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Effect of Pre-sowing Treatments on Vegetative Growth and Production of Graftable Rootstocks in Mango

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Abstract

The present investigations "Studies on the effect of pre-sowing treatment and time of wedge grafting on production of saleable grafts in mango" were carried out in the nursery block of Fruit Science Department. The study was conducted using wild mangoes seeds. The seeds were divided in two equal halves, one half of seeds were sown with intact seed coat (K_1) while, in other half the mango kernels were extracted (K_2), both type of seeds were then soaked in 6 different chemicals of varying concentrations *viz*. C_1- KNO_3 @ 0.5%, C_2- KNO_3 @ 1%, C_3- KNO_3 @ 1.5%, C_4- BA @ 50 ppm, C_5- BA @ 100 ppm, C_6- GA_3 @ 100 ppm, C_7- GA_3 @ 200 ppm, C_8- beejaaumrit @ 2%, C_9- beejaaumrit @ 3%, C_{10}- panchgavya @ 2%, C_{11}- panchgavya @ 3% for 12 hours and C_{12}- Control. The germination and vegetative parameters were observed. The results of study revealed that the extracted kernels pre-soaked with GA_3 @ 100 ppm produced earliest germination, 50 % germination, high rate of germination, germination percentage, number of leaves, maximum leaf area, highest seedling vigour index, while, on pre-soaking extracted kernel with KNO_3 @ 0.5% produced maximum seedling diameter. The Seedling raised from extracted kernels pre-soaked in KNO_3 @ 0.5% (C_1K_2) attained graftable diameter within 210 days of sowing. The present investigation was conducted during 2019-2020 at the nursery block of College of Horticulture and Forestry, Neri Hamirpur (H.P) to study the effect of pre-sowing treatments on germination, growth and production of graft-able seedlings.

Keywords: Pre-sowing treatments, seedling emergence, mango

1. Introduction

King of fruits, "mango" is one of the most favoured fruit of every Indian household (Tharanathan et al., 2006; Paulmurugan, 2021) Origin can be traced back to Indo-Burma region belonging to anacardiaceae family having chromosome number 2n= 40 (Singh et al., 2016). Being perennial it is slow growing and take lot of time to bear fruits, however, taking into consideration the growing demand for the mango cultivation the more amount of planting material is required. Mango being a cross pollinated crop represent a wide variation in the plants propagated through seeds (Schnell et al., 2006). So, commercial mango is propagated through vegetative propagation. Rootstock is the base of successful graft union as it influences the vigor, life of tree, yield and its quality. It becomes mandatory to have healthy and strong rootstock for successfully grafted

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plants. In the last 20 years, India has witnessed an increase in area under mango cultivation as the demand for fresh fruits has taken a rise in domestic as well as global market. Being highly cross-pollinated in nature there is humongous variation in plants even if they are grown from the fruits of the same plant. Thus, it becomes highly necessary to preserve and maintain the desirable characters of each variety by propagation through vegetative methods.

Mango seed being recalcitrant (Berjak and Pammenter, 2004; Umarani et al., 2015) (12-50% germination after a month) and its availability is being restricted to drier part (May -July) of the year makes it equally important for the grower to utilize that time for growing stock. However, on sowing of mangos stones it was found that they have lower germination and survival rate. On using the pre-soaked mango seeds in GA_3 (gibberellic acid) and KNO_3 (Potassium Nitrate) exhibited magnificent effect on germination and vegetative growth of the seedlings so geminated. The hard seed coat present on the mango kernels act as a barrier in germination and is the major reason for delay in the germination. Rapid germination leads to quick establishment of the seedling which prevents the damage to seed on its critical phase of growth (Harris et al., 1999). Many other factors such as the method of sowing and orientation of seed at the time of sowingare also responsible for the growth of seedlings (Ross and Harper, 1972). Sowing of seeds with stalk end up position leads to placement of seeds in most appropriate position resulting in early germination by stimulating metabolic process which initiate the rapid radical emergence (Bewley and Black, 2012; Rajjou et al., 2012). Major key factor having crucial impact on viability of mango stones is the lower content of moisture in mango seeds as the mango ages it can causes disruption of normal metabolic cycle of seed germination and hence, slows the germination process of seed (Patel et al., 2016a; Kozlowski and Pallardy, 1997). To access the effect of removal of seed coat for extraction of kernels and soaking of seeds in chemical with objective of early germination, improving germination percentage for the rapid production of healthy root stocks to fulfill the market demand and to know the best set of practices in order to produce the high quality mango planting material. This study is focused at to gather information regarding the mango seed germination and development of seedling in order to facilitate the production of rootstocks for a successful orchard establishment.

