; NS: Non-significant.

Percentage of germination

With respect to percentage of germination, cultivar Muvandan recorded the maximum germination (85.4%), which was on par with Bappakkai (80.8%), whereas the minimum was found in Vellaikolumban (47.5%). Among the treatments, the highest germination was noticed in the treatment with seed coat removal (78.3%), while minimum germination was in the control treatment (62.0%). The seed coat may prevent germination because it interferes with water uptake and gaseous exchange, and also contains chemical inhibitors, which act as the barrier against the escape of inhibitors from the embryo, modifies the light reaching the embryo, and imposes mechanical restraint (Bewley and Black, 1982; Padma and Reddy, 1997).

Polyembryony

Significant differences were found with respect to extent of polyembryony among different cultivars and treatments. The phenomenon of more than one embryo in the embryo sac, technically called polyembryony, is known to occur in a number of cultivars growing under different soil and climatic conditions (Juliano, 1934; Maheshwari et al., 1955; Sen and Malik, 1940). In the present study, all four polembryonic cultivars produced more than one seedling per stone. However, the extent of polyembryony was high in Muvandan (2.76) followed by Bappakkai (2.30) and the minimum was noticed in Vellaikolumban (2.00). Among the different treatments, the high extent of polyembryony was found in seed coat removal treatment (2.50) and the minimum was noticed in seed coat intact (2.08).

Vegetative growth parameters

Significant differences were observed (Table 2) among different cultivars and treatments in seedling height, number of leaves, stem girth, and leaf area. At 145 days after sowing, the maximum seedling height (22.4 cm) and seedling girth (0.64 cm) were recorded in cultivar Bappakkai followed by Muvandan (18.9 cm and 0.60 cm, respectively) and the minimum was in Vellaikolumban (16.1 cm and 0.54 cm, respectively). The maximum number of leaves and leaf area was noticed in Muvandan and Bappakkai (10.3 and 249.2 cm^2, respectively) while the minimum was found in Vellaikolumban (4.5 and 124.4 cm^2, respectively). Among the treatments, the maximum seedling height (19.5 cm), number of leaves (8.3), girth (0.62 cm), and leaf area (219.2 cm^2) were recorded in seed coat removal and the minimum was in control (17.6 cm, 7.6, 0.56 cm, and 158.5 cm^2, respectively). Interaction effects of cultivars and treatments were found to be non-significant.

Table 2. Seedling characters as influenced by seed coat removal in different varieties and treatments.

	Plant height (cm)					No. of leaves per plant					Stem girth (cm)					Leaf area (cm^2)				
	Cultivars[z]																			
Treatments[y]	V_1	V_2	V_3	V_4	Mean	V_1	V_2	V_3	V_4	Mean	V_1	V_2	V_3	V_4	Mean	V_1	V_2	V_3	V_4	Mean
T_1	16.2	14.9	20.8	18.6	17.6	7.6	4.2	8.6	10.0	7.6	0.54	0.52	0.61	0.57	0.56	99.9	98.0	236.1	199.8	158.5
T_2	17.4	17.2	24.0	19.3	19.5	8.8	4.8	10.7	10.7	8.7	0.61	0.57	0.68	0.62	0.62	175.6	150.7	262.2	288.3	219.2
Mean	16.8	16.1	22.4	18.9		8.2	4.5	9.6	10.3		0.58	0.54	0.64	0.60		137.7	124.4	149.2	244.1	
	Treatments		Varieties		T × V	Treatments		Varieties		T × V	Treatments		Varieties		T × V	Treatments		Varieties		T × V
F-test	*		*		NS	*		*		NS	*		*		NS	*		*		NS
S. Em ±	0.43		0.61		0.87	0.21		0.29		0.42	0.013		0.019		0.027	10.46		14.71		20.92
CD at (p = 0.05)	1.32		1.87		—	0.64		0.90		—	0.041		0.058		—	31.73		44.87		—

[z]Cultivars: V_1—Olour; V_2—Vellaikolumban; V_3—Bappakkai; V_4—Muvandan.
[y]Treatments: T_1—Seed coat intact; T_2—Seed coat removal.
*Significant at 5%; NS: Non-significant.

Fresh weight, dry weight, and vigor index of seedling

Significant differences were observed among different cultivars and treatments in fresh weight, dry weight, vigor index-I, and vigor index-II of seedlings (Table 3). However, interaction effects of cultivars and treatments were found to be non-significant. At 145 days after sowing, Bappakkai recorded the maximum fresh weight, dry weight, vigor index-I, and vigor index-II of seedlings (18.5 g, 8.4 g, 1831.5 cm, and 685.7 g, respectively) whereas the minimum was in Vellaikolumban (11.6 g, 5.3 g, 620.6 cm, and 176.5 g, respectively). Among the treatments, the highest fresh weight and dry weight was noticed in the treatment of seed coat removal (16.2 g, 7.3 g, 1809.4 cm, and 581.8 g respectively), while the minimum was in the control (12.7 and 5.7 g 1123.4 cm and 371.7 g, respectively).

