# Effect of different pre - sowing seed treatments on germination and growth of papaya(*Carica papaya* L.) seedlings cv. Arka Surya


## ABSTRACT

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A study on effect of pre-sowing seed treatments with organics, chemicals and plant growth regulators on seed germination and seedlings growth of papaya cv. Arka Surya was carried out at YSRHU- College of Horticulture, Anantharajupeta during the year 2021 - 2022, under complete randomized design with eighteen treatments and replicated thrice. The papaya seeds were subjected to various organic, chemicals and plant growth regulators treatments. Papaya seeds soaked in $KH_2PO_4$ @ 0.5 % ($T_7$) had recorded minimum days for initiation of germination (8.67) and 50 % germination (10.34). The treated seeds had also recorded maximum germination percentage (86.66), germination index (1.16), dry weight of shoots (2.00 g), tap root length (26.33 cm), number of lateral roots per seedling (22.84), dry weight of roots (0.79 g), quality index of papaya seedlings (0.47) and seedling survivability (100.00 %). In addition the same treatment exhibited higher chlorophyll content (3.51 and 3.91 mg/g), photosynthetic rate (15.32 and 17.76 µmol $Co_2 m^{-2} s^{-1}$), transpiration rate (4.61 and 5.69 mmol $m^{-2}$ $s^{-1}$) and stomatal conductance(2.73 and 4.12 mol $m^{-2}$ $s^{-1}$) at 35 and 45 DAS, respectively. While the lowest values for germination and growth parameters were observed in treatment salicylic acid @ 2 mM ($T_{16}$). Among all the treatments, $KH_2PO_4$ @ 0.5 % ($T_7$) was found to be superior to the other treatments followed by $KNO_3$ @ 0.5 % for the enhancement of germination, growth and physiological traits.



**Key words:** Papaya, Chemicals, Plant growth regulators, Seed germination


## INTRODUCTION

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Define research gap and/or hypothesis clearly and write objective/ objectives of the study followed by research gap.

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Papaya (*Carica papaya* L.) is one of the important fruit crop belongs to the family *Caricaceae* grown in tropical to subtropical areas all over the world. It is popularly termed as wonder fruit and known by different vernacular names like papaw or paw paw (Australia), mamao (Brazil) and tree melon (China). It has emerged from the status of a home garden plant to that of commercial orchards because of the availability of fruits throughout the year, ease of cultivation and the quick returns (Drew et al. 1998).There is a wide diversity of biological types of cultivated papaya, which may be dioecious, monoecious and hermaphrodite (Arrilia et al., 1980).InIndia,papaya was introduced in early part of $16^{th}$ century from Philippines through Malaysia. It is mostly cultivated in the states of Andhra Pradesh, Karnataka, Gujarat, Orissa, West Bengal, Assam, Kerala, Madhya Pradesh and Maharashtra.

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Papaya is mainly propagated by seeds which show wide variability in germination and seedling growth. Hence, healthy seedlings are the pre-requisite to reap the potential yield. Some of the problems faced by papaya growers at nursery stage are slow, erratic growth and high initial seedling mortality. Thus, producing healthier and quality seedlings obtained from a nursery influences establishment in the field and the eventual productivity of an orchard (Dayeswari *et al*., 2018).The seed is enclosed with a whitish a gelatinous sarcotesta (aril, or outer seed coat which is formed from the outer integument) which can prevent germination (Yahiro, 1979). Pre-soaking of the seeds in water or water soluble endogenous hormones has been reported to promote germination (Riely, 1981).

Proper seed germination and seedling growth are most important considerations in successful production under nursery technique of papaya cultivation. The seed cost of many gynodioceious cultivars of papaya is very high.So increasing germination and producing vigorous seedling are very important for papaya nursery growers. In view of several treatments in improving the seed germination, the present study is planned to assess the possibility of hastening seed germination and promoting seedling growth in papaya with the help of different organics, chemicals and plant growth regulators there by reducing the duration of plants handling in the nursery.



## MATERIALS AND METHODS

The present experiment was carried out in Fruit Science block, department of Fruit Science, YSRHU - College of Horticulture, Anantharajupeta during the year 2021 - 2022. The trial was conducted in Completely Randomized Design with three replications. The seed material was procured from the ICAR-Indian Institute of Horticultural Research, Bengaluru, Karnataka. Papaya seeds were treated with different pre-sowing treatments *viz.*, $T_1$: Seaweed extract @ 3 ml/l, $T_2$: Seaweed extract @ 4 ml/l, $T_3$: Panchagavya @ 1.5 %, $T_4$: Panchagavya @ 3.0 %, $T_5$: $Ca(ClO)_2$ @ 0.5 %, $T_6$: $Ca(ClO)_2$ @ 1 %, $T_7$: $KH_2PO_4$ @ 0.5 %, $T_8$: $KH_2PO_4$ @ 1.0 %, $T_9$: $KNO_3$ @ 0.5 %, $T_{10}$: $KNO_3$ @ 1 %, $T_{11}$: Putrescine @ 25 Mm, $T_{12}$: Putrescine @ 50 mM, $T_{13}$: Brassinosteroids @ 0.2 ppm, $T_{14}$: Brassinosteroids @ 0.4 ppm, $T_{15}$: Salicylic acid @ 1 mM, $T_{16}$: Salicylic acid @ 2 mM, $T_{17}$: Trisodium phosphate @ 500 ppm, $T_{18}$: control for 12 hours. The treated seeds were shade dried for 15 minutes and sown in polythene bags of 9 ×x 3 inches size which were properly filled with soil and labelled with tags. Observations on number of days taken for initiation of germination, days taken to reach 50 % germination, seed germination percentage, germination Iindex and growth characteristics *viz.*, height of the seedling, diameter of the stem, number of leaves,leaf area were recorded at 25, 35 and 45 days after sowing. Dry weight of shoots, length of taproot, number of lateral roots, dry weight of the roots (g), root to shoot ratio (dry weight basis), vigor Index, quality Index and seedling survivability were recorded at 45 days after sowing and. Physiological attributes (leaf temperature, chlorophyll content, photosynthetic rate, transpiration rate, stomatal conductance) were recorded at 35 and 45 days after sowing.

**Comment [H3]:** Information on soil and climate/weather is missing.
Information on crop growing practices need to be given in this section which is missing;
Procedure for measurement of parameter or else references for the procedure need to be given;
Information on statistical analysis procedure software used need to be given.

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## RESULTS AND DISCUSSION

### A. Germination parameters

The data pertaining to the effect of pre-sowing treatments on germination attributes are depicted in table - 1 showed a significant influence on germination attributes.

**a) Number of days taken for initiation of germination**

The minimum days taken for initiation of germination of papaya seeds (8.67 days) was recorded in seeds treated with $KH_2PO_4$ @ 0.5 % ($T_7$) whereas, maximum number of days (13.00) taken for initiation of germination was recorded in the seeds treated with salicylic acid @ 2 mM ($T_{16}$).The present findings are in accordance with the findings of (Aswin *et al*. (2019) in tomato, Arin *et al* (2020) in onion, Balaji and Narayanan (2019) in millets and Sathish and Sundareswaran (2010) in maize Hybrid COH (M) 5.

**b) Days taken to reach 50 % germination**

The minimum number of days taken to reach 50 % germination (10.34 days) was recorded in treating the seeds with $KH_2PO_4$ @ 0.5 % ($T_7$) however, the maximum number of days (17.00) taken to reach 50 % germination was noticed in seeds treated with salicylic acid @ 2 mM ($T_{16}$). The present findings are in conformity with the findings of Sathish and Sundareswaran (2010) in Maize hybrid COH(M) 5.

**c) Seed germination (%)**

Maximum seed germination percentage (86.66 %) was noticed when the seeds soaked in $KH_2PO_4$ @ 0.5 % ($T_7$) and it was on par with $KNO_3$ @ 0.5 % ($T_9$) (82.22) and putrescine @ 25 mM ($T_{11}$) (80.00 %), whereas, minimum seed germination percentage (54.44 %) was recorded with salicylic acid @ 2 mM ($T_{16}$).The minimum number of days taken for initiation of germination, days required to reach 50 % germination and increase in germination percentage as a result of seed treated with $KH_2PO_4$ @ 0.5 % ($T_7$) in the present study might be due to weakened the seed coat by the chemical and may also due to the fact that germination inhibitors might have washed away due to priming. The current study findings are in accrordance with results of Sahib *et al*. (2014) in okra, Singh and Bassi (2016) in bitter gourd, Aswin *et al*. (2019) in tomato, Sathish *et al.* (2011), Balaji and Narayanan *et al.* (2019) in maize cv. CO1 and Yari *et al*. (2010) in wheat seeds

**d) Germination Index**

The maximum germination index (1.16) was noticed when the seeds were treated with $KH_2PO_4$ @ 0.5 % ($T_7$) which was found to be at par with putrescine @ 25 mM ($T_{11}$) (1.03) whereas, minimum germination index (0.17) was recorded in treatment consist of salicylic acid @ 2 mM ($T_{16}$). The maximum germination index with $KH_2PO_4$ @ 0.5 % ($T_7$) might be due to its influence in inducing early germination and thus increased percent germination. The results are in conformity with findings of Sahib *et al*. (2014) in okra.

