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Effects of different treatments on seed germination improvement of jamun (*Syzygium cuminii* Skeels)

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Abstract
The purpose of this study was to investigate the effects of different treatments on seed germination in jamun (*Syzygium cuminii* Skeels). This species is known to have short time of viable seeds. An investigation was carried out in department of Fruit Science, Kittur Rani Channamma College of horticulture, Arabhavi during year 2015-16. Six treatments viz., T_1- Poly bag (300 gauges thick), T_2- Poly bag + Charcoal powder, T_3- Poly bag + Carbendazim, T_4- Poly bag + Saw dust, T_5- Poly bag + *Trichoderma harzianum* and T_6- Control (Paper bag) were used for evaluating the germination. Germination index was recorded highest in *Trichoderma harzianum* + Poly bag and seeds of Poly bag, compared to other treatments while, the untreated seeds recorded the least germination index. Vegetative parameters like seedling height and number of leaves was significantly more in *Trichoderma harzianum* + Poly bag treated seeds at 60 and 75 days of sowing (DAS). Prolonging the viability of seeds for more days would facilitate the availability of seeds for multiplication and also use by local farmers throughout the year.

Keywords: Germination Index, Poly bag, Charcoal powder, Carbendazim, *Trichoderma harzianum*

Introduction
Jamun (*Syzygium cuminii* Skeels) is an evergreen multipurpose tree. It is an important minor fruit belonging to the family Myrtaceae consisting of over 75 species and is a native of India. It is also known as Black Plum, Java Plum, Indian blackberry, Jambolan, *etc*. It is tall and evergreen tree distributed throughout India for its edible fruits. 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. The fruits are good source of iron, minerals, sugars and proteins. The fruits are tasty and pleasantly flavoured very much liked by children as well as elders. Besides being preferred for dessert purpose, fruits are used in the preparation of delicious beverages, jellies, 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) [11]. They are also seen growing in parks, on roadsides, avenues and as windbreaks. Maximum number of jamun trees is found scattered throughout the tropical and subtropical regions of the country including the Nilgiri and Himalayan region upto altitude of about 1200 meters. Seeds are recalcitrant and are relatively high in moisture content and possess a characteristic feature of losing their viability during desiccation. Despite the fact that cooling and drying form the basis for preserving all types of seeds, the recalcitrant seeds impose serious storage problems due to their desiccation and chilling sensitivity. Desiccation below critical level leads to loss of viability. Recalcitrant seeds are tolerant to drying and low temperatures. Seeds continue to be viable for three to five months after pre-sprouting. Thus the main objectives of the experiment is to provide the viability of seeds for more days would facilitate the availability of seeds for multiplication and also use by local farmers throughout the year.

Materials and Methods
The present investigation was carried out during the year 2015-2016 at K.R.C. College of Horticulture, Arabhavi in Belgaum district of Karnataka. The experiment was laid in Factorial completely randomized design along with six treatments comprised of different seed treatments viz., T_1- Poly bag (300 gauges thick), T_2- Poly bag + Charcoal powder,

T_3- Poly bag + Carbendazim, T_4- Poly bag + Saw dust, T_5- Poly bag + *Trichoderma harzianum* and T_6- Control (Paper bag) with two factors and three replications. Each replication has 10 seeds (Number of seeds per treatment- 30). Dried and treated jamun seeds were packed in 300 gauge thick poly bags and paper bags (control) and stored in three environment conditions viz deep freeze at 20^0C, refrigerated at 5^0C and at room temperature. 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. Observations were recorded in respect of zero, 15, 30, 45, 60, 75 and 90 days after extraction respectively. The data for germination vigour index and growth parameters like seedling height and number of leaves were also recorded. Seedling height was recorded at monthly intervals and was measured from a marked point just above the crown region up to the tip and was expressed in centimetres. Number of leaves on the seedlings were counted and recorded at monthly intervals. Fresh weight of two month old shoot after separating from the root were recorded by weighing on weighing balance and expressed in grams. Fresh weight of two month old root after separating from the shoot were recorded by weighing on weighing balance and expressed in grams. Fresh weight of two month old shoot after separating roots from the seedling and also the roots of the seedling were carefully separated from the seedling and the samples were kept in hot air oven for recording dry weight of seedlings. The samples were dried at 60 degree Celsius to attain constant weight and dry weight of shoots and roots was recorded and expressed as grams. Vigour index I of the seedling was calculated by multiplying seedling height with germination percentage and expressed in terms of centimetres. Vigour index-II of the seedling was calculated by multiplying dry weight of the seedling with germination percentage expressed in terms of grams.

