Plant Archives Vol. 25, Supplement 2, 2025 pp. 2559-2565 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2025.v25.supplement-2.323

STUDY ON GERMINATION OF ACID LIME (*CITRUS AURANTIFOLIA*) INFLUENCED BY GA_3 AND GROWING MEDIA

Archa Raj R.*, Manohar Lal Meghwal, Om Prakash Regar, Champa Lal Regar, Rajendra Bairwa, Narendra Kumar Teli and Suresh Kumawat

Faculty of Agriculture and veterinary Science, Mewar University Gangrar, Chittorgarh (Rajasthan)- 312901, India.
*Corresponding author E-mail: archarajr@gmail.com

(Date of Receiving : 23-04-2025; Date of Acceptance : 27-06-2025)

ABSTRACT

The experiment was laid out in a Completely Randomized Design with Factorial concept by three replication and 6 growing media viz. (T_1) Soil (Control) , (T_2) Soil + Sand + GA3 25 ppm (1:1), (T_3) Soil + Sand + Vermicompost + GA3 50 ppm (1:1:1), (T_4) Soil + Sand + Perlite + GA 50 ppm (1:1:1), (T_5) Soil + Sand + Vermiculite + GA 50 ppm (1:1:1) , (T_6) Soil + Sand + Cocopeat + GA 25 ppm (1:1:1) , (T_7) Soil + Sand + Cocopeat + Vermicompost + GA 50 ppm (1:1:1:1) ,(T_8) Soil + Sand + Cocopeat + Vermicompost + Vemiculite + GA 25 ppm (1:1:1:1:1), (T_9) Soil + Sand + Vermicompost + Vermiculite + GA 50 ppm (1:1:1:1), having 9 treatment combinations .Among the growing media, Soil + Sand + Cocopeat + Vermicompost and among the seed treatment, GA3 (50ppm) were proved most promising as compare to others. Among the various treatment combinations, the T_7R_1 treatment combination Soil + Sand + Cocopeat + Vermicompost + GA 50 ppm was proved most superior over rest of the treatment combinations with respect to early seed germination (16 days), early 50% seeds germination (22.33 days) maximum percentage of germination at 30 days (72%), growth parameters like seedling height (5.77, 6.41, 7.34, 8.03 cm), number of leaves per seedling (2.53, 4, 5.66, 7.66), girth of stem (1.52, 1.84, 1.94, 2.20mm), Root length(18.53, 21.92, 26.87 cm),shoot length (5.42, 6.25, 7.66 cm) at 30, 60, 90 and 120 DAS respectively.

Keywords **:** Acidlime, Seed soaking, Growing Media, Germination.

Introduction

Citrus is one of the most important fruit crops of tropical and subtropical regions. It occupies 3rd rank after mango and banana in India. It is grown in over 100 countries and often regarded as golden fruit. The total area under cultivation of acid lime & lemon in India is 316 thousand hectare with production of around 3628 thousand MT (Anonymous, 2020-21). In Gujarat, area under citrus cultivation is 48503 hectare with 625833 MT production (Anonymous, 2020-21). It is mainly grown in Ahmedabad, Kheda, Mehsana, Bhavnagar, Gandhinagar and Junagadh districts of Gujarat. Propagation of acid lime is generally done by grafting, budding, air layering and by seed. The commercial practice of propagation is by seed (Khatana and others 2015). It produces true to type, because of high degree (39-60 %) of nucellar embryony. The resultant seedlings are known to be free from tristeza virus and thus perform better. In acid lime germination percentage is low and it takes about 3 weeks to germinate (Cheema and others 1954). Some of the problems faced by acid lime growers are slow, erratic and incomplete germination with high initial seedling mortality. The possible reason of slow germination is presence of the growth inhibitors and physical resistance of seed coat to radical protrusion (Khan and others, 2002). The growth of acid lime seedling is very slow in nursery as well as in the field. The increasing germination percentage and producing healthier seedling are major challenges for farmers. So, the seeds of acid lime cv. Kagzi Lime are soaked with plant growth regulator such as gibberellic acid (GA_3). GA_3 controls mobilization of starch which acts as a respiratory substrate leading to immediate

enhancement in cell elongation. Gibberellins also help in enhancing the availability of reserved mineral elements which promote the germination process. Media not only act as a growing place but also as a source of nutrient for plant growth. It is a substrate that provides the required elements and physical support to the growing plants. Vermicompost provides sufficient levels of oxygen to roots, adequate storage of water and nutrient for the plants. Cocopeat provides excellent pore space (25-30 %) and fine structure required for proper growth. It is a rich source of nutrients and can easily mixed with other growing media used in seed germination and growth of seedling. Sand is used as a rooting media or adding the coarser texture needed to induce proper drainage and aeration. Keeping in view above, the aims of the study was to identify suitable treatment combinations for better seed germination and seedling growth of acid lime.