### B. Growth parameters

**Comment [H4]:** Combine a) Number of days taken for initiation of germination and b) Days taken to reach 50 % germination as the trend was remain same.
Write the results in terms of statistical terms rather than writing maximum and minimum?
Discuss the results rather than just enlisting the references;
Write the results only for significant parameters and also for significant treatment rather than reading entire table or writing maximum and minimum values.
Avoid writing non-significant results (For example number of leaves per seedling).
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**a) Height of the seedling (cm)**

It was observed from the data (Table- 2) the maximum height of the seedling(11.52, 22.22 and 30.64 cm) was recorded when seeds were treated with $KH_2PO_4$ @ 0.5 % ($T_7$) and it was found to be on par with treatment $T_9$ ($KNO_3$ @ 0.5 %) having plant height of 10.39, 20.53 and 29.12 cm. Whereas, the minimum plant height (7.16, 13.31 and 19.24 cm) were observed in treatment salicylic acid @ 2 mM ($T_{16}$) at 25, 35 and 45 DAS, respectively.

**b) Diameter of the stem (mm)**

From the pooled mean (Table - 3) it was observed that the maximum diameter of the stem (3.42, 6.68 and 9.34 mm) was recorded when seeds were treated with $KH_2PO_4$ @ 0.5 % ($T_7$). Whereas, the minimum (2.29, 4.02 and 6.25 mm) were observed in treatment salicylic acid @ 2 mM ($T_{16}$) at 25, 35 and 45 DAS, respectively.

Seed treatment with $KH_2PO_4$ @ 0.5 % resulted with maximum diameter of the stem. It may be due to improved seed germination, earlier seedling emergence and better seedling growth that led to the maximum seedling diameter. These factors might have improved the nutrient uptake after seedling germination, which increased the production of higher amount of assimilate and increased stem diameter. The results of the present study are in tandem with findings of Reddy and Reddy (2017) and Shaban, (2010).

**c) Number of leaves per seedling**

The perusal of the pooled mean presented in table - 4 indicated that pre-sowing seed treatments with organics, chemicals, and plant growth regulators had no significant effect on the number of leaves per seedling at 25, 35, and 45 DAS. However, the maximum number of leaves (6.24, 8.63 and 11.10) were recorded with $KH_2PO_4$ @ 0.5 % ($T_7$) and the minimum (4.74, 6.97 and 9.27) with salicylic acid @ 2 mM ($T_{16}$) at 25, 35, and 45 DAS, respectively.

**d) Leaf area ($cm^2$)**

The maximum leaf area of the seedling (Table- 5) (60.32, 89.40 and 111.84$cm^2$) was recorded when seeds were treated with $KH_2PO_4$ @ 0.5 % ($T_7$). Whereas, the minimum (18.56, 45.00 and 64.62 $cm^2$) were observed in treatment salicylic acid @ 2 mM ($T_{16}$) at 25, 35 and 45 DAS, respectively.

**e) Dry weight of shoots (g)**

Seed treatment with $KH_2PO_4$ @ 0.5 % ($T_7$) (Table - 6 ) recorded maximum dry weight of shoots (2.00 g) and minimum was (0.78 g) was recorded in salicylic acid @ 2 mM ($T_{16}$). The maximum accumulation of dry weight of shoots in $KH_2PO_4$ @ 0.5 % treated seeds might be due to early emergence of seeds that promoted plants to accumulate biomass at faster rate and formation of longer shoots helped in better absorption of moisture and nutrients as well as shoots through which photosynthetic production would have increased that ultimately leads to more dry weight of shoots.

Similar results were obtained by Dayeswari *et al*. (2018) in papaya, Mura *et al*. (2015) in sesame, Gayathri (2001) in tomato, Singh and Bassi (2016) in bitter gourd, Ghassemi-

Golezani *et al*. (2008) in lentil, Ahmadvand *et al*. (2012) in soybean, Singh and Agarwal (1988) in soybean and Sathish *et al*. (2011) in maize hybrid.

**f) Length of taproot (cm)**

The seed treatments significantly influenced the tap root length. The pooled mean showed that (Table - 6 ), the maximum tap root length (24.67 cm) was noticed in seed treatment with $KH_2PO_4$ @ 0.5 % ($T_7$) and was found to be significantly superior over all the other treatments. Whereas, minimum tap root length (16.33 cm) was recorded in seed treatment with salicylic acid @ 2 mM ($T_{16}$).

**g) Number of lateral roots per seedling**

Maximum number of lateral roots per seedling (22.84)(Table - 6 ) was noticed in treatment $KH_2PO_4$ @ 0.5 % ($T_7$) which was found to be at par with $KNO_3$ @ 0.5 % ($T_9$) (21.33), $KH_2PO_4$ @ 1 % ($T_8$) (20.34) and putrescine @ 25 mM ($T_{11}$) (19.50), whereas, minimum number of lateral roots per seedling (12.00) was recorded in treatment salicylic acid @ 2 mM ($T_{16}$).

**h) Dry weight of the roots (g)**

The pooled mean (Table - 6) indicated that, dry weight of roots was significantly influenced by various pre sowing seed treatments. The dry weight of roots varied from 0.16 to 0.79 g. The maximum dry weight of roots (0.79 g) was recorded in treatment $T_7$ ($KH_2PO_4$ @ 0.5 %).Whereas, the minimum root dry weight (0.16 g) of the seedlings was observed in treatment $T_{16}$ (salicylic acid @ 2 mM). The increase in root dry weight might be due to advanced seed germination, formation of roots and better absorption of nutrients from the medium which improved root development and increases root dry weight. The present findings are in accordance with the findings of Dayeswari *et al*. (2018) in papaya, Rangaswamy *et al*. (1993) in groundnut, Ghassemi-Golezani *et al*. (2008) in lentil, Shehzad *et al*. (2012) in sorghum, and Singh and Bassi (2016) in bitter gourd.

**i) Root to shoot ratio (Dry weight basis)**

Data presented in table - 7 indicated that pre-sowing seed treatments with organic, chemicals, and plant growth regulators had no significant effect on root to shoot ratio of papaya seedling at 45 DAS. The pooled data of two consecutive years *i.e.* 2021 and 2022 clearly indicated that the minimum root to shoot ratio (0.22 g) was recorded in treatment $T_{16}$ (Salicylic acid @ 2 mM) whereas, the maximum root to shoot ratio (0.42 g) was observed in treatments $T_7$ ($KH_2PO_4$ @ 0.5 %) and $T_1$ (Seaweed extract @ 3 ml/l).

**j) Seedling vigor index**

The maximum vigour index of papaya seedlings (2652.44) (Table - 7) was recorded when the seeds treated with $KH_2PO_4$ @ 0.5 % ($T_7$) which was found to be at par with treatments $T_9$ ($KNO_3$ @ 0.5 %) (2394.77) whereas, minimum vigour index (280.37) was recorded in the treatment salicylic acid @ 2 mM ($T_{16}$). The maximum vigour index in treatment $KH_2PO_4$ might be due to seed soaking with $KH_2PO_4$ improved root-shoot length and germination %, which resulted in an increase in vigour index. These results are in agreement with the findings of Thiruppathi and Mullaimaran(2020) in papaya, Aswin *et al*. (2019) in tomato, Sahib *et al*. (2014) in okra, Pandey *et al*. (2017) in cucumber, Paul and Choudhury (1993) in wheat, Balaji and Narayanan *et al*. (2019) in maize cv. CO1 and Menaka and Vanangamudi (2009) in sorghum and Singh and Bassi (2016) in bitter gourd.

**k) Quality index**

The maximum quality index of papaya seedlings (0.47) (Table - 7) was seen in treatment $KH_2PO_4$ @ 0.5% ($T_7$), which was on par with treatment $T_9$ ($KNO_3$) (0.47), however the treatments salicylic acid @ 1 mM ($T_{15}$) and salicylic acid @ 2 mM ($T_{16}$) had the lowest quality index (0.12). Quality index is a assessment of seedling quality based on height, stem diameter, and dry biomass ($T_7$). In this pooled analysis the quality assessment characters were found maximum with seed treatment with $KH_2PO_4$. This mightbe due to the fact that in this treatment, the majority of growth parameters and seedling biomass parameters were recorded maximum.

**l) Seedling survivability (%)**

The data pertaing to table - 7 showed that pre-sowing seed treatments with organics, chemicals, and plant growth regulators had no appreciable impact on the survivability of seedlings of papaya. The pooled mean of two consecutive years *i.e.* 2021 and 2022 clearly indicated that the minimum seedling survivability (83.33 %) was recorded in treatment $T_{16}$ (Salicylic acid @ 2 mM) whereas, the maximum seedling survivability (100.00 %) was observed in treatment $T_7$ ($KH_2PO_4$ @ 0.5 %). The easy root and shoot development, making the seedling stronger to endure transplanting stress, resistance to root infections, and better growth are the likely causes of the greater survival rate of papaya seedlings. The present findings are in accordance with the results obtained by Thiruppathi and Mullaimaran(2020) in papaya.

**j) Leaf temperature (°c)**

It was evident from the data (Table - 8) that pre-sowing seed treatments with organic, chemicals, and plant growth regulators had no significant effect on the leaf temperature of seedling at 35 and 45 DAS.The pooled mean of two consecutive years *i.e.* 2021 and 2022 at 35 DAS clearly indicated that the minimum leaf temperature of seedling (30.02 °C) was recorded in treatment $T_9$ ($KNO_3$ @ 0.5 %) whereas, the maximum leaf temperature of seedling (31.68 °C) was observed in treatment $T_{16}$ (Salicylic acid @ 2 mM).At 45 DAS, minimum leaf temperature of seedling (31.88 °C) was recorded in treatment $T_9$ ($KNO_3$ @ 0.5 %) whereas, the maximum leaf temperature (33.92 °C) was observed in treatment $T_{16}$ (Salicylic acid @ 2 mM).