Germination vigour index (GVI) was computed by using the formule:

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

Where x1, x2, x3 ……, xn are the number of seeds germinated on d1, d2, d3,….,dn days taken for germination respectively.

Results and Discussions

Germination vigour index

Zero days after extraction (DAE)

The perusal of the data on germination index for zero DAE as influenced by different treatments and storage conditions are presented in Table 1. The data indicates that, there were significant differences between the different treatments, irrespective of storage conditions. Germination index ranged from (2.61 to 2.13). Sowing seeds of control gave maximum germination index (2.61) and significantly minimum germination index was observed when seeds were treated with Carbendazim and saw dust (2.13 and 2.13 respectively). There were significant differences between the storage conditions, irrespective of treatments. Significantly maximum germination index was observed when seeds were sown from ambient condition (3.53) whereas, seeds sown from refrigerated recorded minimum germination index (3.17). The interaction effects between the different treatments and storage conditions were found to be significant. Seeds of control from refrigerated conditions gave maximum germination index 0.43 (3.79) and minimum germination index was recorded when seeds were treated with Carbendazim from refrigerated conditions 0.40 (2.55).

15 days after extraction (DAE)

The perusal of the data on germination index for 15 DAE as influenced by different treatments and storage conditions are presented in Table 1. The data indicates that, there were significant differences between the different treatments, irrespective of storage conditions. Germination index ranged from (2.31 to 1.57). Sowing seeds of polybag gave maximum germination index (2.31) and significantly minimum germination index was observed in control (1.57). There were significant differences between the storage conditions, irrespective of treatments. Significantly maximum germination index was observed when seeds were sown from refrigerated condition (3.34) whereas, seed sown from ambient conditions recorded minimum germination index (2.26). The interaction effects between the different treatments and storage conditions were found to be significant. Seeds treated with Carbendazim from refrigerated conditions gave maximum germination index 0.39 (3.62) and minimum germination index was recorded in control from ambient conditions 0.04 (1.20).

30 days after extraction (DAE)

The perusal of the data on germination index for 30 DAE as influenced by different treatments and storage conditions are presented in Table 1. The data indicates that, there were significant differences between the different treatments, irrespective of storage conditions. Germination index ranged from (1.69 to 0.89). Sowing seeds of poly bag gave maximum germination index (1.69) and significantly minimum germination index was observed when seeds were treated with saw dust (0.89). There were significant differences between the storage conditions, irrespective of treatments. Significantly maximum germination index was observed when seeds were sown from refrigerated condition (2.51), whereas seed sown from ambient conditions recorded minimum germination index (0.64). The interaction effects between the different treatments and storage conditions were found to be significant. Seeds of control from refrigerated conditions gave maximum germination index 0.16 (3.62) and minimum germination index was recorded when seeds were treated with saw dust from refrigerated conditions 0.13 (2.09).

45 days after extraction (DAE)

The perusal of the data on germination index for 45 DAE as influenced by different treatments and storage conditions are presented in Table 1. The data indicates that, there were significant differences between the different treatments, irrespective of storage conditions. Germination index ranged from (2.10 to 0.99). Sowing seeds of poly bag gave maximum germination index (2.10) and significantly minimum germination index was observed in control (0.99). There were significant differences between the storage conditions, irrespective of treatments. Significantly maximum germination index was observed when seeds were sown from refrigerated condition (3.08) whereas, seed sown from ambient conditions recorded minimum germination index (0.69). The interaction effects between the different treatments and storage conditions were found to be

significant. Seeds treated with *Trichoderma harzianum* from refrigerated conditions gave maximum germination index 0.35 (3.41) and significantly minimum germination index was recorded in control from refrigerated conditions 0.17 (2.39).