Material and Methods

The experiment was carried out at Research Farm, Mewar University, Gangrar, Chittorgarh, Rajasthan from 2024-2025. The experiment comprised of Nine growing media viz (T_1) Soil ,(T_2) Soil + Sand + GA_3 25 ppm (1:1), (T_3) Soil + Sand + Vermicompost + GA_3 50 ppm (1:1:1),(T_4) Soil+ Sand + Perlite + GA_3 50 ppm (1:1:1), (T_5) Soil+ Sand + Vermicultite + GA_3 50 ppm (1:1:1),(T_6) Soil+ Sand + Cocopeat + GA_3 25 ppm (1:1:1), (T_7) Soil+ Sand + cocopeat + Vermicompost + GA_3 50 ppm, (T_8) Soil + Sand + Cocopeat + Vermicompost + Vermiculite + GA_3 25 ppm, (T_9) Soil+ Sand + Vermicompost + Vermiculite + GA_3 50 ppm . The experiment was laid out in polybag in factorial randomized block design with three replications. Observations were recorded using standard procedure and statistically analysed.

Germination percentage

The germination in each treatment was recorded at 30 days after sowing. Number of seedlings were counted and expressed as germination percentage.

$$\text{Germination percentage} = \frac{\text{Total no. of seeds germinate}}{\text{Total no. of seeds sown}} \times 100$$

Number of days taken for 50 per cent germination

The number of days taken to reach 50 per cent of germination was recorded in each treatment from the germination percentage calculated for each observation. Growth parameter-The following observations were recorded at 120 days after sowing.

Randomly selected five plants were tagged for following observations.

Height of seedling (cm) – Height was measured from ground level to the tip of opened leaf.

Girth of stem (mm) – The girth of stem was measured with the help of digital verneer calipers just above the ground surface and the average was calculated.

Number of leaves per seedling – The total number of leaves per seedling was counted and the average was calculated. Matured leaves were taken into account.

Root length (cm) –Base of the stem to the tip of the longest root in a seedlings.

Shoot length (cm) – Above ground part of a plant grows from the base of the stem to the tip of the tallest shoot or leaf.

Results and Discussion

As per the results, the significant different was observed between the treatment on seed germination and seedling growth attributes.

Germination

The combination of growing media Soil + sand + cocopeat + vermicompost + vermiculite GA_3 25 ppm (1:1:1:1) enhance germination rate and took minimum days for first seed germination (17), fifty percent seed germination (22.33) germination percent of 30 days (72%). Early germination, fifty percent germination and final germination percent might be attributed to the conducive effect of this medium mixture on water holding capacity, porosity, soil aeration and supplying substantial amount of nutrients specially nitrogen and micronutrients as well as improve the microbial activities which might be helping in better germination. GA_3 helps break seed dormancy by promoting the synthesis of hydrolytic enzymes, which mobilize stored food in the endosperm. Patil and Jadhav (2014) demonstrated that GA_3 25 ppm treatment along with a porous media mixture increased germination speed and uniformity in citrus. Pandey and Rajput (2020) found that a medium with cocopeat and vermiculite along with soil and sand enhanced seedling vigour index and germination rate. The physiological activity of GA_3 includes stimulating enzymes production that softens the seed coat and mobilizes stored food for embryo growth. The seed soaking in the solution of GA3 50ppm took minimum days to first seed germination (17) and 50 percent seeds germination (22.48) while maximum days taken by the untreated seed. The promising effect of GA3 to the seeds replaced the dormancy mechanism of the seeds resulting in early germination (Khan, 1981). Gibberellic acid acts on the embryo and causes synthesis of hydrolyzing enzymes particularly amylase and protease and this hydrolyzed food is utilized for growth of embryo and thereby