**k) Chlorophyll content of the leaves (mg g$^{-1}$)**

The chlorophyll content of the leaves of papaya seedlings was recorded at 35 and 45 DAS was depicted in table - 8 and it was found that the chlorophyll content was significantly altered by the organics, chemicals and plant growth regulators. At 35 DAS, the pooled mean showed that the minimum chlorophyll content (2.22 mg) in the leaves was recorded in treatment salicylic acid @ 2 mM ($T_{16}$) whereas, the maximum chlorophyll content (3.51 mg) was recorded in treatment $KH_2PO_4$ @ 0.5 % ($T_7$).The pooled data of two consecutive years *i.e.* 2021 and 2022 at 45 DAS clearly indicated that the minimum chlorophyll content (2.78 mg) was recorded in treatment salicylic acid @ 2 mM ($T_{16}$) whereas, the maximum chlorophyll content (3.91 mg) was recorded in treatment $KH_2PO_4$ @ 0.5 % ($T_7$).

The increase in chlorophyll content in papaya seedlings treated with $KH_2PO_4$ @ 0.5 % could be attributed to the role of potassium in maintaining leaf turgor and assisting in the opening and closing of leaf stomata. Increased stomatal conductivity results in increased transpiration rate, photosynthetic process that results in maximum chlorophyll content. Potassium also plays a vital role in preventing the decomposition of newly produced chlorophyll (Tanaka and Tsuji, 1980). The present findings are in accordance with the findings of Dayeswari *et al*. (2018) in papaya, Anwar *et al*. (2020) in cucumber and Yanglem *et al*. (2021) in pea.

**l) Photosynthetic rate (µmol $Co_2m^{-2}s^{-1}$)**

The data regarding photosynthetic rate of papaya seedlings as influenced by organics, chemicals and plant growth regulators were recorded at 35 and 45 DAS and are presented in table - 9. The data indicated that photosynthetic rate of papaya seedlings was significantly influenced by the various pre sowing seed treatments. Pooled mean indicated that, at 35 DAS, the maximum photosynthetic rate of papaya seedlings (15.32 µmol $Co_2m^{-1}s^{-1}$) was noticed in treatment $KH_2PO_4$ @ 0.5% ($T_7$) followed by treatment $KNO_3$ @ 0.5 % ($T_9$) (14.78 µmol $Co_2m^{-2}s^{-1}$). However, the treatments salicylic acid @ 2 mM ($T_{16}$) had recorded the minimum photosynthetic rate (9.80 µmol $Co_2m^{-1}s^{-1}$).At 45 DAS, the maximum photosynthetic rate (17.76 µmol $Co_2m^{-2}s^{-1}$) was recorded in treatment $KH_2PO_4$ @ 0.5% ($T_7$) followed by treatment putrscine @ 25 mM ($T_{11}$) (16.65 µmol $Co_2m^{-1}s^{-1}$), however the treatments salicylic acid @ 2 mM ($T_{16}$) had showed the minimum photosynthetic rate (12.63 µmol $Co_2m^{-1}s^{-1}$).

**m) Transpiration rate (mmol $m^{-2}$ $s^{-1}$)**

The data presented in table - 9 signifies the effect of transpiration rate of papaya seedlings at 35 and 45 DAS as influenced by organics, chemicals, and plant growth regulators. It was evident from the data that the various pre-sowing seed treatments had a substantial impact on transpiration rate of papaya seedlings. The pooled mean of two consecutive years *i.e.* 2021 and 2022 clearly showed at 35 DAS that the highest transpiration rate (4.61) of papaya seedlings was found in treatment $KH_2PO_4$ @ 0.5 % ($T_7$), followed by treatments putrescine @ 25 mM ($T_{11}$) with transpiration rate of 4.46 (mmol $m^{-2}$ $s^{-1}$) however, the lowest transpiration rate (2.65 mmol $m^{-2}$ $s^{-1}$) was observed in treatment salicylic acid @ 2 mM. ($T_{16}$).

At 45 DAS, the highest transpiration rate (5.69 mmol $m^{-2}$ $s^{-1}$) of papaya seedlings was found in treatment $KH_2PO_4$ @ 0.5% ($T_7$), followed by treatments $T_9$ ($KNO_3$ @ 0.5 %) with transpiration rate of 5.64 mmol $m^{-2}$ $s^{-1}$ however, the lowest transpiration rate (2.85 mmol $m^{-2}$ $s^{-1}$) was observed in treatment salicylic acid @ 2 mM. ($T_{16}$).$KH_2PO_4$ @ 0.5 % treatment had the highest transpiration rate of papaya seedlings, followed by treatment $KNO_3$. This could be due to potassium, which is required for stomatal function via maintaining turgor pressure and is expected to improve stomatal conductivity there by increase in transpiration rate (Pervez *et al*., 2004).The present findings are in line with the results obtained by Waraich *et al*. (2020) in canola, Mookhrjee (2014) in *Brassica rapa*, Anwar *et al*. (2020) in cucumber and Ali *et al*. (2020) in tomato.

**n) Stomatal conductance (mol $m^{-2}$ $s^{-1}$)**

The data regarding stomatal conductance of papaya seedlings as influenced by organics, chemicals and plant growth regulators were recorded at 35 and 45 DAS are presented in table - 10. The data showed that, The stomatal conductance of papaya seedlings was significantly influenced by the various pre sowing seed treatments (Table 10). Pooled mean indicated that, at 35 DAS, the maximum stomatal conductance of papaya seedlings (2.73 mol $m^{-2}$ $s^{-1}$) was noticed in treatment $KH_2PO_4$ @ 0.5% ($T_7$) followed by treatment $T_{13}$ (Brassinosteriods @ 0.2 ppm) (2.02 mol $m^{-2}$ $s^{-1}$), however the treatments salicylic acid @ 2 mM ($T_{16}$) had the lowest stomatal conductance (0.52).

At 45 DAS, the maximum stomatal conductance of papaya seedlings (4.12 mol $m^{-2}$ $s^{-1}$) was seen in treatment $KH_2PO_4$ @ 0.5% ($T_7$) followed by treatment $T_9$ ($KNO_3$) (3.95 mol $m^{-2}$ $s^{-1}$), however the treatments salicylic acid @ 2 mM ($T_{16}$) had the lowest stomatal conductance (0.76 mol $m^{-2}$ $s^{-1}$).The highest stomatal conductance of papaya seedlings was observed in treatment $KH_2PO_4$ @ 0.5% ($T_7$), followed by treatment $KNO_3$ ($T_9$). This could be due to potassium, which is essential for stomatal function by maintaining turgor pressure and is anticipated to increase stomatal conductivity (Pervez *et al*., 2004).Tsialtas *et al*. (2016) observed that foliar K treatment increased leaf gas exchange, sustained open stomata, and increase stomatal conductance, subsequently increased transpiration rate. The present finding are in conformity with the findings of Mookhrjee *et al*. (2014) in *Brassica rapa*, Anwar *et al*. (2020) in cucumber and Waraich *et al*. (2019) in canola.

## CONCLUSION

From the present study it was concluded that higher germination, growth parameters, seedling vigour and survival percentage of seedlings could be obtained by pre- soaking seed treatment of $KH_2PO_4$ @ 0.5 % for 10 minutes (soaking time) in papaya cv. Arka Surya.

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**Comment [H6]:** Write the conclusion in quantifiable terms (% increase in best treatment over control for important parameters)

**Table 1: Effect of different pre sowing seed treatments with organics, chemicals and PGR's on germination parameters of papaya cv. Arka Surya**