60 days after extraction (DAE)

The perusal of the data on germination index for 60 DAE as influenced by different treatments and storage conditions are presented in Table 2. The data indicates that, there were significant differences between the different treatments, irrespective of storage conditions. Germination index ranged from (1.82 to 0.79). Sowing seeds of poly bag gave maximum germination index (1.82) and minimum germination index was observed in saw dust treated seeds (0.79). There were significant differences between the storage conditions, irrespective of treatments. Significantly maximum germination index was observed when seeds were sown from refrigerated condition (2.67) whereas, seed sown from ambient conditions recorded minimum germination index (0.65). The interaction effects between the different treatments and storage conditions were found to be significant. Seeds treated with charcoal powder from refrigerated conditions gave maximum germination index 0.30 (3.20) and minimum germination index was recorded in saw dust treated seeds from refrigerated conditions 0.10 (1.80).

75 days after extraction (DAE)

The perusal of the data on germination index for 75 DAE as influenced by different treatments and storage conditions are presented in Table 2. The data indicates that, there were significant differences between the different treatments, irrespective of storage conditions. Germination index ranged from (1.18 to 0.72). Sowing of seeds treated with charcoal powder gave maximum germination index (1.18) and minimum germination index was observed in poly bag (0.72). There were significant differences between the storage conditions, irrespective of treatments. Significantly maximum germination index was observed when seeds were sown from refrigerated condition (2.52). The interaction effects between the different treatments and storage conditions were found to be significant. Seeds treated with Carbendazim from refrigerated conditions gave maximum germination index 0.28 (3.05) and minimum germination index was recorded in poly bag seeds from refrigerated conditions 0.08 (1.59).

90 days after extraction (DAE)

The perusal of the data on germination index for 90 DAE as influenced by different treatments and storage conditions are presented in Table 2. The data indicates that, there were significant differences between the different treatments, irrespective of storage conditions. Germination index ranged from (1.28 to 0.60). Sowing of seeds treated with charcoal powder gave maximum germination index (1.28) and minimum germination index was observed in control (0.60). There were significant differences between the storage conditions, irrespective of treatments. Significantly maximum germination index was observed when seeds were sown from refrigerated condition (2.58). The interaction effects between the different treatments and storage conditions were found to be significant. Seeds treated with charcoal powder from refrigerated conditions gave maximum germination index 0.35 (3.24) and minimum germination index was recorded in control from refrigerated conditions 0.05 (1.24).