2. Materials and Methods

The present investigation was conducted during 2019–2020 at the nursery block of College of Horticulture and Forestry, Neri Hamirpur (H.P) the experiment was carried out using Randomized block design having 24 treatments combination having four replications. The 24 different combinations were performed by the use of 2 type of seeds (Intact stones and Extracted mango kernels) and 12 treatments for pre-soaking with chemicals namely, GA_3 @ 100 ppm and 200 ppm, KNO_3 @ 0.5%, 1% and 1.5%, benzyl adenine @ 50 ppm and 100 ppm, beejaaumrit @ 2% and 3 %, panchgavya @ 2% and 3% and control. Wild mango fruits were collected from the nearby villages and stones were extracted. The seeds were washed thoroughly to remove pulp adhering to the stones. Whole lot of mango stones were immersed in water bucket and the stones which settled at bottom were selected for the experiment further while, the stones which were floating were rejected. The mango stone were shade dried. Then the stones were divided in 2 equal number one half was use with the intact seed coat while in other half was used for extracting kernel. After that the intact stones and extracted kernels were soaked simultaneously in the abovementioned chemicals for the time period of 12 hours. The 24 treatments were replicated thrice having 100 seeds per replication and were sown in nursery beds.

Germination parameters were recorded and calculated:

Germination percentage=(number of seeds germinated)/(Total number of seeds sown)×100

Rate of germination= (Number of Seed Germinated till 30 Days of sowing)/(Total Number of Seeds Sown)×100

The seedling vigour index on growth basis was calculated using the seedling height multiplied by germination percentage.

Percent survival=(Number of seedlings survived)/(Total number ofseedlings germinated)×100

Observations were recorded from all seedlings and average value was calculated and was represented. The initiation of germination was found within 8 days after sowing of extracted kernels while, sown stones required time of 18 days. Observation related to germination of seedling were recorded on daily basis while, those pertaining to vegetative parameters were recorded after interval of 30 days. The data so recorded was analyzed using the statistically procedure used by Gomez and Gomez (1984).

3. Results and Discussion

Germination and growth of mango seedlings was found significantly influenced by the use of pre-sowing treatments given to mango seeds.

3.1. Effect on germination

The data (Table 1) revealed that on soaking extracted kernel with GA_3 @ 100 ppm was found best to initiate the germination within 8.47 days while 50% germination was completed within the time of 13.65 days. Highest (90.38%) germination percentage and rate of germination (54.00%) was recorded in extracted kernels treated with GA_3 @100 ppm. This difference in germination parameters could be attribute to the presence of a hard seed coat outside the kernel which act as a barrier in uptake of water (Mwaurah et al., *2020*), so the removal outer covering which increase the water absorption and cause hydrolysis of carbohydrate present in cotyledons leading to better germination (Kaur et al., 1998; Paleg 1960; Sanchez

Table 1: Effect of pre-soaking treatments on germination parameters

Chemicals	Days for initiation of germination			Days for 50% germination		
	K_1 (Intact mango stone)	K_2 (Extracted Kernel)	Mean	K_1 (Intact mango stone)	K_2 (Extracted kernel)	Mean
C_1 (KNO_3 @ 0.5%)	30.72	9.87	19.63	42.65	13.72	28.18
C_2 (KNO_3 @ 1%)	34.75	9.52	22.14	46.93	16.17	31.55
C_3 (KNO_3 @ 1.5%)	35.58	9.46	22.52	41.65	16.00	28.83
C_4 (BA @ 50 ppm)	32.48	9.97	21.23	49.45	15.33	32.39
C_5 (BA @ 100 ppm)	38.23	12.81	25.52	48.56	17.60	33.08
C_6 (GA_3 @ 100 ppm)	22.20	8.47	15.33	36.76	13.65	25.20
C_7 (GA_3 @ 200 ppm)	25.93	8.54	17.90	39.64	15.45	27.54
C_8 (Beejaumrit @ 2%)	40.85	17.67	29.26	51.23	23.48	37.36
C_9 (Beejaumrit @ 3%)	41.94	16.01	28.98	56.34	23.75	40.05
C_{10} (Panchgavya @ 2%)	34.15	13.54	23.84	45.76	17.91	31.84
C_{11} (Panchgavya@3%)	35.37	11.47	23.42	43.21	14.98	29.09
C_{12} (Control)	42.27	22.66	32.47	58.17	35.67	46.92
Mean	34.54	12.49		46.70	18.64	
SEm±	C 0.49 K 1.20 C×K 1.70			C 0.38 K 0.92 C×K 1.30		
CD (p=0.05)	C 0.95 K 2.31 C× K 3.31			C 1.76 K 4.20 C×K NS		