enhanced the germination (Paleg, 1965). Similar result have been reported by Meena *et al.* (2003) who revealed that papaya seeds treated with GA_3 100ppm taken minimum days for germination and found maximum percentage of germination. This was due to the fact that GA_3 plays a key role in the initiation of germination. The findings of Venkatrao and Reddy (2005) are close to the conformity of the findings. It may be because of faster germination which was facilitate by the media in combinations of GA_3 application, where the combination of soil, sand, cocopeat,vermicompost and vermiculite and GA_3 provides adequate nutrients and enhance both the physical properties of the water holding capacity of the soil on the other hand GA_3 helps in promoting the germination percentage due to its participation in the activities of hydrolyzing enzyme and alpha-amylase at initial stage of germination and thus, facilited the germination process (Singh *et al.*, 1979). Enhancement of seed germination by growth regulators might be due to increase of transcription and/or translation during protein synthesis. The mobilization of protein and lipid storage bodies upon specific enzymes, which hydrolyze stored molecules and catalyze result into the production of energy and substrates and provide the structural components essential for growth and emergence of the embryo. This result is in agreement with the findings of Feza Ahmad (2010).The findings are also in agreement with the findings of Sinish *et al.* (2005) and Syamal *et al.* (2012) who reported the earlier germination with better germination percentage by the application of growing media. El-zaher (2008) also found similar result.

Table 1 : Effect of growing media and gibberllic acid on days taken to first seed germination ,50 percent seed germination and overall germination percentage

Treatment	Seed germination		
Growing Media	**Days taken to first seed germination**	**Days taken to 50% seed germination**	**Germination per sent at 30 DAS**
(T_1) Soil	22.33	34.667	44
(T_2)Soil +Sand + GA_3 25 ppm	17.667	28.667	58.66
(T_3) Soil + Sand + Vermicompost + GA_3 50 ppm	18	27.33	64.66
(T_4) Soil + Sand + Perlite + GA_3 50 ppm	20.00	25.33	58.66
(T_5) Soil +Sand + Vermiculite + GA_3 50 ppm	19.667	24.667	62
(T_6) Soil + Sand + Cocopeat + GA_3 25 ppm	21	24.667	69.32
(T_7) Soil+ Sand + Cocopeat + Vermicompost + GA_3 50 ppm	17	22.333	72
(T_8) Soil + Sand + Cocopeat + Vermicompost + vermiculite + GA_3 25 ppm	17.667	22.33	60.66
(T_9) Soil + Sand + Vermicompost + Vermiculite + GA_3 50 ppm	19.33	23.333	64
C.D.	N/A	3.161	4.242
SE (m)	1.252	1.045	1.403
SE (d)	1.771	1.478	1.984
C.V.	11.305	6.993	7.894

