International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(5): 535-538

Received: 21-07-2018
Accepted: 24-08-2018

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Effect of ga_3 and different containers on seed germination and seedling growth of papaya (*Carica papaya* L.) cv. Madhubindu

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Abstract
An experiment entitled "Effect of GA_3 and different containers on seed germination and seedling growth of papaya (*Carica papaya* L.) cv. Madhubindu" was carried out at Fruit Research Station, Lalbaug, Junagadh Agricultural University, Junagadh during March to May 2017. Twelve treatment combinations arising from three levels of GA_3 (G_1 - GA_3 100 ppm, G_2 - GA_3 200 ppm and G_3 - GA_3 300 ppm) and four levels of containers (C_1 - Paper cup, C_2 - Plastic cup C_3 - Polybag and C_4 - Root trainer) were allocated in completely randomized design with factorial concept in three repetitions. The results showed that the application of treatment G_3C_3 (Papaya seeds are sowed in polybag after soaking in GA_3 300 ppm for 24 hours) was found better for early germination, highest germination percentage, maximum shoot length, number of leaves, stem diameter, fresh and dry weight of seedling as well as highest leaf area and survival percentage of papaya seedling.

Keywords: papaya, seedlings, GA_3, containers, germination

Introduction
Papaya (*Carica papaya* L.) is a tropical fruit crop and has long been known as wonder fruits of the tropics. It belongs to the family Caricaceae and is native of Tropical America. In India, it is grown in an area of 13.6 lakh ha with an annual production of 61.08 lakh tonne and productivity 44.9 MT/ha. In Gujarat the area of papaya is 2.017 lakh ha with an annual production of 12.41 lakh tonne and productivity 61.53 MT/ha (Anon., 2017) [3]. The leading producer of papaya in India is Andhra Pradesh followed by Gujarat.

Gibberellins are plant hormones that regulate growth and influence various developmental processes, including germination, dormancy, stem elongation, flowering, sex expression, enzyme induction and leaf and fruit senescence. Gibberellins act in improving the mobilization of seed reserves during the germination process. The quality of seedlings used in the formation of an orchard defines the productive potential of the crop, requiring high quality and strong seedlings with good nutritional status.

Container grown nursery stock is becoming a more widely accepted method for producing seedlings. Seeds sown in a container can be kept in a protected environment that provides their basic needs of warm temperatures, water and oxygen. This can increase the rate of germination. Other advantages of container are large, fibrous, compact root system, higher physiological function, reduced transplant shock, better survival and early growth.

Papaya is an important fruit crop of tropical and subtropical region. For successful production of papaya, vigorous and healthy seedling is the most important for papaya growers. Gibbrelic acid is the most important PGR and considered as an important germination promoters. Container grown nursery stock required shorter duration for healthy seedling production. Looking to the immense need and importance of healthy seedling of better quality, the research problem has been finalized by using various types of containers and different concentrations of GA_3. The type of containers are finalized on the bases of volume of media used, feasibility to transport and quick use of seedlings for transplanting. The findings of this research will help nurserymen, growers and researchers to produce and supply early germination and healthy seedlings.

Materials and Methods

The present experiment was carried out at Fruit Research Station, Lalbaug; Junagadh Agricultural University, Junagadh during March to May 2017. The experiment was laid out in a Completely Randomized Design (Factorial) with twelve (12) treatment combinations and replicated thrice. The papaya seeds of the variety Madhubindu was procured from Fruit Research Station, Lalbaug; Junagadh Agricultural University, Junagadh. Treatment comprised of three levels of GA_3 (G_1- GA_3 100 ppm, G_2- GA_3 200 ppm and G_3- GA_3 300 ppm) and four levels of containers (C_1- Paper cup, C_2- Plastic cup C_3- Polybag and C_4- Root trainer). Seeds were soaked in GA_3 solution separately for 24 hours, before sowing as per the allocation of treatments.

First of all made 4 to 6 drainage hole in every containers. Perforation was made by using punch machine and with the help of pointed iron rod then thoroughly mixed one part of soil and one part of FYM. This soil mixture was sieved and removed all the debris, hard particle and lumps. After that all the containers were filled with this prepared media mixture. (Propagation media were taken on the basis of v/v.) Three seeds were sown in each of paper cup, plastic cup, polybag as well as root trainers at 1cm depth in triangle manners. Twenty five containers were taken for each treatment.