Growth characters

Seedling height

Data pertaining to seedling height as influenced by different treatments and storage conditions are presented in Table 3. The perusal of the data indicates that, the influence of different treatments, irrespective of storage conditions were found to be significant. At 60 days after extraction (DAE) seeds in polybag recorded significantly higher seedling height (14.00 cm) and lower seedling height was recorded in control *i.e.* untreated seeds (6.67 cm). At 75 (DAE), seeds in polybag recorded significantly maximum seedling height (8.76 cm), which was statistically on par with seeds treated with *Trichoderma* and charcoal powder (8.69 cm and 8.64 cm, respectively) and minimum seedling height was recorded with seeds treated with saw dust (8.30 cm). There were significant differences between the storage conditions, irrespective of treatments. Sowing of seeds from refrigerated recorded highest seedling height (21.27 cm) compared to that of seeds sown from ambient conditions (3.62 cm) at 60 (DAE). Sowing of seeds from refrigerated recorded highest seedling height (25.04 cm) at 75 DAE compared to that of ambient conditions. The interaction effects between the different treatments and storage conditions were found to be significant. Sowing of seeds treated with charcoal powder from refrigerated conditions resulted in maximum seedling height at 60 DAE 14.81 (22.63 cm) and poly bag 18.83 (25.70 cm) at 75 DAE. Whereas minimum seedling height was recorded in control from refrigerated conditions (19.46 cm) at 60 DAE and at 75 DAE the seeds treated with saw dust recorded least seedling height from refrigerated conditions (24.33 cm). Data pertaining to number of leaves as influenced by different treatments and storage conditions are presented in Table 4. The perusal of the data indicates that, the influence of different treatments, irrespective of storage conditions were found to be significant. At 60 days after extraction (DAE) poly bag recorded significantly higher number of leaves (12.86). Lower number of leaves was recorded in control *i.e.* untreated seeds (6.53) and at 75 (DAE) seeds treated with charcoal powder recorded significantly maximum number of leaves (7.72) which was statistically on par with seeds treated with *Trichoderma* and Carbendazim (7.67 and 7.67, respectively). Minimum number of leaves was recorded when seeds were treated with saw dust (7.55). There were significant differences between the storage conditions, irrespective of treatments. Sowing of seeds from refrigerated recorded highest number of leaves (19.88) compared to that of seeds sown from ambient conditions (3.43) at 60 (DAE). Sowing of seeds from refrigerated recorded highest number of leaves (22.36) at 75 DAE compared to that of other ambient conditions. The interaction effects between the different treatments and storage conditions were found to be significant. Sowing of seeds treated with Carbendazim 12.58 (20.77) followed by seeds treated with charcoal powder 12.10 (20.34) from refrigerated conditions resulted in maximum number of leaves at 60 DAE and seeds treated with charcoal powder 14.77 (22.59) at 75 DAE. Minimum number of leaves was recorded in control from refrigerated conditions (19.03) at 60 DAE and at 75 DAE the seeds treated with saw dust recorded minimum number of leaves from refrigerated conditions 14.13 (22.08).

Table 1: Effect of different treatments and storage conditions on germination vigour index

Treatments	Zero days after storage				15 days after storage				30 days after storage				45 days after storage			
	Deep freeze	Refrigerated	Ambient	Mean	Deep freeze	Refrigerated	Ambient	Mean	Deep freeze	Refrigerated	Ambient	Mean	Deep freeze	Refrigerated	Ambient	Mean
T_1	0.000 (0.28)	0.29 (3.10)	0.34 (3.37)	2.25	0.00 (0.28)	0.32 (3.23)	0.36 (3.43)	2.31	0.00 (0.28)	0.17 (2.37)	0.17 (2.42)	1.69	0.00 (0.28)	0.33 (3.31)	0.16 (2.71)	2.10
T_2	0.000 (0.28)	0.34 (3.40)	0.38 (3.56)	2.41	0.00 (0.28)	0.28 (3.06)	0.24 (2.83)	2.06	0.00 (0.28)	0.15 (2.27)	0.00 (0.28)	0.94	0.00 (0.28)	0.32 (3.30)	0.00 (0.28)	1.29
T_3	0.00 (0.28)	0.40 (2.55)	0.37 (3.54)	2.13	0.00 (0.28)	0.39 (3.62)	0.08 (1.72)	1.87	0.00 (0.28)	0.16 (2.33)	0.00 (0.28)	0.96	0.00 (0.28)	0.29 (3.10)	0.00 (0.28)	1.22
T_4	0.00 (0.28)	0.22 (2.71)	0.35 (3.39)	2.13	0.00 (0.28)	0.35 (3.44)	0.13 (1.99)	1.90	0.00 (0.28)	0.13 (2.09)	0.00 (0.28)	0.89	0.00 (0.28)	0.26 (2.97)	0.00 (0.28)	1.17
T_5	0.00 (0.28)	0.36 (3.46)	0.38 (3.55)	2.43	0.00 (0.28)	0.36 (3.45)	0.17 (2.40)	2.06	0.00 (0.28)	0.16 (2.34)	0.00 (0.28)	0.97	0.00 (0.28)	0.35 (3.41)	0.00 (0.28)	1.33
T_6	0.00 (0.28)	0.43 (3.79)	0.42 (3.76)	2.61	0.00 (0.28)	0.31 (3.22)	0.04 (1.20)	1.57	0.00 (0.28)	0.16 (3.62)	0.00 (0.28)	1.39	0.00 (0.28)	0.17 (2.39)	0.00 (0.28)	0.99
Mean	0.28	3.17	3.53		0.28	3.34	2.26		0.28	2.51	0.64		0.28	3.08	0.69	
For comparing the means		S.Em±	CD@1%	-		S.Em±	CD@1%	-		S.Em±	CD@1%	-		S.Em±	CD@1%	-
Conditions (C)		0.12	0.48			0.05	0.21			0.12	0.49			0.04	0.18	
Treatments (T)		0.17	0.68			0.07	0.30			0.17	0.69			0.06	0.25	
Interaction (CxT)		0.31	1.19			0.13	0.52			0.31	1.20			0.11	0.44	