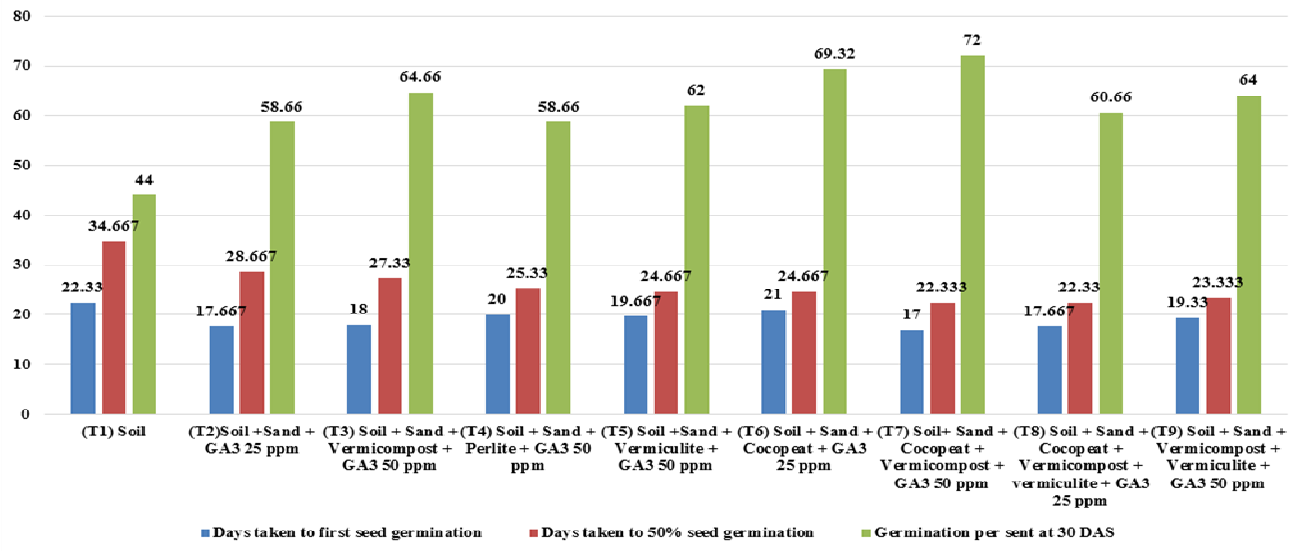

Fig. 1: Effect of growing media and gibberllic acid on days taken to first seed germination, 50 percent seed germination and overall germination percentage

Table 2 : Effect of growing media and gibberellic acid on seedlings height at 30,60, 90 and 120 DAS of Acid lime seedlings

Treatment	Seedling height (cm)			
Growing Media	**30 DAS**	**60 DAS**	**90 DAS**	**120 DAS**
(T_1) Soil	3.59	4.426	5.32	6.41
(T_2)Soil +Sand + GA_3 25 ppm	4.086	5.0	5.61	6.66
(T_3) Soil + Sand + Vermicompost + GA_3 50 ppm	4.463	5.36	6.28	7.476
(T_4) Soil + Sand + Perlite + GA_3 50 ppm	4.17	5.003	6.026	7
(T_5) Soil +Sand + Vermiculite + GA_3 50 ppm	5.77	6.367	7.29	7.717
(T_6) Soil + Sand + Cocopeat + GA_3 25 ppm	4.72	5.593	6.613	7.63
(T_7) Soil+ Sand + Cocopeat + Vermicompost + GA_3 50 ppm	5.77	6.416	7.343	8.03
(T_8) Soil + Sand + Cocopeat + Vermicompost + vermiculite + GA_3 25 ppm	5.17	5.853	6.913	7.89
(T_9) Soil + Sand + Vermicompost + Vermiculite + GA_3 50 ppm	4.713	5.28	6.453	7.28
C.D.	0.717	0.736	0.801	N/A
SE (m)	0.237	0.24	0.265	0.387
SE (d)	0.335	0.34	0.375	0.547
C.V.	8.704	7.629	7138	9.128

Table 3 : Effect of growing media and gibberellic acid on Root length at 60,90 and 120 DAS od Acidlime seedlings.

Treatment	Root length (cm)		
Growing media	**60 DAS**	**90 DAS**	**120 DAS**
(T_1) Soil	13.607	17.363	22.473
(T_2)Soil +Sand + GA_3 25 ppm	12.723	15.46	21.253
(T_3) Soil + Sand + Vermicompost + GA_3 50 ppm	14.25	17.753	22.75
(T_4) Soil + Sand + Perlite + GA_3 50 ppm	16.667	20.05	25.093
(T_5) Soil +Sand + Vermiculite + GA_3 50 ppm	15.353	18.697	22.99
(T_6) Soil + Sand + Cocopeat + GA_3 25 ppm	14.62	19.173	23.993
(T_7) Soil+ Sand + Cocopeat + Vermicompost + GA_3 50 ppm	18.533	21.923	26.877
(T_8) Soil + Sand + Cocopeat + Vermicompost + vermiculite + GA_3 25 ppm	17.757	20.593	25.637
(T_9) Soil + Sand + Vermicompost + Vermiculite + GA_3 50 ppm	16.223	19.693	24.277
C.D.	N/A	N/A	N/A
SE (m)	1.417	1.339	1.203
SE (d)	2.003	1.893	1.701
C.V.	15.804	12.225	8.708

Table 4 : Effect of Growing media and gibberellic acid on shoot length at 60 DAS,90 DAS and 120 DAS of Acidlime seedlings.

