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# Response of gibberellic acid, cow urine and bio-fertilizers on seedling growth parameters of papaya (*Carica papaya* L.)

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**Abstract**
An experiment entitled "Response of gibberellic acid, cow urine and bio-fertilizers on seedling growth parameters of papaya (*Carica papaya* L.)" was conducted at Instructional cum Research Farm, College of Agriculture and Research Station, (IGKV), Bemetara, Chhattisgarh, India during the year 2018 and 2019. The experiment was laid out in Completely Randomized Design (CRD) with Seventeen different treatments replicated three times. The papaya seeds were sown in polybags which was filled with common media and treated with three different concentration of $GA_3$ (*viz.*, 50, 100 and 150) and 10 per cent cow urine with addition of bio-fertilizers in media soil. The results showed that the treatment $T_{11}$ (seed soaking with 150 ppm $GA_3$ + 12 hours + azotobacter) was found best for length of shoots, stem girth , height of sapling, fresh weight of root, number of roots, length of root and dry weight of sapling. While, $T_{15}$ (seed soaking with cow urine 10 (%) + 12 hours + azotobacter) gave higher number of leaves, maximum fresh weight of shoot and fresh weight of sapling.

**Keywords:** Papaya, $GA_3$, media, cow urine, bio- fertilizers, hours

## Introduction

Papaya (*Carica papaya* L) is known as a wonder fruit of the tropics. It belongs to the family caricaceae, originated in tropical America (Hofmeyr, 1938) [15]. It gives one of the highest productions of fruits per hectare and an income next to banana as well as it is cheaper source of vitamins (vitamin A) and minerals. In India, papaya is being cultivated about 138.4 thousand hectares of land having annual production of 5989.88 thousand metric tonnes with productivity of 43.30 mt/ha. In Chhattisgarh, papaya is cultivated in an area of about 14.40 thousand hectares and having production of 381.42 thousand metric tonnes with productivity of 26.48 mt/ha (Anon., 2018) [4]. Its cultivation is practiced with several limitations resulting in its cultivation in restricted areas in the country. Under existing conditions, variable sex-forms, propagation problems, susceptibility to frost and water logging, fungal and viral diseases are well identified constraints in papaya cultivation. Papaya plants respond best to integrated management practices. Since, it is a highly cross pollinated crop and generally propagated by seeds, variable plant population is obtained. The variability in plants is also affected by a number of internal and external factors such as temperature, oxygen, water, plant species, growth regulators (hormones) and radiation effect etc.

Gibberellins act in the mobilization of seed reserves during the germination process. Therefore they are considered important germination promoters and contribute to increased seed germination speed and uniformity thus improving the performance of papaya seeds (Zanotti and Barros, 2014) [33].

The use of suitable growing media or substrates for sowing of seeds directly affects the germination, development and functional rooting system. A good growing medium provides sufficient anchorage or support to the plant, serves as reservoir for nutrients and water, allow oxygen diffusion to the roots and permit gaseous exchange between the roots and atmosphere outside the root substrate (Abad *et al.*, 2002) [1].

To study the combined effect of seed treatments, potting mixtures, chemicals and bio-inoculants on germination, seedling growth and vigour of papaya. A good growing media(would provide proper anchorage or support to the plant, serves as a nutrient and water reservoir and permits gaseous exchange between roots and atmosphere (Anjanawe *et al.* 2013) [3].

Proper seed germination and seedling growth are most important considerations in successful seedling production under nursery technique of papaya cultivation. As the germination rate and seedling growth are affected by pre-sowing seed treatment of papaya with growth regulators and micronutrients, an experiment was carried out to identify a suitable treatment for getting better seed germination and seedling growth. A wide variety of pre sowing seed treatment, which includes the plant growth regulators and growing media are used to enhance the seed germination and seedling growth in several fruit crops.