| Treatments | No. of days taken for initiation of germination | | | Days taken to reach 50 % germination | | | Seed germination percentage (%) | | | Germination index | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2021 | 2022 | Pooled mean | 2021 | 2022 | Pooled mean | 2021 | 2022 | Pooled mean | 2021 | 2022 | Pooled mean |
| $T_1$ | 10.00 | 10.33 | 10.17 | 11.00 (3.46) | 12.33 (3.65) | 11.67 (3.55) | 64.44 (53.38) | 68.88 (56.10) | 66.66 (54.72) | 0.79 | 0.78 | 0.79 |
| $T_2$ | 10.00 | 10.00 | 10.00 | 12.67 (3.69) | 12.00 (3..60) | 12.34 (3.65) | 64.44 (53.49) | 71.11 (57.49) | 67.78 (55.43) | 0.71 | 0.76 | 0.74 |
| $T_3$ | 9.00 | 10.33 | 9.67 | 11.33 (3.50) | 11.67 (3.55) | 11.50 (3.53) | 77.78 (66.76) | 68.89 (56.28) | 73.34 (59.18) | 0.87 | 0.80 | 0.84 |
| $T_4$ | 9.00 | 10.67 | 9.84 | 11.33 (3.51) | 11.67 (3.55) | 11.50 (3.53) | 66.66 (55.55) | 66.66 (55.00) | 66.66 (55.23) | 0.94 | 0.77 | 0.86 |
| $T_5$ | 9.00 | 10.00 | 9.50 | 13.33 (3.77) | 13.67 (3.82) | 13.50 (3.80) | 71.11 (57.68) | 68.89 (56.39) | 70.00 (56.99) | 0.86 | 0.84 | 0.85 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $T_6$ | 9.33 | 10.33 | 9.83 | 14.33 (3.90) | 12.67 (3.69) | 13.50 (3.80) | 82.22 (65.76) | 64.44 (53.38) | 73.33 (59.00) | 0.75 | 0.77 | 0.76 |
| $T_7$ | 8.33 | 9.00 | 8.67 | 10.00 (3.31) | 10.67 (3.41) | 10.34 (3.36) | 88.88 (70.70) | 84.44 (66.83) | 86.66 (68.65) | 1.17 | 1.14 | 1.16 |
| $T_8$ | 9.33 | 9.67 | 9.50 | 10.33 (3.36) | 11.33 (3.50) | 10.83 (3.44) | 66.66 (55.44) | 64.44 (53.68) | 65.55 (54.24) | 0.83 | 0.77 | 0.80 |
| $T_9$ | 8.67 | 9.33 | 9.00 | 10.33 (3.36) | 11.33 (3.51) | 10.83 (3.43) | 84.44 (66.83) | 80.00 (63.61) | 82.22 (65.12) | 0.99 | 0.96 | 0.98 |
| $T_{10}$ | 9.00 | 10.00 | 9.50 | 12.00 (3.59) | 12.33 (3.65) | 12.17 (3.62) | 62.22 (52.40) | 75.55 (60.39) | 68.89 (56.28) | 0.74 | 0.71 | 0.73 |
| $T_{11}$ | 8.67 | 9.33 | 9.00 | 10.33 (3.36) | 11.67 (3.55) | 11.00 (3.46) | 82.22 (65.12) | 77.78 (61.90) | 80.00 (63.45) | 1.06 | 1.00 | 1.03 |
| $T_{12}$ | 9.00 | 12.00 | 10.50 | 12.00 (3.60) | 13.33 (3.78) | 12.67 (3.69) | 53.33 (47.28) | 66.66 (54.78) | 60.00 (50.89) | 0.89 | 0.65 | 0.77 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $T_{13}$ | 9.00 | 10.00 | 9.50 | 11.67 (3.55) | 12.00 (3.60) | 11.84 (3.58) | 66.66 (54.78) | 62.22 (52.17) | 64.44 (53.40) | 0.80 | 0.78 | 0.79 |
| $T_{14}$ | 9.67 | 10.00 | 9.84 | 11.33 (3.51) | 12.00 (3.60) | 11.67 (3.55) | 64.44 (53.61) | 66.66 (54.78) | 65.55 (54.13) | 0.80 | 0.74 | 0.77 |
| $T_{15}$ | 12.00 | 12.67 | 12.34 | 14.67 (3.95) | 16.33 (4.16) | 15.50 (4.06) | 57.78 (49.46) | 57.78 (49.46) | 57.78 (49.45) | 0.19 | 0.34 | 0.27 |
| $T_{16}$ | 12.67 | 13.33 | 13.00 | 17.00 (4.24) | 17.00 (4.24) | 17.00 (4.24) | 53.33 (46.89) | 55.55 (48.17) | 54.44 (47.53) | 0.16 | 0.18 | 0.17 |
| $T_{17}$ | 9.00 | 11.00 | 10.00 | 14.00 (3.85) | 13.33 (3.78) | 13.67 (3.82) | 57.78 (49.46) | 53.33 (46.94) | 55.56 (48.17) | 0.48 | 0.60 | 0.54 |
| $T_{18}$ | 12.33 | 11.33 | 11.83 | 15.67 (4.08) | 14.33 (3.91) | 15.00 (4.00) | 60.00 (50.78) | 55.55 (48.22) | 57.78 (49.46) | 0.70 | 0.70 | 0.70 |
| C.D | 1.21 | 1.26 | 0.99 | 0.32 | 0.19 | 0.18 | 15.02 | 8.58 | 8.73 | 0.17 | 0.17 | 0.13 |
| SE(m) | 0.42 | 0.43 | 0.34 | 0.11 | 0.06 | 0.06 | 5.2 | 3.07 | 3.03 | 0.06 | 0.06 | 0.04 |

**Table 2: Effect of different seed treatments with organics, chemicals and PGRs on height of the seedlings in papaya cv. Arka Surya**

| Treatments | | Height of the seedling @ 25 DAS (cm) | | | Height of the seedling @ 35 DAS (cm) | | | Height of the seedling @ 45 DAS (cm) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 2021 | 2022 | Pooled mean | 2021 | 2022 | Pooled mean | 2021 | 2022 | Pooled mean |
| $T_1$ | Seaweed extract @ 3ml/l | 9.34 | 8.74 | 9.04 | 16.88 | 18.73 | 17.81 | 23.87 | 23.42 | 23.65 |
| $T_2$ | Seaweed extract @ 4 ml/l | 9.71 | 8.93 | 9.32 | 17.30 | 16.24 | 16.77 | 25.77 | 24.43 | 25.10 |
| $T_3$ | Panchgavya @ 1.5 % | 9.56 | 9.24 | 9.40 | 17.17 | 17.63 | 17.40 | 26.09 | 27.23 | 26.66 |
| $T_4$ | Panchgavya @ 3% | 9.93 | 9.72 | 9.83 | 18.30 | 19.19 | 18.75 | 26.27 | 27.63 | 26.95 |
| $T_5$ | $Ca(ClO)_2$ @ 0.5 % | 9.90 | 9.87 | 9.89 | 16.09 | 15.27 | 15.68 | 21.74 | 21.53 | 21.64 |
| $T_6$ | $Ca(ClO)_2$ @ 1 % | 9.16 | 9.47 | 9.32 | 16.99 | 18.33 | 17.66 | 24.66 | 23.50 | 24.08 |
| $T_7$ | $KH_2PO_4$ @ 0.5 % | 11.61 | 11.43 | 11.52 | 22.60 | 21.83 | 22.22 | 30.27 | 31.00 | 30.64 |
| $T_8$ | $KH_2PO_4$ @ 1 % | 9.72 | 9.23 | 9.48 | 19.20 | 19.10 | 19.15 | 27.93 | 26.83 | 27.38 |
| $T_9$ | $KNO_3$ @ 0.5 % | 10.75 | 10.02 | 10.39 | 20.14 | 20.92 | 20.53 | 29.17 | 29.07 | 29.12 |
| $T_{10}$ | $KNO_3$ @ 1 % | 8.91 | 8.61 | 8.76 | 16.43 | 16.83 | 16.63 | 23.83 | 22.17 | 23.00 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| T11 | Putrescine @ 25 mM | 10.56 | 9.85 | 10.21 | 19.80 | 20.32 | 20.06 | 28.70 | 25.73 | 27.22 |
| T12 | Putrescine @ 50 mM | 8.33 | 8.23 | 8.28 | 14.90 | 16.03 | 15.47 | 23.56 | 23.01 | 23.29 |
| T13 | Brassinosteroids @ 0.2 ppm | 8.67 | 8.51 | 8.59 | 18.73 | 18.83 | 18.78 | 24.70 | 23.17 | 23.94 |
| T14 | Brassinosteroids @ 0.4 ppm | 9.66 | 9.62 | 9.64 | 17.86 | 18.68 | 18.27 | 24.83 | 23.90 | 24.37 |
| T15 | Salicylic acid @ 1 mM | 7.37 | 7.07 | 7.22 | 13.07 | 13.90 | 13.49 | 21.78 | 20.03 | 20.91 |
| T16 | Salicylic acid @ 2 mM | 7.54 | 6.77 | 7.16 | 13.32 | 13.30 | 13.31 | 19.81 | 18.67 | 19.24 |
| T17 | Trisodium phosphate @  500 ppm | 9.57 | 8.12 | 8.85 | 18.60 | 18.00 | 18.30 | 27.05 | 26.00 | 26.53 |
| T18 | Control | 8.09 | 7.77 | 7.93 | 15.70 | 15.77 | 15.74 | 22.87 | 21.50 | 22.19 |
| | C.D. | 1.46 | 1.19 | 0.97 | 2.76 | 2.53 | 2.04 | 2.63 | 2.55 | 2.06 |
| | SE (m) | 0.51 | 0.41 | 0.33 | 0.96 | 0.87 | 0.71 | 0.91 | 0.88 | 0.71 |



**Table 3: Effect of different seed treatments with organics, chemicals and PGRs on diameter of the stem in papaya cv. —Arka Surya**

| Treatments | | Diameter of the stem @ 25 DAS (mm) | | | Diameter of the stem @ 35 DAS (mm) | | | Diameter of the stem @ 45 DAS (mm) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 2021 | 2022 | Pooled mean | 2021 | 2022 | Pooled mean | 2021 | 2022 | Pooled mean |
| $T_1$ | Seaweed extract @ 3ml/l | 2.74 | 2.73 | 2.74 | 5.07 | 4.51 | 4.79 | 7.02 | 7.15 | 7.09 |
| $T_2$ | Seaweed extract @ 4 ml/l | 2.65 | 2.83 | 2.74 | 4.74 | 4.61 | 4.68 | 7.21 | 7.39 | 7.30 |
| $T_3$ | Panchgavya @ 1.5 % | 2.93 | 2.99 | 2.96 | 5.04 | 4.97 | 5.01 | 7.22 | 7.40 | 7.31 |
| $T_4$ | Panchgavya @ 3% | 3.17 | 3.07 | 3.12 | 5.55 | 5.13 | 5.34 | 7.31 | 7.53 | 7.42 |
| $T_5$ | Ca $(ClO)_2$ @ 0.5 % | 3.28 | 3.21 | 3.25 | 5.68 | 5.02 | 5.35 | 7.89 | 7.80 | 7.85 |
| $T_6$ | Ca $(ClO)_2$ @ 1 % | 3.40 | 3.32 | 3.36 | 5.98 | 5.58 | 5.78 | 7.73 | 7.92 | 7.83 |
| $T_7$ | $KH_2PO_4$ @ 0.5 % | 3.47 | 3.37 | 3.42 | 6.69 | 6.67 | 6.68 | 9.66 | 9.01 | 9.34 |
| $T_8$ | $KH_2PO_4$ @ 1 % | 3.24 | 3.17 | 3.21 | 5.08 | 5.27 | 5.18 | 8.37 | 8.09 | 8.23 |
| $T_9$ | $KNO_3$ @ 0.5 % | 3.51 | 3.27 | 3.39 | 6.19 | 6.08 | 6.14 | 8.91 | 8.62 | 8.77 |
| $T_{10}$ | $KNO_3$ @ 1 % | 3.05 | 3.03 | 3.04 | 5.58 | 5.49 | 5.54 | 8.36 | 8.26 | 8.31 |
| $T_{11}$ | Putrescine @ 25 mM | 3.26 | 3.20 | 3.23 | 6.11 | 5.95 | 6.03 | 8.74 | 8.73 | 8.74 |
| $T_{12}$ | Putrescine @ 50 mM | 3.07 | 3.17 | 3.12 | 5.63 | 5.50 | 5.57 | 7.99 | 7.84 | 7.92 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| $T_{13}$ | Brassinosteroids @ 0.2 ppm | 3.17 | 3.14 | 3.16 | 5.35 | 5.52 | 5.44 | 8.42 | 8.22 | 8.32 |
| $T_{14}$ | Brassinosteroids @ 0.4 ppm | 3.03 | 3.21 | 3.12 | 5.28 | 5.62 | 5.45 | 8.32 | 7.78 | 8.05 |
| $T_{15}$ | Salicylic acid @ 1 mM | 2.64 | 2.49 | 2.57 | 4.78 | 4.14 | 4.46 | 6.58 | 6.40 | 6.49 |
| $T_{16}$ | Salicylic acid @ 2 mM | 2.27 | 2.30 | 2.29 | 4.44 | 3.59 | 4.02 | 6.55 | 5.94 | 6.25 |
| $T_{17}$ | Trisodium phosphate @ 500 Ppm | 2.39 | 2.62 | 2.51 | 4.99 | 4.39 | 4.69 | 6.85 | 7.12 | 6.99 |
| $T_{18}$ | Control | 2.50 | 2.62 | 2.56 | 4.63 | 4.43 | 4.53 | 6.81 | 7.04 | 6.93 |
| | C.D. | 0.43 | 0.31 | 0.33 | 0.62 | 0.66 | 0.40 | 0.78 | 0.87 | 0.64 |
| | SE (m) | 0.15 | 0.10 | 0.11 | 0.21 | 0.23 | 0.14 | 0.27 | 0.30 | 0.22 |