Observations were recorded in respect to first germination from the date of sowing up to germination of the first seedling. Germination percentage was measured by counting number of papaya seeds germinated out of total seed dibbled into the containers and its average was calculated. Vigour index was calculated as per following formula given by Abdual-Baki and Anderson (1973) [1]. Vigour index length = Germination percentage x Seedling length (cm) and Vigour index mass = Germination percentage x Seedling dry weight (g). Shoot and Root lenth of the seedling is measured by metric scale. The length between the collar region and the tip of the shoot was measured as shoot length and the length between the collar region and the tip of primary root was measured as root length. Stem diameter was measured by vernier calipers. Number of leaves and number of nodes were counted at 30 and 45 days after sowing and its average was calculated. Leaf area was measured with the help of leaf area meter. Fresh and dry weight of seedlings was weighed on digital weighing balance at 30 and 45 days after sowing and its average value was calculated. Survival percentage was calculated by counting number of survived seeds out of total seed germinated into the containers and its average was calculated.

Results and Discussion

Effect of GA_3 on seed parameters

The GA_3 300 ppm executed significantly maximum germination percentage (85%), seed vigour index length (2938.33 cm), seed vigour index mass (56.10 g) and significantly minimum days to germination (12.54) as compare to GA_3 200 ppm and GA_3 100 ppm concentrations. It might be due to the fact that GA_3 involved in the activation of cytological enzymes which stimulates α – amylase enzyme that converts insoluble starch into soluble sugars and it also initiates the radical growth by removing some metabolic blocks (Babu *et al*. 2010) [4]. GA_3 also plays an important role in leaching out of the inhibitors which in turn helps in breaking the seed dormancy. The results are conformity with the findings reported by veeraragavathatham *et al.* (1980) [16], Pandit *et al*. (2001) [13], Anburani and Shakila (2010) [2], Deb *et al*. (2010) [7], Barche *et al*. (2010) [5], Pratibha *et al.* (2015) [14] and Padma *et al.* (2013) [11] in papaya. The papaya seeds treated with GA_3 prior to sowing gave an early seed germination. This might be due to the fact that, GA_3 plays an important role in two stages of germination one at initial enzyme induction and other in activation of reserve food mobilizing system which help in enhancement of germination (Jha *et al*. 1997) [10]. The vigour index of seed is directly dependent on germination percentage and seedling length. The hike in vigour index in GA3 seed treatment might be due to the direct influence on the extensive growth of seedlings probably by increased mobilization of reserve foods to growing apices.

Effect of GA_3 on growth parameters

Significantly maximum shoot length (20.65 cm), root length (13.27 cm), stem diameter (5.86 mm), maximum number of leaves, (11.36), maximum number of nodes (12.32), significantly higher seedling fresh weight (4.62 g) and maximum dry weight of seedling (0.65 g), were recorded in GA_3 300 ppm at 45 DAS. Further more significantly higher leaf area (25.34 cm^2) was recorded in GA_3 300 ppm at 45 DAS. Likewise significantly the highest percentage of survival (90%) was observed in GA_3 300 ppm in comparision to GA_3 200 ppm and GA_3 100 ppm concentrations.

The maximum seedling length in GA_3 treated seeds might be due to the effect of gibberellic acid in increasing the osmotic uptake of nutrients and thereby causing cell elongation reflects in greater internodal length, ultimately resulting in increase shoot and seedling length. The maximum root length was recorded under the GA_3 treatment might be due to reason that shoot growth result in production of photosynthates which is translocated through phloem to the root zone might be responsible for increase in root length. These results are in conformity with Begum *et al*. (1987) [6], Palanisamy and Ramamoorthy (1987) [12], Barche *et al*. (2010) [5], Babu *et al*. (2010) [4] and Pratibha *et al*. (2015) [14] in papaya. The maximum collar diameter with GA3 treatment might be due to its vital role in stimulation of cambium and its immediate cell progeny, which increase the collar diameter, as observed by Dhankhar and Singh (1996) [8] in aonla. The maximum fresh weight with GA_3 seed treatment might be due to rapid growth of seedling with increase in plant height, number of leaves, and stem diameter which in turn increase in shoot and root fresh weight resulted in maximum fresh weight of seedlings. The maximum dry weight of seedling with GA3 might be due to involvement of gibberellic acid in mobilizing, translocation and accumulation of water and nutrients transported at higher rate which might have promoted more production of photosynthetic products in various plant parts might have resulted in increased total dry weight of seedling. Similar effect of GA_3 on dry weight of seedling were reported by Dhankar and Singh (1996) [8]. The maximum leaf area associated in GA_3 seed treatment might be due to the fact that activity of gibberellic acid at apical meristem result in more production and accumulation of nucleoprotein responsible for increasing leaf initiation and leaf expansion. Similar effect of GA3 on leaf area was noticed by Sen and Ghanti (1976) [15] in papaya.