Treatment	Shoot length (cm)		
Growing media	**60 DAS**	**90 DAS**	**120DAS**
(T_1) Soil	4.603	5.373	6.65
(T_2)Soil +Sand + GA_3 25 ppm	4.67	5.58	6.807
(T_3) Soil + Sand + Vermicompost + GA_3 50 ppm	4.6	5.71	6.99
(T_4) Soil + Sand + Perlite + GA_3 50 ppm	4.82	5.817	6.857
(T_5) Soil +Sand + Vermiculite + GA_3 50 ppm	4.733	5.713	7.08
(T_6) Soil + Sand + Cocopeat + GA_3 25 ppm	5.03	6.117	7.28
(T_7) Soil+ Sand + Cocopeat + Vermicompost + GA_3 50 ppm	5.423	6.253	7.663
(T_8) Soil + Sand + Cocopeat + Vermicompost + vermiculite + GA_3 25 ppm	4.71	5.757	7.43
(T_9) Soil + Sand + Vermicompost + Vermiculite + GA_3 50 ppm	4.71	5.623	6.833
C.D.	0.307	0.352	0.369
SE (m)	0.102	0.116	0.122
SE (d)	0.144	0.164	0.172
C.V.	3.66	3.49	2.99

Table 5 : Effect of growing media and gibberellic acid on No. of leaves /plant seedlings at 30 DAS,60 DAS,90 DAS and 120 DAS of Acid limes

Treatment	No. of leaves /Plant seedling			
Growing media	**30 DAS**	**60 DAS**	**90 DAS**	**120 DAS**
(T_1) Soil	2	2.533	4	4.333
(T_2)Soil +Sand + GA_3 25 ppm	2.533	4.333	6	7.333
(T_3) Soil + Sand + Vermicompost + GA_3 50 ppm	2..433	5	6.333	8
(T_4) Soil + Sand + Perlite + GA_3 50 ppm	2.2	4	5.333	6.667
(T_5) Soil +Sand + Vermiculite + GA_3 50 ppm	2.667	4.667	6	8
(T_6) Soil + Sand + Cocopeat + GA_3 25 ppm	2.333	5	6.333	8
(T_7) Soil+ Sand + Cocopeat + Vermicompost + GA_3 50 ppm	2.533	4	6.77	7.667
(T_8) Soil + Sand + Cocopeat + Vermicompost + vermiculite + GA_3 25 ppm	2.333	4.333	6.333	8.66
(T_9) Soil + Sand + Vermicompost + Vermiculite + GA_3 50 ppm	2	4.333	6	8
C.D.	N/A	0.734	N/A	1.479
SE (m)	0.258	0.243	0.514	0.489
SE (d)	0.364	0.343	0.726	0.692
C.V.	19.1	9.911	15.4	11.436

Table 6 : Effect of growing media and gibberellic acid on Stem girth at 30 DAS,60 DAS,90 DAS and 120 DAS of Acid limes seedlings.

Treatment	Stem girth (mm)			
Growing media	**30 DAS**	**60 DAS**	**90 DAS**	**120 DAS**
(T_1) Soil	0.697	1.72	1.910	2.21
(T_2)Soil +Sand + GA_3 25 ppm	0.923	1.833	1.96	2.093
(T_3) Soil + Sand + Vermicompost + GA_3 50 ppm	1.09	1.827	1.963	2.247
(T_4) Soil + Sand + Perlite + GA_3 50 ppm	1.293	1.833	2.033	2.77
(T_5) Soil +Sand + Vermiculite + GA_3 50 ppm	1.315	1.867	1.92	2.15
(T_6) Soil + Sand + Cocopeat + GA_3 25 ppm	1.363	1.82	2.053	2.2
(T_7) Soil+ Sand + Cocopeat + Vermicompost + GA_3 50 ppm	1.527	1.84	1.94	2.203
(T_8) Soil + Sand + Cocopeat + Vermicompost + vermiculite + GA_3 25 ppm	1.467	1.767	1.963	2.267
(T_9) Soil + Sand + Vermicompost + Vermiculite + GA_3 50 ppm	1.373	1.86	1.937	2.26
C.D.	0.109	N/A	N/A	0.1
SE (m)	0.036	0.032	0.042	0.033
SE (d)	0.051	0.045	0.059	0.047
C.V.	5.1	3.025	3.692	2.623