Treatment details

Figure in parentheses are arc sign transformed values.

T_1- Poly bag (300 gauge thick) T_2- Poly bag + Charcoal powder T_3- Poly bag + Carbendazim

T_4- Poly bag + Saw dust T_5- Poly bag + *Trichoderma harzianum* T_6- Control (Paper bag)

Table 2: Effect of different treatments and storage conditions on germination vigour index

Treatments	60 days after storage				75 days after storage				90 days after storage			
	Deep freeze	Refrigerated	Ambient	Mean	Deep freeze	Refrigerated	Ambient	Mean	Deep freeze	Refrigerated	Ambient	Mean
T_1	0.00 (0.28)	0.23 (2.77)	0.18 (2.41)	1.82	0.00 (0.28)	0.08 (1.59)	0.00 (0.28)	0.72	0.00 (0.28)	0.27 (2.97)	0.00 (0.28)	1.19
T_2	0.00 (0.28)	0.30 (3.20)	0.00 (0.28)	1.26	0.00 (0.28)	0.27 (2.96)	0.00 (0.28)	1.18	0.00 (0.28)	0.35 (3.24)	0.00 (0.28)	1.28
T_3	0.00 (0.28)	0.29 (3.11)	0.00 (0.28)	1.23	0.00 (0.28)	0.28 (3.05)	0.00 (0.28)	1.21	0.00 (0.28)	0.22 (2.57)	0.00 (0.28)	1.04
T_4	0.00 (0.28)	0.10 (1.80)	0.00 (0.28)	0.79	0.00 (0.28)	0.10 (1.86)	0.00 (0.28)	0.81	0.00 (0.28)	0.19 (2.48)	0.00 (0.28)	1.02
T_5	0.00 (0.28)	0.28 (3.04)	0.00 (0.28)	1.21	0.00 (0.28)	0.24 (2.80)	0.00 (0.28)	1.12	0.00 (0.28)	0.26 (2.93)	0.00 (0.28)	1.17
T_6	0.00 (0.28)	0.14 (2.14)	0.00 (0.28)	0.91	0.00 (0.28)	0.25 (2.89)	0.00 (0.28)	1.16	0.00 (0.28)	0.05 (1.24)	0.00 (0.28)	0.60
Mean	0.28	2.67	0.65		0.28	2.52	0.28		0.28	2.58	0.28	
For comparing the means		S.Em±	CD@1%	-		S.Em±	CD@1%	-		S.Em±	CD@1%	-
Conditions (C)		0.06	0.26			0.04	0.18			0.05	0.18	
Treatments (T)		0.09	0.37			0.06	0.26			0.07	0.26	
Interaction (CxT)		0.16	0.65			0.11	0.45			0.12	0.45	

Treatment details

Figure in parentheses are arc sign transformed values.