Discussion

Germination characters

Days to germination

The faster germination in Olour and Bappakkai cultivars may be due to increased weight of stone in these varieties. As the stone weight was more, the endosperm weight would have been more, which might have supplied all of the necessary nutrients and hormones for faster germination of seedlings. The wide variation observed in time requirement for germination may be due to thick endocarp present in the stones of mango. The less stone weight cultivars exhibited slow germination due to less endosperm content in the stone, which might have supplied less nutrient and food material for germination. These results were comparison with the findings of Rao and Reddy (2006).

Percentage of germination

The seed coat removal enhances the early germination, which may be due to seed coat involvement in prevention of water uptake exerting a mechanical restraint on the growth of the embryo. Late germination with seed coat intact could be due to the stony endocarp acting as a barrier against the escape of inhibitors and exerting a physical restraint on growth of the embryo. These results obtained on this aspect were in agreement with Padma and Reddy (1997). The easy absorption of water increases the α-amylase activity and it also helps for early emergence of plumule.

Polyembryony

Seed coat removal also has an effect on the number of seedlings produced from a single seed. Seed coat removal encouraged all of the nucellar embryos and seedlings in the seed to develop and establish themselves. In normal seeds, the seed coat tended to inhibit the sprouting of the weaker nucellar embryos and

Table 3. Fresh weight, dry weight, and vigor index of mango seedlings influenced by seed coat removal in different varieties and treatments.

	Fresh weight (g)					Dry weight (g)					Vigour index-I (cm)					Vigour index-II (g)				
											Cultivars[z]									
Treatments[y]	V_1	V_2	V_3	V_4	Mean	V_1	V_2	V_3	V_4	Mean	V_1	V_2	V_3	V_4	Mean	V_1	V_2	V_3	V_4	Mean
T_1	9.2	9.5	17.8	14.4	12.7	4.5	4.2	8.0	6.2	5.7	918.3	620.6	1515.1	1439.5	1123.4	257.0	176.5	582.1	471.4	371.7
T_2	14.4	13.7	19.2	17.7	16.2	6.4	6.4	8.8	7.5	7.3	1355.1	923.8	2147.8	1809.4	1559.0	496.1	343.2	789.4	698.6	581.8
Mean	11.8	11.6	18.5	16.0		5.5	5.3	8.4	6.8		1136.7	772.2	1831.5	1624.4		376.6	359.9	685.7	585.0	
	Treatments		Varieties		T × V	Treatments		Varieties		T × V	Treatments		Varieties		T × V	Treatments		Varieties		T × V
F-test	*		*		NS	*		*		NS	*		*		NS	*		*		NS
S. Em ±	0.83		1.17		1.66	0.38		0.53		0.76	45.9		64.9		91.8	26.9		38.1		53.9
CD at (p = 0.05)	2.51		3.56		—	1.15		1.63		—	139.3		197.0		—	81.8		115.7		—

[z]Cultivars: V_1—Olour; V_2—Vellaikolumban; V_3—Bappakkai; V_4—Muvandan.
[y]Treatments: T_1—Seed coat intact; T_2—Seed coat removal.
*Significant at 5%; NS—Non-significant.

seedlings and as result suppressed within the seed. Similar results were reported by Sinnadurai (1975) and Shaban (2010) in mango. Similar observations on variation in extent of polyembryony were reported by Khobragade et al. (1999) and Singh and Reddy (1990). Sturrock (1968) reported that, in polyembryonic seeds, variation in sprouts was due to the failure of few embryos to germinate. Thus, it can be assumed that variation in polyembryony was due to temporary aberration mediated through other extraneous factors.

Vegetative growth parameters

This high growth potential and low growth potential of different seedlings may be basically due to the stone characters as well as faster and quicker germination of the different varieties. If the stone weight was more it may lead to vigorous seedlings. The vigorous growth of seedlings observed in seed coat removal may be due to the early initiation of germination, which was in conformity with the findings of Shaban (2010) and Padma and Reddy (1997). The variation in the number of leaves and their leaf area could be expected among the cultivars, as the attribute is generally a genetic character. Variation in leaf area due to the cultivars was also observed by Shinde (1982) and Agarwal (1986) in citrus and Khobragade et al. (1999) in mango, who reported that greater leaf area was associated with vigorous rootstocks. Seed coat removal increases the vigor of seedlings due to early initiation of germination; it may also due to the development of a good root system for nutrient uptake, which also increases the photosynthetic activity due to early exposure of leaves to sunlight.

Fresh weight, dry weight, and vigor index of seedling

The seed coat removal with cultivar Bappakkai recorded the maximum fresh and dry weight. These variations may be due to increased or decreased growth of seedlings and also due to vigorous or dwarf stature of the seedlings (Rao, 2002). Seed coat removal resulted in more fresh and dry weight mainly due to more seedling growth and development and also due to increased leaf area and fresh weight. In seed coat removal in cultivars Bappakkai and Muvandan the vigor index may be high, due to vigorous growth of seedlings and high germination percent. In Vellaikolumban the vigor index may be low due to the dwarf nature of the seedling as well as slow growth. In long-range rootstock, trials also indicated the same trend by these vigorous rootstocks (Reddy and Singh, 1993).

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