Effect of containers on seed parameters

The polybag executed significantly higher germination percentage (86.67%), seed vigour index length (3577.11 cm), seed vigour index mass (62.20 g) and significantly minimum days to germinate (13.42). The possible reason for the observed results might be due to adequate drainage in the

polybags. Optimum water content increases permeability of seed coat and allows gaseous exchange which ensures better germination. The results are in line with the investigation of Jabbar *et al.* (2010) [9] on *Albizia procera.*

Effect of containers on growth parameters

Significantly maximum shoot length (26.51 cm), root length (15.13 cm), collar diameter (6.70 mm), number of leaves (12.46) and number of nodes (12.89) were recorded in polybag at 45 DAS. Similarly significantly maximum fresh weight of seedling (5.53 g), dry weight of seedling (0.71 g) and higher leaf area (32.37 cm^2) were observed at 45 DAS in polybag. Furthermore percentage of survival (92.00%) was observed in polybag as compare to other containers. Conical shape of root trainer facilitates less available space for root spread than gusseted poly bag. Also, the individual polybags allows better environment for seedling growth which facilitates circulation of warm air around the seedling and optimal relative humidity as compared to the root trainer**.** optimal relative humidity and optimal moisture which help to increase plant height, number of leaves, and stem diameter which in turn increase in shoot and root fresh weight resulted in maximum fresh weight of seedlings. The higher root and shoot dry weight noticed in polybags is due to the higher values of fresh weight recorded in the same which is an outcome of better root spread.

Interaction effect of GA_3 and different containers

Maximum shoot length (29.27 cm), collar diameter (6.97 mm), number of leaves (12.77), number of nodes (13.50) and fresh weight of seedling (5.77g), were recorded in G_3C_3 at 45 DAS. In the same way significantly maximum leaf area (36.43 cm^2) and percentage of survival (96.00%) were recorded in G_3C_3 at 45 DAS.

The minimum shoot length, root length and seedling length was found in G1C4. It might be due to lower concentration of GA_3 and lesser available space in root trainer due to conical shape which result in minimum length of seedling while higher concentration of GA_3 and more space in polybag in treatment G_3C_3 which in turns help towards increasing shoot length and root length of papaya seedling. In treatment G_3C_3 Gibberellic acid play an important role in cell division, cell elongation and cell multiplication which reflect in maximum number of nodes per seedling and also stimulate the cambium and its immediate cell progeny, which increase the collar diameter along with polybag provide better environment for seedling growth. The higher leaf area might be attributed to better root system in polybags and higher concentration of GA_3 produce nucleoprotein responsible for increasing leaf initiation and leaf expansion. Polybags facilitates circulation of warm air around the seedling, optimal relative humidity and optimal moisture present in polybags and also higher concentration of GA_3 result in more survival percentage of seedlings.

Table 1: Studies on seed parameters of papaya (*Carica papaya* L.) cv. Madhubindu influenced by GA_3 and different containers.

Treatments	Germination (%)	Days to germinate	Seed vigour length (cm)	Seed vigour mass (g)
G_1	67.00	14.96	1906.43	34.25
G_2	76.00	14.53	2407.43	46.57
G_3	85.00	12.54	2938.33	56.10
S.Em.±	0.69	0.24	26.20	0.69
C.D. at 5%	2.03	0.70	76.48	2.02
C_1	80.44	13.67	2614.00	49.57
C_2	74.67	14.03	2107.82	42.95
C_3	86.67	13.42	3577.11	62.20
C_4	62.22	14.93	1370.67	27.84
S.Em.±	0.80	0.28	30.25	0.80
C.D. at 5%	2.34	0.80	88.31	2.33
C.V.%	3.16	5.90	2614.00	5.24
Interaction G x C	NS	NS	Sig.	Sig.

Table 2: Studies on seedling growth parameters of papaya (*Carica papaya* L.) cv. Madhubindu influenced by GA_3 and different containers.