**Materials and Methods**

Present experiment was carried out during the year 2018 and 2019 at Intructional cum Research Farm, College of Agriculture and Research Station, (IGKV), Bemetara, Chhattisgarh, India. The experiment was laid out in Completely Randomized Design (CRD) with three replications. The treatments included $T_1$: Untreated (control), $T_2$: Seed soaking with 50 ppm $GA_3$ + 06 hours + Azotobacter), $T_3$: Seed soaking with 50 ppm $GA_3$ + 12 hours + Azotobacter, $T_4$: Seed soaking with 50 ppm $GA_3$ + 06 hours + Phosphate solubilizing bacteria, $T_5$: Seed soaking with 50 ppm $GA_3$ + 12 hours + Phosphate solubilizing bacteria, $T_6$: Seed soaking with 100 ppm $GA_3$ + 06 hours + Azotobacter, $T_7$: Seed soaking with 100 ppm $GA_3$ + 12 hours + Azotobacter, $T_8$: Seed soaking with 100 ppm $GA_3$ + 06 hours + Phosphate solubilizing bacteria, $T_9$: Seed soaking with 100 ppm $GA_3$ + 12 hours + Phosphate solubilizing bacteria, $T_{10}$: Seed soaking with 150 ppm $GA_3$ + 06 hours + Azotobacter, $T_{11}$: Seed soaking with 150 ppm $GA_3$ + 12 hours + Azotobacter, $T_{12}$: Seed soaking with 150 ppm $GA_3$ + 06 hours + Phosphate solubilizing bacteria, $T_{13}$: Seed soaking with 150 ppm $GA_3$ +12 hours + Phosphate solubilizing bacteria, $T_{14}$: Seed soaking with Cow urine 10 (%) + 06 hours + Azotobacter, $T_{15}$: Seed soaking with Cow urine 10 (%) +12 hours + Azotobacter, $T_{16}$: Seed soaking with Cow urine 10 (%) + 06 hours + Phosphate solubilizing bacteria and $T_{17}$: Seed soaking with Cow urine 10 (%) + 12 hours + Phosphate solubilizing bacteria. Observations were recorded by ten randomly selected seedlings for length of shoot, number of leaves and stem girth and height of sapling, fresh weight of shoot, fresh weight of root, number of roots, length of root, fresh weight of sapling and dry weight of sapling at 60 days after sowing and its average value was calculated. The data generated from these investigations were appropriately computed, tabulated and analyzed as described by Panse and Sukhatme, 1985) [27] using MS-Excel and OPSTAT in Completely Randomized Design (CRD).

**Results and Discussion**

The findings that were obtained from the execution of the experiment were recorded and are thoroughly discussed below:

On the basis of pooled data (Table 1), at 60 days after sowing of papaya seeds, the maximum height of the sapling 41.87 cm was recorded in the treatment $T_{11}$ (seed soaking with 150 ppm $GA_3$ + 12 hours + Azotobacter) followed by 41.34 cm in treatment $T_{10}$ (seed soaking with 150 ppm $GA_3$ + 06 hours + Azotobacter) and 36.45 cm in the treatment $T_{13}$ (seed soaking with 150 ppm $GA_3$ + 12 hours + PSB). It might be due to fact that the effect of $GA_3$ in increasing the osmotic uptake of nutrients and thereby causing cell elongation. Reflects in greater intermodal length, ultimately resulting in plant height. The results are close conformity with the results obtained by Begum *et al.* (1987) [7]; Palanisamy and Ramamurthy (1987); Dhinesh babu *et al.* (2010) [12]; Deb *et al.* (2010) [10] and Amit Desai *et al.* (2017) [9] in papaya and Gurung *et al.* (2014) in passion fruit.

On the basis of pooled data (Table 1), at 60 days after sowing of papaya seeds, maximum number of leaves of the sapling 12.83 was recorded in the treatment $T_{15}$ (seed soaking with cow urine 10 (%) + 12 hours + Azotobacter) followed by 12.30 in treatment $T_{14}$ (seed soaking with cow urine 10 (%) + 06 hours + Azotobacter) and 11.90 in the treatment $T_{11}$ (seed soaking with 150 ppm $GA_3$ + 12 hours + Azotobacter). It might be due to the cow urine was maintaining of high water content in cell, increased cell division and cell elongation which had increased the number of leaves per seedlings. These results are supported by Shinde and Malshe (2015) [28] in khirni. The improvement in vegetative character might be due to the ability of *Azatobacter* to fix atmospheric nitrogen which may share its role in increasing the percentage of mineral nutrient in soil.