Chemicals	Germination percentage (%)			Rate of germination (%)		
	K_1 (Intact mango stone)	K_2 (Extracted Kernel)	Mean	K_1 (Intact mango stone)	K_2 (Extracted kernel)	Mean
C_1 (KNO_3 @ 0.5%)	61.33 (51.59)	88.74 (70.40)	75.04 (60.99)	22.00 (27.95)	43.33 (41.09)	32.67 (34.52)
C_2 (KNO_3 @ 1%)	60.00 (50.78)	72.23 (58.19)	66.12 (54.49)	20.67 (26.95)	42.00 (40.37)	31.33 (33.66)
C_3 (KNO_3 @ 1.5%)	59.33 (50.49)	73.49 (59.09)	66.41 (54.79)	20.67 (26.81)	39.67 (39.02)	30.17 (32.92)
C_4 (BA @ 50 ppm)	55.67 (50.36)	80.67 (63.90)	70.00 (57.13)	14.33 (22.20)	40.33 (39.39)	27.33 (30.80)
C_5 (BA @ 100 ppm)	71.33 (48.26)	76.45 (60.97)	66.06 (54.61)	14.33 (22.20)	35.33 (36.40)	24.83 (29.30)
C_6 (GA_3 @ 100 ppm)	64.67 (57.62)	90.38 (73.34)	80.86 (65.48)	24.00 (29.29)	54.00 (47.33)	39.00 (38.31)
C_7 (GA_3 @ 200 ppm)	56.00 (53.52)	78.88 (57.42)	67.77 (55.47)	24.33 (29.54)	41.67 (40.14)	33.00 (34.84)
C_8 (Beejaumrit @ 2%)	56.00 (48.43)	61.81 (51.92)	58.91 (50.18)	14.33 (22.22)	40.00 (39.21)	27.17 (30.72)
C_9 (Beejaumrit @ 3%)	55.00 (47.86)	67.22 (55.22)	61.11 (51.54)	14.33 (22.14)	36.67 (37.23)	25.50 (29.69)
C_{10} (Panchgavya @ 2%)	57.00 (49.01)	75.71 (60.50)	66.36 (54.76)	17.00 (24.32)	35.33 (36.43)	26.17 (30.37)
C_{11} (Panchgavya@3%)	59.67 (50.57)	71.74 (57.92)	65.70 (54.24)	16.00 (23.32)	30.00 (33.17)	23.00 (28.25)
C_{12} (Control)	47.67 (43.64)	51.21 (45.67)	49.44 (44.66)	10.67 (19.02)	19.67 (26.13)	15.17 (22.58)
Mean	58.92 (50.18)	73.38 (59.54)		17.72 (24.66)	38.17 (37.99)	
SEm±	C 1.07 K 2.62 C×K 3.70			C 0.39 K 0.94 C×K 1.33		
CD (p=0.05)	C 1.76 K 4.32 C×K 6.11			C 1.59 K 6.18 C × K NS		

et al., 1967). GA_3 at lower doses were found responsible for enhancing the enzymatic processes and lead to suppression of inhibitors. The early germination in extracted kernels might be the result of presence of no active barrier in germination which caused the easy absorption of the chemicals and GA_3 caused stimulation of the radical and plumule to initiate germination, 50% germination, germination percentage and rate of germination (Kumar, 2007). The above results were found in conformity with the results of Aatla and Srihari (2013) in mango, and Patel et al. (2016a).

3.2. Vegetative parameters

Maximum diameter and least number of days to obtain maximum seedling girth were observed in seedlings raised from extracted kernels pre-soaked with KNO_3 @ 0.5%. This might be due the initiation of early accumulation of the food material in the seedling tissues which helped in obtaining the maximum seedling diameter. The above results were found in compliance with the reports provided by Aatla and Srihari (2013), Patel et al. (2016b), Kumar et al. (2008), Padma and Reddy (1997) in mango (Table 2).