**Table 4: Effect of different seed treatments with organics, chemicals and PGRs on number of leaves in papaya cv. Arka Surya**

| Treatments | | Number of leaves @ 25 DAS | | | Number of leaves @ 35 DAS | | | Number of leaves @ 45 DAS | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 2021 | 2022 | Pooled mean | 2021 | 2022 | Pooled mean | 2021 | 2022 | Pooled mean |
| $T_1$ | Seaweed extract @ 3ml/l | 5.73 | 5.80 | 5.77 | 8.40 | 8.20 | 8.30 | 9.47 | 9.40 | 9.44 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| $T_2$ | Seaweed extract @ 4 ml/l | 5.60 | 6.07 | 5.84 | 8.33 | 8.33 | 8.33 | 9.40 | 9.47 | 9.44 |
| $T_3$ | Panchgavya @ 1.5 % | 5.33 | 6.40 | 5.87 | 8.13 | 7.47 | 7.80 | 10.07 | 10.20 | 10.14 |
| $T_4$ | Panchgavya @ 3% | 5.47 | 6.00 | 5.74 | 8.13 | 7.53 | 7.83 | 9.53 | 9.73 | 9.63 |
| $T_5$ | Ca $(ClO)_2$ @ 0.5 % | 5.13 | 6.33 | 5.73 | 8.13 | 7.67 | 7.90 | 10.07 | 10.27 | 10.17 |
| $T_6$ | Ca $(ClO)_2$ @ 1 % | 5.27 | 5.67 | 5.47 | 8.20 | 7.00 | 7.60 | 9.87 | 10.07 | 9.97 |
| $T_7$ | $KH_2PO_4$ @ 0.5 % | 6.07 | 6.40 | 6.24 | 8.73 | 8.53 | 8.63 | 10.80 | 11.40 | 11.10 |
| $T_8$ | $KH_2PO_4$ @ 1 % | 5.53 | 6.27 | 5.90 | 8.20 | 7.47 | 7.84 | 9.87 | 10.13 | 10.00 |
| $T_9$ | $KNO_3$ @ 0.5 % | 5.87 | 6.07 | 5.97 | 8.33 | 7.33 | 7.83 | 9.87 | 9.93 | 9.90 |
| $T_{10}$ | $KNO_3$ @ 1 % | 5.40 | 5.87 | 5.64 | 8.20 | 7.13 | 7.67 | 10.27 | 10.20 | 10.24 |
| $T_{11}$ | Putrescine @ 25 mM | 6.00 | 5.93 | 5.97 | 8.60 | 7.60 | 8.10 | 9.87 | 10.20 | 10.04 |
| $T_{12}$ | Putrescine @ 50 mM | 5.07 | 6.07 | 5.57 | 8.00 | 7.80 | 7.90 | 9.53 | 10.00 | 9.77 |
| $T_{13}$ | Brassinosteroids @ 0.2 ppm | 5.47 | 6.00 | 5.74 | 8.20 | 7.40 | 7.80 | 9.60 | 10.00 | 9.80 |
| $T_{14}$ | Brassinosteroids @ 0.4 ppm | 5.67 | 5.87 | 5.77 | 8.20 | 7.07 | 7.64 | 9.47 | 9.73 | 9.60 |
| $T_{15}$ | Salicylic acid @ 1 mM | 4.47 | 5.13 | 4.80 | 7.67 | 6.53 | 7.10 | 9.33 | 9.27 | 9.30 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| $T_{16}$ | Salicylic acid @ 2 mM | 4.40 | 5.07 | 4.74 | 7.67 | 6.27 | 6.97 | 9.27 | 9.20 | 9.24 |
| $T_{17}$ | Trisodium phosphate @ 500 ppm | 5.60 | 5.40 | 5.50 | 8.27 | 7.60 | 7.94 | 8.87 | 10.00 | 9.44 |
| $T_{18}$ | Control | 5.40 | 5.93 | 5.67 | 8.07 | 7.27 | 7.67 | 9.20 | 9.27 | 9.24 |
| | C.D. | 0.61 | NS | 0.57 | NS | NS | NS | NS | NS | 0.79 |
| | SE (m) | 0.21 | 0.30 | 0.19 | 0.20 | 0.55 | 0.28 | 0.49 | 0.41 | 0.27 |

**Table 5: Effect of different seed treatments with organics, chemicals and PGRs on leaf area in papaya cv. Arka Surya**

| Treatments | | Leaf area @ 25 DAS ($cm^2$) | | | Leaf area @ 35 DAS ($cm^2$) | | | Leaf area @ 45 DAS ($cm^2$) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 2021 | 2022 | Pooled mean | 2021 | 2022 | Pooled mean | 2021 | 2022 | Pooled mean |
| $T_1$ | Seaweed extract @ 3ml/l | 30.41 | 32.38 | 31.40 | 46.96 | 50.18 | 48.57 | 64.79 | 75.45 | 70.12 |
| $T_2$ | Seaweed extract @ 4 ml/l | 33.81 | 40.79 | 37.30 | 48.83 | 50.19 | 49.51 | 82.13 | 80.98 | 81.56 |
| $T_3$ | Panchgavya @ 1.5 % | 36.60 | 32.99 | 34.80 | 52.13 | 51.49 | 51.81 | 83.20 | 80.21 | 81.71 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| $T_4$ | Panchgavya @ 3% | 37.59 | 35.16 | 36.38 | 53.20 | 53.13 | 53.17 | 86.38 | 84.41 | 85.40 |
| $T_5$ | Ca $(ClO)_2$ @ 0.5 % | 37.07 | 41.16 | 39.12 | 53.28 | 55.21 | 54.25 | 80.31 | 86.20 | 83.26 |
| $T_6$ | Ca $(ClO)_2$ @ 1 % | 38.96 | 46.71 | 42.84 | 51.90 | 57.51 | 54.71 | 94.74 | 85.12 | 89.93 |
| $T_7$ | $KH_2PO_4$ @ 0.5 % | 59.97 | 60.67 | 60.32 | 97.56 | 81.24 | 89.40 | 114.51 | 109.16 | 111.84 |
| $T_8$ | $KH_2PO_4$ @ 1 % | 48.62 | 46.39 | 47.51 | 69.70 | 61.93 | 65.82 | 90.68 | 100.53 | 95.61 |
| $T_9$ | $KNO_3$ @ 0.5 % | 54.81 | 53.99 | 54.40 | 81.89 | 79.85 | 80.87 | 97.79 | 91.70 | 94.75 |
| $T_{10}$ | $KNO_3$ @ 1 % | 48.04 | 51.71 | 49.88 | 58.08 | 61.51 | 59.80 | 81.85 | 79.67 | 80.76 |
| $T_{11}$ | Putrescine @ 25 mM | 49.35 | 50.45 | 49.90 | 66.08 | 69.57 | 67.83 | 89.88 | 87.21 | 88.55 |
| $T_{12}$ | Putrescine @ 50 mM | 43.33 | 49.00 | 46.17 | 52.33 | 55.52 | 53.93 | 83.99 | 80.30 | 82.15 |
| $T_{13}$ | Brassinosteroids @ 0.2 ppm | 45.44 | 38.40 | 41.92 | 54.01 | 57.82 | 55.92 | 66.34 | 67.42 | 66.88 |
| $T_{14}$ | Brassinosteroids @ 0.4 ppm | 36.22 | 39.22 | 37.72 | 48.33 | 58.85 | 53.59 | 71.98 | 65.32 | 68.65 |
| $T_{15}$ | Salicylic acid @ 1 mM | 23.15 | 23.93 | 23.54 | 46.46 | 46.71 | 46.59 | 71.52 | 66.59 | 69.06 |
| $T_{16}$ | Salicylic acid @ 2 mM | 19.73 | 17.39 | 18.56 | 45.51 | 44.48 | 45.00 | 64.45 | 64.79 | 64.62 |
| $T_{17}$ | Trisodium phosphate @ 500 Ppm | 26.59 | 37.07 | 31.83 | 57.63 | 60.27 | 58.95 | 79.80 | 77.20 | 78.50 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| $T_{18}$ | Control | 40.02 | 29.94 | 34.98 | 49.10 | 42.21 | 45.66 | 79.83 | 76.80 | 78.32 |
| | C.D. | 5.75 | 6.94 | 4.87 | 8.52 | 13.58 | 8.82 | 8.34 | 10.23 | 7.79 |
| | SE (m) | 1.99 | 2.41 | 1.69 | 2.95 | 4.71 | 3.06 | 2.89 | 3.55 | 2.70 |