On the basis of pooled data (Table 1), at 60 days after sowing, maximum length of shoot of the sapling 28.38 cm was recorded in the treatment $T_{11}$ (seed soaking with 150 ppm $GA_3$ + 12 hours + Azotobacter) followed by 28.18 cm in treatment $T_{10}$ (seed soaking with 150 ppm $GA_3$ + 06 hours + Azotobacter) and 26.47 in the treatment $T_7$ (seed soaking with 100 ppm $GA_3$ + 12 hours + Azotobacter). It was due to additional gibberellic acid, activated α- amylase which digested the available carbohydrate into simple sugar so that energy and nutrition were easily available to faster growing seedlings. This finding is closely associated with the Wanyama *et al.* (2006) [32] and Mostafa *et al.* (2011) [22] in *Balanites aegyptiaca* and Amit Desai *et al.* (2017) [9] in papaya.

On the basis of pooled data (Table 1), at 60 days after sowing, the maximum number of root of the sapling 18.65 was recorded in the treatment $T_{11}$ (seed soaking with 150 ppm $GA_3$ + 12 hours + Azotobacter) followed by 18.23 in treatment $T_{10}$ (seed soaking with 150 ppm $GA_3$ + 06 hours + Azotobacter) and 17.72 g in the treatment $T_{15}$ (seed soaking with cow urine 10 (%) + 12 hours + Azotobacter).

The treatment with gibberellic acid might have resulted in more production of photosynthatates and their translocation through phloem to the root zone, resulting in more number of roots. Results are closely associated with the results of earlier worker Palanisamy and Ramamoorthy (1987) and Anjanwe *et al*. (2013) in papaya; and Wagh *et al.* (1998) in aonla.

On the basis of pooled data (Table 1), at 60 days after sowing the maximum length of root of the sapling 13.46 cm was recorded in the treatment $T_{11}$ (seed soaking with 150 ppm $GA_3$ + 12 hours + Azotobacter) followed by 13.17 cm in treatment $T_{10}$ (seed soaking with 150 ppm $GA_3$ + 06 hours + Azotobacter) and 11.37 cm in the treatment $T_{15}$ (seed soaking with cow urine 10 (%) + 12 hours + Azotobacter). This might be due to fact that, gibberellic acid increase somatic uptake of nutrients, causing cell elongation and thus increasing the length of tap root. The results obtained in accordance with the results of earlier workers Palanisamy and Ramamoorthy (1987); Anburani and Shakila (2010) [2]; Anjanawe *et al.* (2013) [3] in papaya.

*Azotobacter* also helps with other growing media in creating sufficient porus space to permit adequate aeration, improved soil texture, structure, water holding capacity, activity of usefull micro flora and fauna ,maintained soil temperature and improved soil health and nutrient status of medium for better root growth. The findings are closely associated with the Hartmann and Kester (1997) and Madgaonkar *et al.* (2013) [20] in rough lemon and *Amaranthus paniculatus*, respectively.

On the basis of pooled data (Table 2), at 60 days after sowing, maximum stem girth of the sapling 4.84 cm was recorded in the treatment $T_{11}$ (seed soaking with 150 ppm $GA_3$ + 12 hours + Azotobacter) followed by 4.72 mm in treatment $T_{10}$ (seed soaking with 150 ppm $GA_3$ + 06 hours + Azotobacter) and 4.54 mm in the treatment $T_7$ (seed soaking with 100 ppm $GA_3$ + 12 hours + Azotobacter). The increase in stem diameter as result of gibberellic acid application might be due to the fact that, $GA_3$ increase somatic uptake of nutrients, causing cell elongation and thus increasing height of the plant (Feucht and Watson, 1958) [13]. Gibberellic acid application may be attributed to the cell multiplication and elongation in the cambium tissue. The results are closely associated with the findings of Hore and Sen (1985) [16] in bael, Dhankar and Singh (1996) [11] in aonla and Barche *et al.* (2010) [6]; Meena and Jain (2012) [21]; Deb *et al.* (2010) [10]; Anjanwe *et al.* (2013); and Amit Desai *et al.* (2017) [9] in papaya.

On the basis of pooled data (Table 2), the maximum fresh weight of shoot of the sapling 18.50 g was recorded in the treatment $T_{15}$ (seed soaking with cow urine 10 (%) + 12 hours + Azotobacter) followed by 18.31 g in treatment $T_{14}$ (Cow urine 10 (%) + 06 hours + Azotobacter) and 15.44 g in the treatment $T_{11}$ (seed soaking with 150 ppm $GA_3$ + 12 hours + Azotobacter). This might be due to the cow urine contains physiologically active substances *viz.*, growth regulators, nutrients (Josef and Nair, 1989) [17] and trace elements (Munoz, 1988) [23] which helped to increase growth and development of seedlings leads to increase fresh weight of shoot. This finding is closely associated with the Amit Desai *et al.* (2017) [9] in papaya.