T_1- Poly bag (300 gauge thick) T_2- Poly bag + Charcoal powder T_3- Poly bag + Carbendazim

T_4- Poly bag + Saw dust T_5- Poly bag + *Trichoderma harzianum* T_6- Control (Paper bag)

Table 3: Effect of different treatments and storage conditions on height of two months old jamun seedling

Treatments	Seedling height (cm)							
	60 days after extraction				75 days after extraction			
	Deep freeze	Refrigerated	Ambient	Mean	Deep freeze	Refrigerated	Ambient	Mean
T_1 (Polybag)	0.00 (0.28)	13.3 (21.38)	12.11 (20.33)	14.00	0.00 (0.28)	18.83 (25.70)	0.00 (0.28)	8.76
T_2 (Polybag + Charcoal powder)	0.00 (0.28)	14.81 (22.63)	0.00 (0.28)	7.73	0.00 (0.28)	18.38 (25.34)	0.00 (0.28)	8.64
T_3 (Polybag + Carbendazim)	0.00 (0.28)	14.17 (22.11)	0.00 (0.28)	7.56	0.00 (0.28)	17.16 (24.47)	0.00 (0.28)	8.34
T_4 (Polybag + Saw dust)	0.00 (0.28)	12.61 (20.78)	0.00 (0.28)	7.11	0.00 (0.28)	17.02 (24.33)	0.00 (0.28)	8.30
T_5 (Polybag + *Trichoderma harzianum*)	0.00 (0.28)	13.15 (21.25)	0.00 (0.28)	7.27	0.00 (0.28)	18.63 (25.51)	0.00 (0.28)	8.69
T_6 (Paper bag)	0.00 (0.28)	11.11 (19.46)	0.00 (0.28)	6.67	0.00 (0.28)	17.71 (24.88)	0.00 (0.28)	8.48
Mean	0.28	21.27	3.62		0.28	25.04	0.28	
For comparing the means		S.Em±	CD@1%	-		S.Em±	CD@1%	-
Conditions (C)		0.13	0.52			0.21	0.84	
Treatments (T)		0.19	0.73			0.30	1.19	
Interaction (CxT)		0.33	1.28			0.53	2.07	

Table 4: Effect of different treatments and storage conditions on number of leaves of two months old jamun seedling

Treatments	Number of leaves per seedling							
	60 days after extraction				75 days after extraction			
	Deep freeze	Refrigerated	Ambient	Mean	Deep freeze	Refrigerated	Ambient	Mean
T_1(Polybag)	0.00 (0.28)	10.75 (19.13)	11.05 (19.16)	12.86	0.00 (0.28)	14.41 (22.31)	0.00 (0.28)	7.62
T_2(Polybag + Charcoal powder)	0.00 (0.28)	12.10 (20.34)	0.00 (0.28)	6.97	0.00 (0.28)	14.77 (22.59)	0.00 (0.28)	7.72
T_3(Polybag +Carbendazim)	0.00 (0.28)	12.58 (20.77)	0.00 (0.28)	7.11	0.00 (0.28)	14.58 (22.44)	0.00 (0.28)	7.67
T_4 (Polybag + Saw dust)	0.00 (0.28)	11.91 (20.19)	0.00 (0.28)	6.92	0.00 (0.28)	14.13 (22.08)	0.00 (0.28)	7.55
T_5 (Polybag + *Trichoderma harzianum*)	0.00 (0.28)	11.50 (19.82)	0.00 (0.28)	6.79	0.00 (0.28)	14.61 (22.46)	0.00 (0.28)	7.67
T_6 (Paper bag)	0.00 (0.28)	10.64 (19.03)	0.00 (0.28)	6.53	0.00 (0.28)	14.41 (22.30)	0.00 (0.28)	7.62
Mean	0.28	19.88	3.43		0.28	22.36	0.28	
For comparing the means		S.Em±	CD@1%	-		S.Em±	CD@1%	-
Conditions (C)		0.13	0.50			0.09	0.36	
Treatments (T)		0.18	0.71			0.13	0.51	
Interaction (CxT)		0.31	1.23			0.22	0.88	

Growth characters of two months old jamun seedling after 60 days of extraction (DAE)

Fresh weight

Data pertaining to fresh weight from refrigerated two months ld jamun seedling are presented in Table 5. The close study of the data indicates the influence of different treatments on fresh weight was significant, recording maximum fresh weight in Carbendazim (3.48 g) whereas, minimum fresh weight was recorded with seeds of polybag (1.96 g).