Treatment	Shoot length (cm)		Root length (cm)		Stem girth (mm)	Number of leaves per seedling		Number of nodes per seedling		Fresh weight of seedling (g)		Dry weight of seedling (g)		Leaf area (cm^2)		Survival (%)
	30 DAS	45 DAS	30 DAS	45 DAS	45 DAS	30 DAS	45 DAS	30 DAS	45 DAS	30 DAS	45 DAS	30 DAS	45 DAS	30 DAS	45 DAS	45 DAS
G_1	8.33	17.13	7.04	10.58	4.99	7.20	10.46	7.33	10.88	2.24	4.20	0.36	0.50	13.84	20.35	82.67
G_2	11.20	18.86	7.88	12.28	5.64	8.09	11.19	8.13	11.94	2.52	4.44	0.40	0.60	14.96	22.30	85.33
G_3	12.18	20.65	8.90	13.27	5.86	8.35	11.36	8.42	12.32	2.69	4.62	0.42	0.65	16.26	25.34	90.00
S.Em.±	0.15	0.27	0.11	0.19	0.07	0.13	0.09	0.12	0.08	0.03	0.03	0.005	0.008	0.16	0.42	0.38
C.D. at 5%	0.44	0.77	0.31	0.55	0.21	0.37	0.28	0.34	0.22	0.07	0.08	0.016	0.022	0.47	1.21	1.12
C_1	11.57	19.06	7.67	13.21	5.91	8.25	11.72	8.39	12.28	2.61	4.57	0.42	0.61	16.39	23.21	88.00
C_2	10.20	16.59	7.17	11.48	5.35	7.66	10.89	7.76	11.98	2.44	4.35	0.39	0.57	14.24	18.42	87.56
C_3	13.06	26.51	11.39	15.13	6.70	8.87	12.46	8.92	12.89	3.59	5.53	0.47	0.71	19.97	32.37	92.00
C_4	7.47	13.37	5.54	8.33	4.02	6.73	8.94	6.78	9.69	1.28	3.22	0.30	0.44	9.49	16.65	76.44
S.Em.±	0.18	0.31	0.12	0.22	0.08	0.15	0.11	0.13	0.09	0.03	0.03	2.24	4.20	0.19	0.48	0.44
C.D. at 5%	0.51	0.89	0.36	0.63	0.24	0.42	0.32	0.39	0.26	0.09	0.10	2.52	4.44	0.54	1.40	1.30
C.V.%	4.99	4.86	4.63	5.41	4.48	5.54	2.98	5.09	2.27	3.53	2.32	4.79	4.47	3.70	6.36	1.55
Interaction G x C	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	NS	Sig.	Sig.	Sig.	Sig.

Table 3: Interaction studies on seedling growth parameters of papaya (*Carica papaya* L.) cv. Madhubindu influenced by GA_3 and different containers.

Treatments	Shoot length (cm)		Root length (cm)		Stem girth (mm)	Number of leaves per seedling		Number of nodes per seedling		Fresh weight of seedling (g)		Dry weight of seedling (g)	Leaf area (cm^2)		Survival (%)
	30 DAS	45 DAS	30 DAS	45 DAS	45 DAS	30 DAS	45 DAS	30 DAS	45 DAS	30 DAS	45 DAS	45 DAS	30 DAS	45 DAS	45 DAS
G_1C_1	9.07	18.00	6.63	11.20	5.47	7.00	10.83	7.33	11.17	2.32	4.30	0.53	15.43	21.54	86.67
G_1C_2	8.10	15.10	6.37	9.77	4.55	6.75	10.17	6.83	11.00	2.12	4.12	0.47	12.31	16.62	82.67
G_1C_3	10.30	23.17	10.43	13.83	6.48	8.67	12.00	8.67	12.17	3.35	5.23	0.61	18.68	28.04	88.00
G_1C_4	5.87	12.27	4.73	7.50	3.46	6.37	8.83	6.50	9.17	1.16	3.15	0.41	8.95	15.21	73.33
G_2C_1	12.10	19.00	7.20	13.27	5.92	8.75	11.83	8.83	12.67	2.67	4.60	0.64	16.17	22.30	85.33
G_2C_2	10.63	16.00	7.07	11.33	5.56	8.10	11.33	8.10	12.17	2.53	4.33	0.59	14.61	17.23	88.00
G_2C_3	14.20	27.10	11.40	15.83	6.64	8.83	12.60	8.92	13.00	3.57	5.60	0.73	19.55	32.65	92.00
G_2C_4	7.87	13.33	5.87	8.67	4.44	6.67	9.00	6.67	9.92	1.32	3.22	0.43	9.52	17.01	76.00
G_3C_1	13.53	20.17	9.17	15.17	6.36	9.00	12.50	9.00	13.00	2.86	4.82	0.66	17.56	25.79	92.00
G_3C_2	11.87	18.67	8.07	13.33	5.93	8.13	11.17	8.33	12.77	2.68	4.60	0.65	15.79	21.41	92.00
G_3C_3	14.67	29.27	12.33	15.73	6.97	9.10	12.77	9.17	13.50	3.86	5.77	0.79	21.68	36.43	96.00
G_3C_4	8.67	14.50	6.03	8.83	4.17	7.17	9.00	7.17	10.00	1.35	3.28	0.49	10.02	17.73	80.00
S.Em.±	0.27	0.53	0.21	0.38	0.14	0.25	0.19	0.23	0.15	0.05	0.05	0.015	0.32	0.83	0.77
C.D. at 5%	0.77	1.55	0.62	1.10	0.41	0.73	0.55	0.68	0.45	0.15	0.17	0.044	0.94	2.43	2.25

Conclusion

On the basis of experiment it can be concluded that for the preparation of papaya seedlings in the nursery, the papaya (cv. Madhubindu) seeds are advised to saw in polybag after soaking in GA_3 300 ppm for 24 hours attained the early germination, maximum germination percentage and survival percentage with the highest seedling growth parameters.

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