Table 7 : Observation on various physical characteristics of media

Treatment	pH	EC	Moisture Content %	Bulk density	OC	N	P	K
(T_1) Soil	6.96	0.98	17.24	1.901	0.32%	120	17	290
(T_2)Soil +Sand + GA_3 25 ppm	6.61	1.89	9.47	1.689	0.33%	122	17	295
(T_3) Soil + Sand + Vermicompost + GA_3 50 ppm	6.57	1.96	37.5	1.459	0.41%	151	21	305
(T_4) Soil + Sand + Perlite + GA_3 50 ppm	6.77	1.86	25.65	1.259	0.34%	123	18	296
(T_5) Soil +Sand + Vermiculite + GA_3 50 ppm	6.66	1.91	25.34	1.158	0.34%	124	17.5	300
(T_6) Soil + Sand + Cocopeat + GA_3 25 ppm	6.67	1.88	34.81	1.238	0.35%	124.5	18.5	295
(T_7) Soil+ Sand + Cocopeat + Vermicompost + GA_3 50 ppm	6.58	1.97	32.35	1.027	0.42%	127	22	303
(T_8) Soil + Sand + Cocopeat + Vermicompost + vermiculite + GA_3 25 ppm	6.65	1.96	34.86	1.062	0.42%	128	21.5	301
(T_9) Soil + Sand + Vermicompost + Vermiculite + GA_3 50 ppm	6.7	1.93	27.8	1.436	0.43%	128.5	22	304

The maximum plant height (5.77, 6.41, 7.34, 8.03 cm), stem girth (1.52, 1.84, 2.05, 2.203 mm), Root length (18.533, 21.923, 25.627), Number of leaves (2.667, 4.33, 5.667, 7.667), Shoot length (5.42, 6.25, 7.66) were noted under T_7 (Soil + Sand + Cocopeat + Vermicompost + GA_3 50 ppm .The minimum plant height (3.59, 4.426, 5.32, 6.41) , Stem girth (0.697, 1.85, 1.94, 2.21), Root length (13.607, 17.36, 22.47), Number of leaves (2, 2.33, 4, 4.33), Shoot length (4.60, 5.373, 6.65) were recorder under T_1 (Soil). Increase in seedling height, girth, leaves and shoot, Root in acid lime seedling significantly may be

because of combine effect of medium mixture on water holding capacity, porosity, soil aeration and supply of substantial amount of nutrients required for better growth of seedling (seedling height, stem girth and number of leaves, shoot length and Root length). Soil + Sand + Cocopeat + Vermicompost (1:1:1:1) Could be promotes healthy germination and root development. Maintains a balanced air water- nutrient environment, Reduces risk of disease and water stress and it is suitable for nursery raising and container gardening. Rani *et al* (2015) observed improved survival rate and uniform seedling emergence in acid lime under this combination.

GA_3 will stimulates seed germination by breaking dormancy also promotes stem elongation through cell division and elongation, Enhances flowering and fruit set in some crops and delays leaf and fruit senescence. Kumar *et al* (2007) observed that soaking acid lime seeds in 25 ppm GA_3 for 12 hours increased germination by up to 35% compared to control. The beneficial effect of GA3 was probably due to quicker multiplication of cells and cell elongation after the germination. The possible reason of significant increase in seedling height, stem girth, number of leaves and Shoot length, Root length might be due invigoration of physiological process of plant and stimulatory effect of GA3 to found new cells at faster rate. These results are in conformity with the findings of Venkatrao *et al*. (2005) Wagh *et al*. (1998) and Dalal *et al*. (2002), they have reported GA_3 gave highest percentage of germination and enhance the plant growth or morphological parameter of seedling (plant height, girth and number of leaves) in fruit crops like Mango, Aonla, Rangpur lime etc. Combined application of biofertilizer and GA_3 would have better availability uptake of N, P, K and other plant nutrients which in terms lead to the production of more efficient plant and enhance the overall plant growth while GA_3 increase the plant height by increase in size of meristematic region and it is also significantly enhance the girth, number of leaves. El-zaher *et al*. (2008) also reported the same results.