**Table 6: Effect of different pre sowing seed treatments with organics, chemicals and PGR's on dry weight of shoots, length of taproot, number of lateral roots and dry weight of roots of papaya cv. Arka Surya**

| Treatments | Dry weight of shoots (g) | | | Length of taproot (cm) | | | Number of lateral roots | | | Dry weight of roots (g) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2021 | 2022 | Pooled mean | 2021 | 2022 | Pooled mean | 2021 | 2022 | Pooled mean | 2021 | 2022 | Pooled mean |
| $T_1$ | 1.01 | 1.09 | 1.05 | 17.33 | 17.33 | 17.33 | 16.33 | 16.00 | 16.17 | 0.29 | 0.43 | 0.36 |
| $T_2$ | 1.09 | 1.15 | 1.12 | 19.00 | 17.67 | 18.34 | 17.00 | 16.33 | 16.67 | 0.35 | 0.39 | 0.37 |
| $T_3$ | 1.25 | 1.14 | 1.20 | 18.67 | 18.00 | 18.34 | 18.00 | 17.00 | 17.50 | 0.39 | 0.49 | 0.44 |
| $T_4$ | 1.26 | 1.33 | 1.30 | 19.33 | 18.33 | 18.83 | 18.33 | 18.00 | 18.17 | 0.43 | 0.41 | 0.42 |
| $T_5$ | 1.31 | 1.40 | 1.36 | 18.67 | 17.67 | 18.17 | 18.00 | 17.33 | 17.67 | 0.40 | 0.46 | 0.43 |
| $T_6$ | 1.78 | 1.52 | 1.65 | 21.67 | 20.00 | 20.84 | 17.00 | 18.00 | 17.50 | 0.43 | 0.48 | 0.46 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $T_7$ | 1.95 | 2.05 | 2.00 | 23.00 | 26.33 | 24.67 | 22.00 | 23.67 | 22.84 | 0.80 | 0.77 | 0.79 |
| $T_8$ | 1.56 | 1.58 | 1.57 | 19.33 | 21.67 | 20.50 | 22.00 | 18.67 | 20.34 | 0.32 | 0.43 | 0.38 |
| $T_9$ | 1.87 | 1.52 | 1.70 | 20.00 | 23.00 | 21.50 | 20.33 | 22.33 | 21.33 | 0.57 | 0.61 | 0.59 |
| $T_{10}$ | 1.51 | 1.46 | 1.49 | 18.67 | 20.33 | 19.50 | 19.33 | 18.67 | 19.00 | 0.30 | 0.36 | 0.33 |
| $T_{11}$ | 1.86 | 1.75 | 1.81 | 19.67 | 21.33 | 20.50 | 19.67 | 19.33 | 19.50 | 0.61 | 0.56 | 0.59 |
| $T_{12}$ | 1.26 | 1.65 | 1.46 | 17.33 | 18.67 | 18.00 | 18.00 | 18.00 | 18.00 | 0.31 | 0.50 | 0.41 |
| $T_{13}$ | 1.29 | 1.36 | 1.33 | 18.33 | 19.67 | 19.00 | 17.67 | 18.33 | 18.00 | 0.35 | 0.35 | 0.35 |
| $T_{14}$ | 1.29 | 1.45 | 1.37 | 17.33 | 19.33 | 18.33 | 19.00 | 18.33 | 18.67 | 0.32 | 0.34 | 0.33 |
| $T_{15}$ | 0.72 | 0.90 | 0.81 | 16.33 | 19.33 | 17.83 | 13.33 | 13.00 | 13.17 | 0.12 | 0.25 | 0.19 |
| $T_{16}$ | 0.71 | 0.85 | 0.78 | 15.33 | 17.33 | 16.33 | 11.33 | 12.67 | 12.00 | 0.12 | 0.19 | 0.16 |
| $T_{17}$ | 0.93 | 1.30 | 1.12 | 19.67 | 19.00 | 19.34 | 15.00 | 15.00 | 15.00 | 0.21 | 0.34 | 0.28 |
| $T_{18}$ | 0.79 | 0.99 | 0.89 | 17.67 | 17.33 | 17.50 | 15.00 | 13.33 | 14.17 | 0.29 | 0.46 | 0.38 |
| C.D | 0.61 | 0.64 | 0.44 | 3.71 | 3.54 | 2.57 | 3.62 | 3.56 | 2.94 | 0.22 | 0.25 | 0.21 |
| SE(m) | 0.21 | 0.22 | 0.15 | 1.29 | 1.23 | 0.89 | 1.26 | 1.23 | 1.02 | 0.07 | 0.09 | 0.07 |

**Table 7: Effect of different pre sowing seed treatments with organics, chemicals and PGR's on root to shoot ratio, vigour index, quality index and seedling survivability of papaya cv. Arka Surya**

| Treatments | Root to shoot ratio | | | Seedling Vigour index | | | Quality index | | | Seedling survivability (%) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2021 | 2022 | Pooled mean | 2021 | 2022 | Pooled mean | 2021 | 2022 | Pooled mean | 2021 | 2022 | Pooled mean |
| $T_1$ | 0.37 | 0.47 | 0.42 | 1537.89 | 1612.09 | 1574.99 | 0.19 | 0.26 | 0.23 | 96.67 (9.88) | 93.33 (9.70) | 95.00 (9.79) |
| $T_2$ | 0.33 | 0.40 | 0.37 | 1674.32 | 1737.67 | 1706.00 | 0.21 | 0.24 | 0.23 | 100.00 (10.05) | 96.67 (9.88) | 98.34 (9.96) |
| $T_3$ | 0.32 | 0.44 | 0.38 | 2017.88 | 1877.71 | 1947.80 | 0.24 | 0.27 | 0.26 | 96.97 (9.89) | 100.00 (10.05) | 98.49 (9.97) |
| $T_4$ | 0.33 | 0.32 | 0.33 | 1785.24 | 1837.68 | 1811.46 | 0.25 | 0.25 | 0.25 | 97.43 | 97.22 | 97.33 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | (9.92) | (9.90) | (9.91) |
| $T_5$ | 0.38 | 0.33 | 0.36 | 1553.49 | 1471.90 | 1512.70 | 0.27 | 0.32 | 0.30 | 97.22 (9.90) | 100.00 (10.05) | 98.61 (9.98) |
| $T_6$ | 0.24 | 0.38 | 0.31 | 2037.55 | 1518.78 | 1778.17 | 0.31 | 0.31 | 0.31 | 96.97 (9.89) | 96.67 (9.88) | 96.82 (9.89) |
| $T_7$ | 0.37 | 0.47 | 0.42 | 2689.45 | 2615.42 | 2652.44 | 0.49 | 0.45 | 0.47 | 100.00 (10.05) | 100.00 (10.05) | 100.0 (10.05) |
| $T_8$ | 0.20 | 0.31 | 0.26 | 1852.70 | 1729.97 | 1791.34 | 0.24 | 0.28 | 0.26 | 97.43 (9.92) | 100.00 (10.05) | 98.72 (9.98) |
| $T_9$ | 0.31 | 0.43 | 0.37 | 2461.42 | 2328.12 | 2394.77 | 0.38 | 0.36 | 0.37 | 97.22 (9.90) | 97.43 (9.92) | 97.33 (9.91) |
| $T_{10}$ | 0.21 | 0.26 | 0.24 | 1505.50 | 1673.28 | 1589.39 | 0.23 | 0.27 | 0.25 | 94.44 (9.76) | 96.97 (9.89) | 95.71 (9.82) |
| $T_{11}$ | 0.41 | 0.32 | 0.37 | 2359.49 | 2000.86 | 2180.18 | 0.35 | 0.37 | 0.36 | 94.44 | 100.00 | 97.22 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | (9.76) | (10.05) | (9.90) |
| $T_{12}$ | 0.24 | 0.33 | 0.29 | 1261.42 | 1522.59 | 1392.01 | 0.24 | 0.34 | 0.29 | 88.89 (9.47) | 96.29 (9.86) | 92.59 (9.67) |
| $T_{13}$ | 0.26 | 0.28 | 0.27 | 1408.11 | 1443.28 | 1425.70 | 0.28 | 0.26 | 0.27 | 96.29 (9.86) | 96.97 (9.89) | 96.63 (9.88) |
| $T_{14}$ | 0.26 | 0.24 | 0.25 | 1616.55 | 1594.81 | 1605.68 | 0.24 | 0.23 | 0.24 | 96.97 (9.89) | 96.29 (9.86) | 96.63 (9.88) |
| $T_{15}$ | 0.16 | 0.31 | 0.24 | 771.02 | 403.26 | 587.14 | 0.08 | 0.16 | 0.12 | 91.67 (9.60) | 91.67 (9.60) | 91.67 (9.60) |
| $T_{16}$ | 0.18 | 0.25 | 0.22 | 313.02 | 247.71 | 280.37 | 0.10 | 0.13 | 0.12 | 83.33 (9.08) | 83.33 (9.08) | 83.33 (9.16) |
| $T_{17}$ | 0.24 | 0.29 | 0.27 | 1562.50 | 1092.30 | 1327.40 | 0.15 | 0.21 | 0.18 | 96.29 (9.86) | 95.24 (9.80) | 95.77 (9.83) |
| $T_{18}$ | 0.41 | 0.41 | 0.41 | 1385.06 | 1197.50 | 1291.28 | 0.17 | 0.28 | 0.23 | 96.29 | 96.29 | 96.29 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | (9.86) | (9.86) | (9.86) |
| | NS | NS | NS | 628.21 | 455.53 | 422.09 | 0.15 | 0.12 | 0.12 | NS | NS | NS |
| | 0.06 | 0.09 | 0.06 | 218.14 | 158.18 | 146.56 | 0.05 | 0.04 | 0.04 | 0.30 | 0.29 | 0.18 |