Dry weight

The data pertaining to dry weight from refrigerated two month old jamun seedling are presented in Table 5. The data revealed significant differences in dry weight of the seedling. Significantly maximum dry weight of the seedling was recorded in charcoal (0.94 g) and minimum dry weight of seedling was recorded when seeds were treated with polybag (0.47 g).

Vigour index I

The data pertaining to vigour index-I from refrigerated two month old jamun seedling are presented in Table 5. The perusal of the data revealed significant differences between different treatments. Significantly maximum vigour index was recorded in seed treated with charcoal powder (1286.66) and minimum dry weight of seedling was recorded in control (473.66). Vigour index I ranged from 473.66 to 1286.66.

Vigour index II

The data pertaining to vigour index-II from refrigerated two month old jamun seedling are presented in Table 5. The perusal of the data revealed significant differences between different treatments. Vigour index II ranged from 28.01 to 81.11.

Growth characters of two months old jamun seedling after 75 days of extraction (DAE)

Fresh weight

Data pertaining to fresh weight from refrigerated two months old jamun seedling are presented in Table 6. The close study of the data indicates the influence of different treatments on fresh weight was non-significant, recording maximum fresh weight in saw dust (3.26 g) whereas, minimum fresh weight was recorded when seeds were treated with charcoal powder (2.34 g).

Dry weight

The data pertaining to dry weight from refrigerated two months old jamun seedling are presented in Table 6. The data revealed no significant differences in dry weight of the seedling. Maximum dry weight of the seedling was recorded when seeds were treated with saw dust (1.04 g), followed by seeds treated with Carbendazim (0.91 g). Minimum dry weight of seedling was recorded when seeds were treated with charcoal powder (0.59 g).

Vigour index I

The data pertaining to vigour index-I from refrigerated two months old jamun seedling are presented in Table 6. The perusal of the data revealed significant differences between different treatments. Vigour index I ranged from 540.83 to 1512.31.

Vigour index II

The data pertaining to vigour index-II from refrigerated two months old jamun seedling are presented in Table 6. The perusal of the data revealed significant differences between different treatments. Significant maximum vigour index recorded in seed treated with Charcoal powder (81.11) followed by seed treated with Carbendazim (67.40) and minimum vigour index was recorded in seed treated with saw dust (38.13). Vigour index II ranged from 38.13 to 75.87.

Seed development occurs in three physiological stages. These include histo-differentiation, cell differentiation and maturation drying. In histo-differentiation stage, differentiation of embryo and endosperm occurs due to cell division. The embryo reaches the beginning of the cotyledon stage of development. In cell expansion stage, accumulation of complex storage products including carbohydrates, proteins, fats, oils and other biochemical substance take place into the storage organs of the seed (*i.e.*, cotyledons, endosperm, nucellus, etc). Such substances provide essential energy substrates to ensure survival of the germinating seedlings. In case of recalcitrant seeds like jamun, passion fruit and citrus 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) [7].

The seeds of *Syzygium* spp. are highly recalcitrant which are viable only for few days after seed extraction. So to extend the storage life of recalcitrant jamun seeds a study was conducted by using different moisture holding media *i.e.*, sawdust and charcoal. To get the higher germination of seeds disease preventive measures were taken with *Trichoderma harzianum* and Carbendazim. The most common and important seed treatments are the chemical and physical treatments against seed-borne pathogens (Bennett *et al.*, 1992) [2]. Chemical seed treatments can be applied as powders, liquids, slurries or incorporated into film coating (Jeffs and Tuppen, 1986) [8]. Several studies have been shown that disease prevention with biological agents such as fungal strains (*Trichoderma harzianum*) to be as effective as chemical treatment with fungicides (Callan *et al.*, 1990 and Taylor and Hartman, 1990) [4]. These bio-control agents are known to provide protection to seeds by the production of antibiotic substances, competing with pathogens for space and nutrients and with parasitism (Hartman and Nelson, 1994) [6]. It was observed that the germination index decreased as the storage days increased, irrespective of the storage conditions. Germination index was maximum in zero days of extraction, whereas minimum was observed in 30 days after extraction. With respect to treatments, polythene bag and *Trichoderma harzianum* recorded highest germination index, whereas in 75 DAE and 90 DAE charcoal powder treated seeds also recorded high germination index. While least per cent germination index was recorded in the seeds treated with saw dust kept in poly bag. 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, Yalleshkumar *et al.*, 2007) [3] and hence higher vigour index (Table 1 & 2). The increased germination index was due to increased germination. The height of seedling and number of leaves were recorded monthly interval were significantly influenced by different treatments. The increased height in polythene bag and *Trichoderma harzianum* may be due to preventing desiccation while storing in polythene bag and the fungi enhances tolerance to abiotic stresses during plant growth in part due to improved root growth, improvement in water-holding capacity of plants or enhancement in nutrient uptake (Table 3 & 4). These results are in agreement with the results of Anandalakshmi *et al.* (2005) [1] and Mastouri *et al.* (2010) [9].