Combined application of growing medium and GA_3 was found to have significant on germination percentage (72%) of seedling. The combination of growing media and GA_3 significantly promoted the germination and growth by multiplication and elongation of plant cell. On the other hand, the improved soil condition, soil health, availability of the nutrients, might be supported to appropriate cation exchange capacity and water holding capacity. Thus permitting adequate moisture exchange of gases uptake of nutrients facilitate better and healthy growth resulting maximum germination of seedling under the treatment.

Conclusion

From the present investigation, it can be concluded that, (T7) GA_3 50 ppm and growing media Soil + Sand + Vermicompost + Cocopeat (1:1:1:1) was found to be best for all germination-related attributes and significantly took less time for germination, least span of time for first germination, 50% germination, complete germination and for maximum germination percentage (%). The combination of this treatment was effectively useful for maximum germination percent, seedling height, and overall growth of seedlings. Therefore, the present study will be helpful to the farmers for the cultivation of these important fruit crops as well as the commercialization of acid lime nurseries.

References

Anonymous, (2020-21) 2nd Advance Estimates, National Horticulture Database. National Horticulture Board, Ministry of Agriculture and Farmers Welfare. Horticulture Statistics Division, Department of Agriculture, Cooperation and Farmers Welfare, Government of India, New Delhi.

Cheema, G.S., Bhat, S.S. and Naik, K.C. (1954) Commercial fruits of India with special reference to Western India. Macmillan and Co, London, pp 153-156

Dalal, S. R., Patil, S. R., Gonge, V. S., & Athawale, R. B. (2002). Effect of GA3 and urea on growth of Rangpur lime seedlings in nursery. *Indian Journal Citriculture,* **1**(2), 121-124.

El-Zaher, M.A. (2008). Using the grafting for propagation of the jackfruit and producing the rootstocks for the grafting. *Am.-Euras. J. Agric. Env. Sci,* **3**(3), 459-473.

Feza, A.M. (2010). Enhancement of seed germination in stratification and kiwi fruit gibberellic by acid application. *Indian J. Hort.,* **67**(1), 34- 36.

Khan, A.A. (1981). Hormonal regulation of primary and secondary seed dormancy. *Israel J. Bot.* **24**, 207-224.

Khan, M.M., Usman, M., Waseem, R. and Ali, M.A. (2002) Role of gibberellic acid (GA3) on citrus seed germination and study of some morphological characteristics. *Pak J Agric Sci*., **39**(2), 113-118.

Khatana, K.J., Jadav, R.G. and Nehete, D.S. (2015) Influence of GA3 on germination and growth of acid lime cv. Kagzi Lime seed (*Citrus aurantifolia* Swingle) under field as well as net house conditions. *J Asian Hortic.,* **10**(1),11-16

Meena, R.R., Jain, M.C. and Mukerjee, S. (2012) Effect of pre-sowing dip treatment with Gibberellic acid on germination and survivability of papaya. *Ann Plant Soil Res*., **5**(1), 120-121

Paleg, L. (1965). Physiological effects of gibberellins. *Ann. Rev. PL. Physiol.* **16**, 291-322.

Patel, P.B. and Jadhav. (2014) Effect of different levels of vermicompost on growth and yield of radish cv. Local variety. **1**(2), 29-31.

Singh, H. K., Shankar, G., & Makhija, M. (1979). A study on citrus seed germination as affected by some chemicals. *Haryana J. Hort. Sci.,* **8**(3-4), 194-195.

Sinish, M.S., Mercy, G., and John, P.S. (2005). Organic methods for cashew root stock production. *Cashew,* **19**(1): 8-15.

Syamal, M.M., Ranjeet, K., and Mamta, J. (2012). Performance of wedge grafting in guava under different conditions. *Indian growing Journal of Horticulture,* **69**(3), 424-427.

Venkatarao, P. and Reddy, Y.T.N. (2005). Effect of osmopriming on germination, seedling growth and vigour of mango stones. *The Karnataka Journal of Horticulture,* **1**(4), 29-35.

Wagh, A.P., Choudhary, M.H., Kulwal, L.V., Jadhav, B.J., and Joshi, P.S. (1998). Effect of seed treatment on germination of seed and initial growth of anola seedling in polybag. *Research Journal-Punjabrao Krishi Vidyapeeth,* **22**(2), 176-177.