Whereas, On using extracted kernels pre-soaked in GA_3 @ 100 ppm for sowing in nursery beds and the seedlings so raised were found having maximum seedling height which might be due to the stimulatory action of GA_3 on the axillary and apical meristematic cells causing rapid division and multiplication of the cells (Mauseth, 1976) leading to increase in seedling height also the removal of outer hard seed coat also aids in the better absorption of the chemicals and lead to early activation of amylase enzyme leading to conversion of the starch present in the cotyledons to sugars hence, enhancing the seedling height. However, the influence if GA_3 on the intercalary meristem was also found adding up to increase in the seedling height (Dohono and Walker, 1957; Gupta and Chakrabarty, 2013) which might have resulted in the production of thin stems because the plants were found more oriented toward the vertical growth rather being focused on lateral growth as the KNO_3 @ 0.5% treated seedlings did. Whereas, the other reason for better growth of seedling might be presence of higher number of leaves per plant which leads to production of higher photosynthetic assimilate to be utilized by plant for growth (Loach, 1970) (Table 3 and Figure 1).

Maximum number of leaves per plant might be due to the movement of gibberellins in to shoot apex which increases cell division and cell growth apparently leading to increase in development of young leaves (Salisbury and Ross, 1992) which lead to producing higher number of leaves per plant at much higher rate (Brijwal and Kumar, 2013) in comparison to seedlings under other treatments. The similar results were reported by, Kumar et al. (2008), Shaban (2010), Aatla and Srihari (2013), Sharaf (2016) in Rangpur lime and Choudhari and Chakrawar (1981) in citrus.

Table 2: Effect of pre-soaking treatments on vegetative growth of seedlings

Chemicals	Height			Diameter		
	K_1 (Intact mango stone)	K_2 (Extracted Kernel)	Mean	K_1 (Intact mango stone)	K_2 (Extracted kernel)	Mean
C_1 (KNO_3 @ 0.5%)	26.26	28.28	27.27	7.26	8.24	7.75
C_2 (KNO_3 @ 1%)	26.36	28.57	27.47	5.94	7.22	6.58
C_3 (KNO_3 @ 1.5%)	24.65	29.45	27.05	5.76	7.29	6.53
C_4 (BA @ 50 ppm)	24.37	28.86	26.61	5.87	6.84	6.36
C_5 (BA @ 100 ppm)	25.64	26.99	26.32	6.37	7.25	6.81
C_6 (GA_3 @ 100 ppm)	27.25	39.15	33.20	6.49	7.82	7.15
C_7 (GA_3 @ 200 ppm)	26.97	35.76	31.37	6.14	7.53	6.83
C_8 (Beejaumrit @ 2%)	25.12	26.76	25.94	5.59	6.63	6.11
C_9 (Beejaumrit @ 3%)	24.86	26.63	25.74	5.41	6.53	5.97
C_{10} (Panchgavya @ 2%)	25.32	27.02	26.17	6.29	7.15	6.72
C_{11} (Panchgavya@3%)	24.22	26.69	25.46	5.68	6.57	6.13
C_{12} (Control)	20.40	23.87	22.14	4.89	5.34	5.12
Mean	25.12	29.00		5.97	7.04	
SEm±		C 0.41			C 0.17	
		K 1.00			K 0.42	
		C×K 1.42			C×K 0.59	
CD (p=0.05)		C 0.63			C 0.18	
		K 1.57			K 0.44	
		C × K 2.21			C×K NS	

Table 2: continue...

Chemicals	Number of leaves			Leaf area		
	K_1 (Intact mango stone)	K_2 (Extracted Kernel)	Mean	K_1 (Intact mango stone)	K_2 (Extracted kernel)	Mean
C_1 (KNO_3 @ 0.5%)	8.40	11.65	10.03	78.83	70.86	74.85
C_2 (KNO_3 @ 1%)	9.61	11.56	10.59	82.97	62.81	71.89
C_3 (KNO_3 @ 1.5%)	7.62	10.60	9.11	69.39	84.55	76.97
C_4 (BA @ 50 ppm)	7.66	12.59	10.13	67.56	70.32	68.94
C_5 (BA @ 100 ppm)	7.06	13.00	10.03	63.97	78.97	71.47
C_6 (GA_3 @ 100 ppm)	11.44	13.75	12.60	77.02	91.86	84.44
C_7 (GA_3 @ 200 ppm)	10.08	13.99	12.03	70.85	100.61	85.73
C_8 (Beejaumrit @ 2%)	8.04	12.00	10.02	58.05	70.89	64.47
C_9 (Beejaumrit @ 3%)	9.15	11.01	10.08	65.11	68.26	66.69
C_{10} (Panchgavya @ 2%)	9.57	10.84	10.21	57.77	87.86	72.81
C_{11} (Panchgavya@3%)	8.47	10.08	9.28	59.07	89.93	74.50
C_{12} (Control)	8.10	6.86	7.48	51.04	53.09	52.06
Mean	8.77	11.49		66.80	77.29	
SEm±		C 0.35 K 0.86 C×K 1.73			C 1.42 K 3.48 C×K 4.93	
CD (p=0.05)		C 0.72 K 1.76 C×K 2.48			C 2.55 K 6.24 C×K 8.82	