On the basis of pooled data (Table 2), at 60 days after sowing, the maximum fresh weight of root of the sapling 2.88 g was recorded in the treatment $T_{11}$ (seed soaking with 150 ppm $GA_3$ + 12 hours + Azotobacter) followed by 2.83 g in treatment $T_{10}$ (seed soaking with 150 ppm $GA_3$ + 06 hours + Azotobacter) and 2.82 g in the treatment $T_{15}$ (seed soaking with cow urine 10 (%) + 12 hours + Azotobacter). The results are closely associated with the findings of Pamapanna and Sulikeri (1999) in sapota, Pandit *et al.* (2001) [26] and Amit Desai *et al.* (2017) [9] in papaya,

On the basis of pooled data (Table 2), at 60 days after sowing, the maximum fresh weight of papaya saplings 21.31 g was recorded in the treatment $T_{15}$ (seed soaking with cow urine 10 (%) + 12 hours + Azotobacter) followed by 21.05 g in treatment $T_{14}$ (seed soaking with cow urine 10 (%) + 06 hours + Azotobacter) and 18.32 g in the treatment $T_{11}$ (seed soaking with 150 ppm $GA_3$ + 12 hours + Azotobacter).

On the basis of pooled data (Table 2), at 60 days after sowing, the maximum dry weight of the papaya sapling 2.76 g was recorded in the treatment $T_{11}$ (seed soaking with 150 ppm $GA_3$ + 12 hours + Azotobacter) followed by 2.63 g in treatment $T_{10}$ (seed soaking with 150 ppm $GA_3$ + 06 hours + Azotobacter) and 2.53 g in the treatment $T_{15}$ (seed soaking with cow urine 10 (%) + 12 hours + Azotobacter).The increased fresh and dry weight of seedling may be due to the enhanced root and shoot length. Thus the increase in root length have lead to the overall assimilation and redistribution of photosynthates within the plant and resulted in higher fresh and dry weight of seedling and increased dry matter assimilation (Choudhary and Chakrawar, 1982) [8]. The results are closely associated with the Palaniswamy and Ramamurthy (1987); Kumar *et al.* (2011) [19] and Amit Desai *et al.* (2017) [9] in papaya.