**Table 8: Effect of different pre sowing seed treatments with organics, chemicals and PGR's on leaf temperature and chlorophyll content of papaya cv. Arka Surya**

| Treatments | Leaf temperature (°c) @ 35 DAS | | | Leaf temperature (°c) @ 45 DAS | | | Chlorophyll content (mg/g) @ 35 DAS | | | Chlorophyll content (mg/g) @ 45 DAS | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2021 | 2022 | Pooled mean | 2021 | 2022 | Pooled mean | 2021 | 2022 | Pooled mean | 2021 | 2022 | Pooled mean |
| $T_1$ | 30.80 | 31.30 | 31.05 | 32.66 | 32.97 | 32.82 | 2.49 | 2.67 | 2.58 | 3.02 | 3.12 | 3.07 |
| $T_2$ | 31.93 | 29.90 | 30.92 | 34.46 | 31.88 | 33.17 | 2.54 | 2.69 | 2.62 | 3.25 | 3.19 | 3.22 |
| $T_3$ | 31.43 | 30.85 | 31.14 | 33.59 | 32.70 | 33.15 | 2.71 | 2.74 | 2.73 | 3.33 | 3.21 | 3.27 |
| $T_4$ | 32.10 | 29.60 | 30.85 | 34.18 | 32.32 | 33.25 | 2.76 | 2.76 | 2.76 | 3.30 | 3.22 | 3.26 |
| $T_5$ | 31.33 | 30.77 | 31.05 | 32.89 | 32.53 | 32.71 | 2.84 | 2.80 | 2.82 | 3.41 | 3.27 | 3.34 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $T_6$ | 32.00 | 30.83 | 31.42 | 33.42 | 33.06 | 33.24 | 2.87 | 2.98 | 2.93 | 3.42 | 3.39 | 3.41 |
| $T_7$ | 30.73 | 29.33 | 30.03 | 33.15 | 31.52 | 32.34 | 3.28 | 3.73 | 3.51 | 3.89 | 3.92 | 3.91 |
| $T_8$ | 31.87 | 30.00 | 30.94 | 33.77 | 31.96 | 32.87 | 3.02 | 3.25 | 3.14 | 3.77 | 3.59 | 3.68 |
| $T_9$ | 31.13 | 28.90 | 30.02 | 32.84 | 30.92 | 31.88 | 3.14 | 3.27 | 3.21 | 3.86 | 3.92 | 3.89 |
| $T_{10}$ | 31.43 | 30.43 | 30.93 | 33.33 | 32.24 | 32.79 | 2.93 | 3.06 | 3.00 | 3.79 | 3.68 | 3.74 |
| $T_{11}$ | 31.67 | 29.98 | 30.83 | 33.33 | 31.69 | 32.51 | 3.11 | 3.12 | 3.12 | 3.79 | 3.86 | 3.83 |
| $T_{12}$ | 31.00 | 30.00 | 30.50 | 33.00 | 31.86 | 32.43 | 2.93 | 3.03 | 2.98 | 3.72 | 3.67 | 3.70 |
| $T_{13}$ | 32.07 | 29.25 | 30.66 | 34.21 | 30.78 | 32.50 | 2.91 | 3.18 | 3.05 | 3.68 | 3.63 | 3.66 |
| $T_{14}$ | 31.80 | 31.17 | 31.49 | 33.46 | 32.90 | 33.18 | 2.91 | 2.83 | 2.87 | 3.43 | 3.51 | 3.47 |
| $T_{15}$ | 31.57 | 30.27 | 30.92 | 33.60 | 33.30 | 33.45 | 2.32 | 2.44 | 2.38 | 2.86 | 2.75 | 2.81 |
| $T_{16}$ | 32.43 | 30.93 | 31.68 | 34.93 | 32.91 | 33.92 | 2.30 | 2.13 | 2.22 | 2.81 | 2.74 | 2.78 |
| $T_{17}$ | 30.83 | 29.25 | 30.04 | 33.10 | 31.70 | 32.40 | 2.53 | 2.57 | 2.55 | 2.96 | 3.07 | 3.02 |
| $T_{18}$ | 30.50 | 29.83 | 30.17 | 33.20 | 32.38 | 32.79 | 2.47 | 2.64 | 2.56 | 2.95 | 2.88 | 2.92 |
| | NS | NS | NS | NS | NS | NS | 0.45 | 0.26 | 0.30 | 0.52 | 0.47 | 0.43 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1.19 | 0.76 | 0.56 | 1.1 | 0.79 | 0.77 | 0.15 | 0.09 | 0.10 | 0.18 | 0.16 | 0.15 |

**Table 9: Effect of different pre sowing seed treatments with organics, chemicals and PGR's on photosynthetic rate and transpiration rate of papaya cv. Arka Surya**

| Treatments | Photosynthetic rate (µmol $Co_2 m^{-2} s^{-1}$) @ 35 DAS | | | Photosynthetic rate (µmol $Co_2 m^{-2} s^{-1}$) @ 45 DAS | | | Transpiration rate (mmol $m^{-2} s^{-1}$) @ 35 DAS | | | Transpiration rate (mmol $m^{-2} s^{-1}$) @ 45 DAS | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2021 | 2022 | Pooled mean | 2021 | 2022 | Pooled mean | 2021 | 2022 | Pooled mean | 2021 | 2022 | Pooled mean |
| $T_1$ | 13.55 | 12.73 | 13.14 | 15.35 | 16.11 | 15.73 | 3.58 | 3.27 | 3.43 | 3.98 | 3.96 | 3.97 |
| $T_2$ | 14.45 | 13.32 | 13.89 | 16.09 | 16.00 | 16.05 | 3.63 | 3.39 | 3.51 | 4.01 | 4.02 | 4.02 |
| $T_3$ | 12.47 | 13.45 | 12.96 | 14.79 | 15.43 | 15.11 | 3.45 | 3.55 | 3.50 | 3.99 | 3.91 | 3.95 |
| $T_4$ | 13.05 | 12.91 | 12.98 | 15.42 | 14.12 | 14.77 | 3.82 | 3.57 | 3.70 | 4.23 | 4.25 | 4.24 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $T_5$ | 13.95 | 12.69 | 13.32 | 15.34 | 14.48 | 14.91 | 3.87 | 3.73 | 3.80 | 4.28 | 4.26 | 4.27 |
| $T_6$ | 13.43 | 12.95 | 13.19 | 15.84 | 14.30 | 15.07 | 3.88 | 3.93 | 3.91 | 4.74 | 4.74 | 4.74 |
| $T_7$ | 15.48 | 15.15 | 15.32 | 18.43 | 17.09 | 17.76 | 4.70 | 4.51 | 4.61 | 5.72 | 5.66 | 5.69 |
| $T_8$ | 12.20 | 12.77 | 12.49 | 14.57 | 14.72 | 14.65 | 4.48 | 4.20 | 4.34 | 4.63 | 4.69 | 4.66 |
| $T_9$ | 15.12 | 14.44 | 14.78 | 16.94 | 15.72 | 16.33 | 4.23 | 4.49 | 4.36 | 5.61 | 5.67 | 5.64 |
| $T_{10}$ | 12.70 | 12.21 | 12.46 | 14.85 | 13.52 | 14.19 | 4.15 | 4.12 | 4.14 | 4.84 | 4.95 | 4.90 |
| $T_{11}$ | 14.47 | 14.10 | 14.29 | 16.80 | 16.50 | 16.65 | 4.48 | 4.43 | 4.46 | 5.44 | 5.44 | 5.44 |
| $T_{12}$ | 13.79 | 12.20 | 13.00 | 15.49 | 14.45 | 14.97 | 4.13 | 4.08 | 4.11 | 4.56 | 4.62 | 4.59 |
| $T_{13}$ | 13.26 | 13.35 | 13.31 | 15.29 | 14.39 | 14.84 | 3.81 | 4.03 | 3.92 | 4.18 | 4.28 | 4.23 |
| $T_{14}$ | 13.08 | 12.17 | 12.63 | 14.98 | 14.50 | 14.74 | 4.50 | 3.87 | 4.19 | 5.07 | 5.05 | 5.06 |
| $T_{15}$ | 10.90 | 8.99 | 9.95 | 13.44 | 12.21 | 12.83 | 3.21 | 3.22 | 3.22 | 3.28 | 3.43 | 3.36 |
| $T_{16}$ | 10.51 | 9.08 | 9.80 | 13.95 | 11.31 | 12.63 | 2.68 | 2.62 | 2.65 | 2.78 | 2.92 | 2.85 |
| $T_{17}$ | 11.56 | 12.80 | 12.18 | 13.27 | 13.74 | 13.51 | 3.32 | 3.18 | 3.25 | 3.43 | 3.32 | 3.38 |
| $T_{18}$ | 11.82 | 11.74 | 11.78 | 13.44 | 13.25 | 13.35 | 3.27 | 3.25 | 3.26 | 3.37 | 3.44 | 3.41 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2.60 | 1.96 | 1.68 | 2.48 | 2.31 | 1.96 | 0.88 | 0.69 | 0.67 | 0.76 | 0.71 | 0.72 |
| | 0.90 | 0.68 | 0.58 | 0.86 | 0.80 | 0.68 | 0.30 | 0.24 | 0.23 | 0.26 | 0.24 | 0.25 |