Table 3: Effect of pre-soaking treatments on growth and survival of seedlings

Chemicals	Seedling vigour index			Survival percentage		
	K_1 (Intact mango stone)	K_2 (Extracted Kernel)	Mean	K_1 (Intact mango stone)	K_2 (Extracted kernel)	Mean
C_1 (KNO_3 @ 0.5%)	1610.8	2605.2	2108.1	65.69 (58.27)	69.31 (60.19)	67.50 (59.23)
C_2 (KNO_3 @ 1%)	1583.7	2063.7	1823.7	68.59 (55.96)	75.21 (59.14)	71.90 (57.55)
C_3 (KNO_3 @ 1.5%)	1467.4	2167.5	1817.5	72.19 (54.22)	72.69 (56.42)	72.44 (55.32)
C_4 (BA @ 50 ppm)	1445.6	2329.2	1887.4	67.34 (55.24)	68.27 (55.79)	67.80 (55.51)
C_5 (BA @ 100 ppm)	1432.7	2064.6	1748.6	60.55 (51.11)	77.31 (61.59)	68.93 (56.35)
C_6 (GA_3 @ 100 ppm)	1925.2	3349.9	2637.4	78.35 (62.27)	82.53 (65.43)	80.44 (63.85)
C_7 (GA_3 @ 200 ppm)	1759.8	2441.7	2100.8	70.65 (57.25)	80.56 (63.89)	75.60 (60.57)
C_8 (Beejaumrit @ 2%)	1327.8	1651.9	1489.9	67.52 (55.31)	69.04 (56.19)	68.28 (55.75)
C_9 (Beejaumrit @ 3%)	1364.6	1792.5	1578.6	63.04 (52.59)	72.12 (58.15)	67.58 (55.37)
C_{10} (Panchgavya @ 2%)	1447.1	2045.2	1746.2	62.96 (52.52)	70.59 (57.19)	66.77 (54.85)
C_{11} (Panchgavya@3%)	1443.6	1909.1	1676.3	69.69 (56.59)	69.30 (56.49)	69.50 (56.54)
C_{12} (Control)	974.4	1221.3	1097.8	47.98 (43.82)	56.38 (48.65)	52.18 (46.24)
Mean	1481.9	2136.8		66.21 (54.60)	71.68 (58.26)	
SEm±		C 44.88; K 109.93 C×K 155.47			C 0.86; K 2.10 C×K 2.97	
CD (p=0.05)		C 81.7; K 200 C×K 282.9			C 2.05; K 5.01 C×K NS	