**Table 1:** Effect of different $GA_3$ concentrations, cow urine and bio-fertilizers on seedling growth of papaya

| Treatments | Plant height (cm) | | | Number of leaves | | | Length of shoot (cm) | | | Number of roots | | | Length of roots (cm) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2018 | 2019 | Pooled | 2018 | 2019 | Pooled | 2018 | 2019 | Pooled | 2018 | 2019 | Pooled | 2018 | 2019 | Pooled |
| $T_1$ | 19.11 | 19.19 | 19.14 | 5.87 | 5.80 | 5.83 | 12.84 | 12.88 | 12.86 | 07.90 | 07.80 | 07.85 | 06.27 | 06.30 | 06.29 |
| $T_2$ | 32.40 | 32.43 | 32.42 | 9.27 | 9.33 | 9.30 | 24.12 | 24.10 | 24.11 | 13.60 | 13.53 | 13.57 | 08.28 | 08.33 | 08.31 |
| $T_3$ | 32.88 | 32.93 | 32.89 | 9.70 | 9.73 | 9.72 | 24.35 | 24.35 | 24.35 | 12.73 | 12.67 | 12.70 | 08.53 | 08.57 | 08.55 |
| $T_4$ | 21.59 | 21.51 | 21.57 | 6.20 | 6.27 | 6.23 | 14.23 | 14.14 | 14.17 | 10.00 | 10.07 | 10.03 | 07.36 | 07.40 | 07.38 |
| $T_5$ | 22.44 | 22.54 | 22.48 | 6.57 | 6.70 | 6.63 | 14.59 | 14.65 | 14.62 | 11.50 | 11.43 | 11.47 | 07.85 | 07.90 | 07.87 |
| $T_6$ | 35.86 | 35.95 | 35.90 | 10.47 | 10.53 | 10.50 | 26.25 | 26.26 | 26.27 | 15.37 | 15.30 | 15.33 | 09.62 | 09.66 | 09.64 |
| $T_7$ | 36.41 | 36.52 | 36.45 | 11.27 | 11.33 | 11.30 | 26.43 | 26.50 | 26.47 | 14.50 | 14.43 | 14.47 | 09.98 | 10.02 | 10.00 |
| $T_8$ | 24.66 | 24.77 | 24.70 | 7.07 | 7.03 | 7.05 | 15.43 | 15.47 | 15.46 | 13.60 | 13.63 | 13.62 | 09.24 | 09.28 | 09.26 |
| $T_9$ | 25.63 | 25.72 | 25.67 | 7.40 | 7.30 | 7.35 | 15.88 | 15.92 | 15.90 | 14.10 | 14.20 | 14.15 | 09.75 | 09.79 | 09.77 |
| $T_{10}$ | 41.32 | 41.37 | 41.34 | 11.50 | 11.57 | 11.53 | 28.18 | 28.15 | 28.18 | 18.37 | 18.10 | 18.23 | 13.14 | 13.19 | 13.17 |
| $T_{11}$ | 41.94 | 41.74 | 41.87 | 11.87 | 11.93 | 11.90 | 28.44 | 28.35 | 28.38 | 18.77 | 18.53 | 18.65 | 13.49 | 13.42 | 13.46 |
| $T_{12}$ | 25.16 | 25.19 | 25.17 | 7.47 | 7.57 | 7.52 | 15.10 | 15.14 | 15.11 | 16.10 | 16.17 | 16.13 | 10.06 | 10.08 | 10.07 |
| $T_{13}$ | 25.87 | 25.97 | 25.92 | 7.70 | 7.77 | 7.73 | 15.47 | 15.55 | 15.50 | 16.47 | 16.40 | 16.43 | 10.40 | 10.44 | 10.42 |
| $T_{14}$ | 32.56 | 32.85 | 32.67 | 12.27 | 12.33 | 12.30 | 21.5 | 21.63 | 21.56 | 17.30 | 17.27 | 17.28 | 11.06 | 11.24 | 11.15 |
| $T_{15}$ | 33.00 | 33.38 | 33.14 | 12.80 | 12.87 | 12.83 | 21.66 | 21.98 | 21.83 | 17.80 | 17.63 | 17.72 | 11.34 | 11.39 | 11.37 |
| $T_{16}$ | 23.97 | 24.05 | 24.00 | 8.07 | 7.97 | 8.02 | 13.47 | 13.50 | 13.49 | 15.47 | 15.40 | 15.43 | 10.50 | 10.55 | 10.52 |
| $T_{17}$ | 23.80 | 23.91 | 23.83 | 8.47 | 8.53 | 8.50 | 13.79 | 13.85 | 13.82 | 15.50 | 15.67 | 15.58 | 10.01 | 10.06 | 10.03 |
| SEm± | 0.027 | 0.041 | 0.040 | 0.048 | 0.096 | 0.058 | 0.021 | 0.019 | 0.014 | 0.077 | 0.150 | 0.087 | 0.014 | 0.039 | 0.009 |
| C.D. at 5% | 0.077 | 0.120 | 0.114 | 0.138 | 0.276 | 0.167 | 0.061 | 0.054 | 0.040 | 0.221 | 0.433 | 0.252 | 0.040 | 0.112 | 0.027 |