The highest dry weight of the seedling (Table 6) was recorded in the seeds treated with saw dust (1.04) and *Trichoderma harzianum* (0.87) treated seeds when compared to control (1.00). The increased fresh and dry weight of seedling may be due to the enhanced root and shoot length. The significantly higher number of roots and longer length of root obtained that there were enough macro pores spaces within the germination media that allows roots growth, since there was no compaction of the media that will restrict the growth of roots (Yazdani *et al.*, 2011 and Ndor *et al.*, 2012) [12]. Vigour index-I which was a product of per cent germination and seedling height (Table 5) was found to be significantly highest in seeds receiving in seed treated with charcoal powder (1286.66) followed by seeds treated with Carbendazim (1086.58) and *Trichoderma harzianum* (1095.84). This might be due to increase germination and seedling height which have contributed to higher vigour index-I. Vigour index-II which was a product of per cent germination and dry weight of the seedling (Table 5) was found to be maximum in seeds dressing with charcoal powder (81.11) followed by Carbendazim and *Trichoderma* treated seeds (67.40 and 63.46 resp.).The reason might be attributed to the increased dry matter production in the concerned treatments (Rajamanickam *et al.*, 2004) [10] Dhillon and Sharma (1986) [5] observed a decline in the endogenous levels of gibberellins in litchi seeds and suggested that this decline was the limiting factor for the maintenance of viability and/or germination of these seeds. These factors may be the reason in reduction in germination.

Table 5: Effect of different treatments on fresh weight and dry weight of two months old jamun seedling of 60 days after extraction (DAE) under refrigerated conditions

Treatments	Fresh weight (g)	Dry weight (g)	Vigour index I	Vigour index II
T_1 (Polybag)	1.96	0.47	1081.10	38.69
T_2 (Polybag + Charcoal powder)	3.11	0.94	1286.66	81.11
T_3(Polybag + Carbendazim)	3.48	0.87	1086.58	67.40
T_4 (Polybag + Saw dust)	2.47	0.65	525.20	28.01
T_5 (Polybag + *Trichoderma harzianum*)	3.29	0.75	1095.84	63.46
T_6 (Paper bag)	3.18	0.89	473.66	34.84
SEm ±	0.24	0.09	155.08	10.92
CD @ 5%	0.76	0.27	477.90	33.66

Table 6: Effect of different treatments on fresh weight and dry weight of two months old jamun seedling of 75 days after extraction (DAE) under refrigerated conditions

Treatments	Fresh weight (g)	Dry weight (g)	Vigour index I	Vigour index II
T_1 (Polybag)	2.66	0.68	540.83	38.85
T_2 (Polybag + Charcoal powder)	2.34	0.59	1279.36	43.37
T_3(Polybag + Carbendazim)	2.99	0.91	1435.30	75.87
T_4 (Polybag + Saw dust)	3.26	1.04	672.73	38.13
T_5 (Polybag + *Trichoderma harzianum*)	2.50	0.87	1163.31	60.44
T_6 (Paper bag)	2.59	0.84	1512.31	70.16
SEm ±	0.30	0.09	185.43	8.46
CD @ 5%	NS	NS	571.42	26.08

NS: Non significant

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