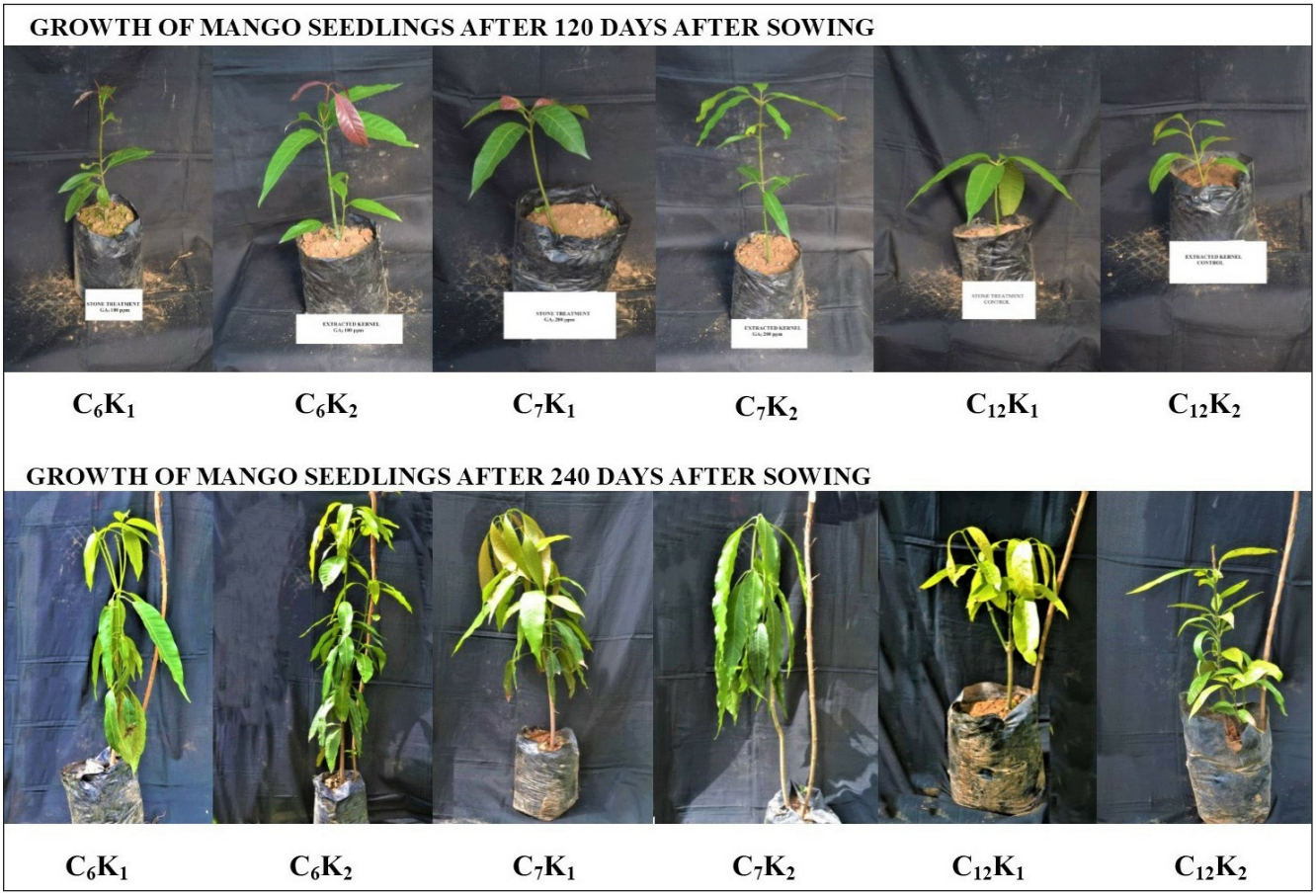

Figure 1: (Please mention figure title in correction table)

Maximum leaf area per leaf was recorded in seedlings raised form extracted kernels presoaked with GA_3 @ 200 ppm and these seed may have obtained maximum leaf area due stimulation of the cells on the use of GA_3. As GA_3 at lower concentration was found effective in inducing division in cell causing the increase in the leaf area. The above results were found in close conformity with the reports provided by Kumar et al. (2008), Shaban (2010), Samir et al. (2016) in khrini, Vasantha et al. (2014) in tamarind.

Survival rate of seedling when calculated after 240 DAS was found maximum in extracted kernels treated with GA_3 @ 100 ppm which can be attributed to the early germination of these seedlings as the time of sowing was august which was being followed by the harsh winter coming in October till February. The seedlings which have provided quick initiation were found having 80.44% survival in seedlings because the seedling had got enough time for establishing a better root network so as to tackle the harsh winter conditions. The results were found in confirmation with reports by Parmar et al. (2018) in jack fruit.

3.3. Vigour parameters

Vigor index is the distinct function of germination and growth, the maximum vigour index was recorded in seedlings which were raised from Extracted kernels treated with GA_3 @100 ppm however, this maximum vigour index can be justified as the seedlings treated with GA_3 resulted production of more number of leaves per plant with maximum leaf area which led to production of high photosynthetic assimilate and providing best seedling height in turn producing the best seedling vigor index. The similar results were also reported by Padma and Reddy (1997), Aatla and Srihari (2013), Pampanna and Sulkieri (2001) in Sapota and Rajamanickam and Balakrishnan (2002) in anola.

4. Conclusion

Soaking of seeds in GA_3 @ 100 ppm produced maximum (33.20 cm) plant height at 240 days. However, treatment of seeds with KNO_3 at lower doses was found promising in producing the highest proportion of graftable rootstocks and thus seedlings raised from extracted kernels pre-soaked in KNO_3 @ 0.5% attained graftable diameter within 210 days of sowing.

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