**Table 2:** Effect of different $GA_3$ concentrations, cow urine and bio-fertilizers on seedling growth of papaya

| Treatments | Stem girth (mm) | | | Fresh weight of shoot (g) | | | Fresh weight of root (g) | | | Fresh weight of sapling (g) | | | Dry weight of sapling (g) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2018 | 2019 | Pooled | 2018 | 2019 | Pooled | 2018 | 2019 | Pooled | 2018 | 2019 | Pooled | 2018 | 2019 | Pooled |
| $T_1$ | 2.42 | 2.45 | 2.44 | 04.63 | 04.74 | 04.69 | 1.15 | 1.13 | 1.14 | 05.78 | 05.87 | 05.83 | 1.16 | 1.25 | 1.21 |
| $T_2$ | 4.25 | 4.27 | 4.26 | 13.13 | 13.16 | 13.15 | 2.03 | 2.05 | 2.04 | 15.16 | 15.22 | 15.19 | 1.98 | 2.07 | 2.03 |
| $T_3$ | 4.33 | 4.34 | 4.33 | 13.35 | 13.38 | 13.36 | 2.15 | 2.16 | 2.16 | 15.5 | 15.54 | 15.52 | 2.16 | 2.23 | 2.20 |
| $T_4$ | 2.61 | 2.59 | 2.60 | 06.61 | 06.64 | 06.62 | 1.47 | 1.48 | 1.47 | 08.08 | 08.11 | 08.10 | 1.28 | 1.38 | 1.33 |
| $T_5$ | 2.65 | 2.63 | 2.64 | 06.83 | 06.85 | 06.84 | 1.54 | 1.51 | 1.53 | 08.37 | 08.36 | 08.37 | 1.40 | 1.49 | 1.45 |
| $T_6$ | 4.47 | 4.50 | 4.49 | 14.52 | 14.55 | 14.54 | 2.57 | 2.59 | 2.58 | 17.09 | 17.14 | 17.12 | 2.28 | 2.24 | 2.26 |
| $T_7$ | 4.53 | 4.53 | 4.54 | 14.78 | 14.80 | 14.79 | 2.56 | 2.63 | 2.60 | 17.34 | 17.43 | 17.39 | 2.35 | 2.28 | 2.32 |
| $T_8$ | 2.71 | 2.74 | 2.73 | 07.54 | 07.59 | 07.56 | 1.65 | 1.66 | 1.66 | 09.19 | 09.25 | 09.22 | 1.50 | 1.52 | 1.51 |
| $T_9$ | 2.84 | 2.86 | 2.85 | 07.83 | 7.85 | 07.84 | 1.70 | 1.73 | 1.72 | 09.53 | 09.58 | 09.56 | 1.56 | 1.55 | 1.56 |
| $T_{10}$ | 4.71 | 4.74 | 4.72 | 15.20 | 15.24 | 15.22 | 2.84 | 2.81 | 2.83 | 18.04 | 18.05 | 18.05 | 2.64 | 2.62 | 2.63 |
| $T_{11}$ | 4.83 | 4.85 | 4.84 | 15.41 | 15.46 | 15.44 | 2.89 | 2.87 | 2.88 | 18.30 | 18.33 | 18.32 | 2.74 | 2.77 | 2.76 |
| $T_{12}$ | 2.83 | 2.85 | 2.84 | 08.57 | 08.61 | 08.59 | 1.91 | 1.88 | 1.90 | 10.48 | 10.50 | 10.49 | 1.73 | 1.74 | 1.74 |
| $T_{13}$ | 2.92 | 2.94 | 2.94 | 08.92 | 08.97 | 08.95 | 1.97 | 1.94 | 1.96 | 10.89 | 10.91 | 10.91 | 1.83 | 1.87 | 1.85 |
| $T_{14}$ | 4.14 | 4.16 | 4.15 | 18.29 | 18.34 | 18.31 | 2.75 | 2.73 | 2.74 | 21.04 | 21.07 | 21.05 | 2.44 | 2.50 | 2.48 |
| $T_{15}$ | 4.23 | 4.25 | 4.24 | 18.47 | 18.51 | 18.50 | 2.83 | 2.80 | 2.82 | 21.30 | 21.32 | 21.31 | 2.53 | 2.54 | 2.53 |
| $T_{16}$ | 2.57 | 2.56 | 2.57 | 12.42 | 12.47 | 12.44 | 1.75 | 1.78 | 1.77 | 14.17 | 14.24 | 14.21 | 1.61 | 1.65 | 1.63 |
| $T_{17}$ | 2.67 | 2.59 | 2.63 | 12.71 | 12.76 | 12.74 | 1.84 | 1.87 | 1.85 | 14.55 | 14.63 | 14.59 | 1.69 | 1.71 | 1.70 |
| SEm± | 0.009 | 0.030 | 0.016 | 0.015 | 0.042 | 0.027 | 0.019 | 0.023 | 0.017 | 0.023 | 0.047 | 0.031 | 0.013 | 0.052 | 0.029 |
| C.D. at 5% | 0.025 | 0.087 | 0.047 | 0.044 | 0.122 | 0.079 | 0.056 | 0.067 | 0.049 | 0.067 | 0.136 | 0.090 | 0.037 | 0.149 | 0.083 |

## Conclusion

From the foregoing discussion it can be concluded that among the different treatment combination $T_{11}$ (Seed soaking with 150 pppm $GA_3$ for 12 hours + Azotobacter) is found superior and most effective for better growth of papaya seedlings over the rest of the treatment combinations.

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