**$T_1$**:Seaweed extract @ 2ml/l .**$T_2$**: Seaweed extract @ 4ml/l. **$T_3$**: Panchgavya @ 1.5 %. **$T_4$**:Panchgavya @ 3.0 %. **$T_5$**:Ca $(ClO)_2$@ 0.5 %. **$T_6$**: Ca $(ClO)_2$@ 1.0 %. **$T_7$**:$KH_2PO_4$ @ 0.5 %. **$T_8$**:$KH_2PO_4$ @ 1.0 %. **$T_9$**: $KNO_3$ @ 0.5 %. **$T_{10}$**:$KNO_3$ @ 1.0 %. **$T_{11}$**:Putrescine @ 25 mM.**$T_{12}$**:Putrescine @ 25 mM.**$T_{13}$**:Brassinosteroids @ 0.2 ppm. **$T_{14}$**:Brassinosteroids @ 0.4 ppm. **$T_{15}$**: Salicylic acid @ 1 mM.**$T_{16}$**:Salicylic acid salicylic acid @ 2 mM.**$T_{17}$**:Trisodium phosphate @ 500 ppmand **$T_{18}$**:Control.

**Table 10: Effect of different seed treatments with organics, chemicals and PGRs on stomatal conductance in papaya cv. Arka Surya**

| Treatments | | Stomatal conductance (mol $m^{-2} s^{-1}$) @ 35 DAS | | | Stomatal conductance (mol $m^{-2} s^{-1}$) @ 45 DAS | | |
|---|---|---|---|---|---|---|---|
| | | 2021 | 2022 | Pooled mean | 2021 | 2022 | Pooled mean |
| $T_1$ | Seaweed extract @ 3ml/l | 0.91 | 0.74 | 0.83 | 1.63 | 1.65 | 1.64 |
| $T_2$ | Seaweed extract @ 4 ml/l | 1.08 | 2.11 | 1.59 | 1.94 | 1.90 | 1.92 |
| $T_3$ | Panchgavya @ 1.5 % | 1.21 | 1.97 | 1.59 | 1.96 | 1.98 | 1.97 |
| $T_4$ | Panchgavya @ 3% | 0.76 | 1.11 | 0.93 | 1.99 | 1.94 | 1.97 |
| $T_5$ | Ca $(ClO)_2$ @ 0.5 % | 1.26 | 1.15 | 1.21 | 1.69 | 1.85 | 1.77 |
| $T_6$ | Ca $(ClO)_2$ @ 1 % | 1.66 | 0.49 | 1.08 | 2.13 | 2.25 | 2.19 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| $T_7$ | $KH_2PO_4$ @ 0.5 % | 2.98 | 2.49 | 2.73 | 3.85 | 4.39 | 4.12 |
| $T_8$ | $KH_2PO_4$ @ 1 % | 1.00 | 0.60 | 0.80 | 2.42 | 2.62 | 2.52 |
| $T_9$ | $KNO_3$ @ 0.5 % | 2.51 | 0.93 | 1.72 | 3.61 | 4.28 | 3.95 |
| $T_{10}$ | $KNO_3$ @ 1 % | 1.80 | 1.40 | 1.60 | 2.65 | 2.81 | 2.73 |
| $T_{11}$ | Putrescine @ 25 mM | 2.09 | 1.12 | 1.61 | 3.18 | 3.38 | 3.28 |
| $T_{12}$ | Putrescine @ 50 mM | 1.93 | 0.62 | 1.27 | 2.77 | 3.08 | 2.93 |
| $T_{13}$ | Brassinosteroids @ 0.2 ppm | 2.05 | 1.98 | 2.02 | 2.17 | 2.71 | 2.44 |
| $T_{14}$ | Brassinosteroids @ 0.4 ppm | 1.61 | 1.30 | 1.45 | 2.36 | 3.06 | 2.71 |
| $T_{15}$ | Salicylic acid @ 1 mM | 0.67 | 0.69 | 0.68 | 1.63 | 1.96 | 1.80 |
| $T_{16}$ | Salicylic acid @ 2 mM | 0.33 | 0.71 | 0.52 | 0.64 | 0.87 | 0.76 |
| $T_{17}$ | Trisodium phosphate @ 500 Ppm | 0.91 | 1.86 | 1.39 | 1.86 | 2.15 | 2.01 |
| $T_{18}$ | Control | 0.88 | 0.66 | 0.77 | 1.77 | 1.85 | 1.81 |
| | C.D. | 1.4 | 1.27 | 0.87 | 1.29 | 1.01 | 1.13 |
| | SE (m) | 0.49 | 0.44 | 0.30 | 0.45 | 0.35 | 0.39 |

**$T_1$**:Seaweed extract @ 2ml/l . **$T_2$**: Seaweed extract @ 4ml/l. **$T_3$**: Panchgavya @ 1.5 %. **$T_4$**:Panchgavya @ 3.0 %. **$T_5$**:Ca $(ClO)_2$@ 0.5 %. **$T_6$**: Ca $(ClO)_2$@ 1.0 %. **$T_7$**:$KH_2PO_4$ @ 0.5 %. **$T_8$**:$KH_2PO_4$ @ 1.0 %. **$T_9$**: $KNO_3$ @ 0.5 %. **$T_{10}$**:$KNO_3$ @ 1.0 %. **$T_{11}$**:Putrescine @ 25 mM . **$T_{12}$**: Putrescine @ 25 mM.**$T_{13}$**:Brassinosteroids @ 0.2 ppm. **$T_{14}$**:Brassinosteroids @ 0.4 ppm. **$T_{15}$**: Salicylic acid @ 1 mM. **$T_{16}$**:Salicylic acid salicylic acid @ 2 mM. **$T_{17}$**:Trisodium phosphate @ 500 ppmand **$T_{18}$**:Control.

## REFERENCE


Ahmadvand G, Soleimani F, Saadatian B, Pouya M (2012). Effects of seed priming on germination and emergence traits of two soybean cultivars under salinity stress. *International Research Journal of Applied and Basic Sciences*. 3(2): 234-241.

Ali M, Liu MM, Wang ZE, LI SE, Jiang TJ, Zheng XL (2020). Pre-harvest spraying of oxalic acid improves postharvest quality associated with increase in ascorbic acid and regulation of ethanol fermentation in kiwifruit cv. Bruno during storage. *Journal of Integrative Agriculture*. 18(11): 2514-2520.

Anwar A, Xianchang YU, Yansu LI (2020). Seed priming as a promising technique to improve growth, chlorophyll, photosynthesis and nutrient contents in cucumber seedlings. *Notulae Botanicae Horti Agrobotanici Cluj-Napoca*. 48(1): 116-127.

Arin L, Polat S, Deveci M, Salk A (2020). Effects of different osmotic solutions on onion seed emergence. *African Journal of Agronomy*. 8 (1): 1-6.

Arrilia MC, De Calzada JF, Mencha JF, Rolz C, Shaw PE (1980). Tropical & sub tropical fruits. AVI. West port, Connecticut, USA: 316-340.

Aswin C, Vakeswaran V, Geetha R (2019). Effect of seed priming on seed quality enhancement in high and low vigour seed lots of tomato var. PKM 1. *International Journal of Chemical Studies*. 7(3): 1645-1648.

Balaji DSP, Narayanan SG (2019). Influence of halo priming treatments on seed quality in certain minor millets under drought condition. *Journal of Emerging Technologies and Innovative Research*. 6(5): 744 - 753.

Dayeswari D, Auxcilia J, Malarkodi K, Vijayakumar RM (2018). Effect of chemicals and bio-inoculants on seedling growth and vigour of TNAU papaya CO. 8 (*Carica papaya* L.). *International Journal of Current Microbiology and Applied Sciences*. 7(3): 3007-3014.

Drew P, Beniwal VS, Singh P (1998). Papaya. Corn publication. 59, pp 66 - 8.

Gayathri M (2001). Studies on seed invigouration to promote seed germination and seedling development in hybrid tomato seeds. M.Sc. thesis, University Agricultural Science, Bengalure.

Ghasemi-Golezani K, Aliloo AA, Valizadeh M, Moghaddam M (2008). Effects of different priming techniques on seed invigoration and seedling establishment of lentil (*Lens culinaris* Medik.). *Journal of Food, Agriculture and Environment*. 6: 222-226.

Menaka C, Vanangamudi K (2009). Biochemical and physiological changes of hardened and pelleted seeds of sorghum. *Journal of Ecobiology*. 24(3): 251-255.

Mookherjee S, Malik GC, Bandyopadhyay S, Mitra B (2014). Growth physiology of *Brassica rapa* var. Yellow Sarson under integrated nutrient management and seed soaking approaches in eastern sub-Himalayan plains. *Journal of Applied and Natural Science*. 6(2): 416-425.

Mura SS, Panda D, Mukherjee A, Pramanik K (2015). Effect of pre-sowing treatment of growth regulators and agrochemicals on germination, dry matter accumulation, chlorophyll content and yield of sesame (*Sesamum indicum* L.). *International Journal of Biological Research*. 89: 49-57.


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Pandey P, Bhanuprakash K, Umesh (2017). Effect of seed priming on seed germination and vigour in fresh and aged seeds of cucumber. *International Journal of Environment, Agriculture and Biotechnology*. 2 (4): 2261-2264.

Paul SR, Choudhury AK (1993). Effect of seed hardening with potash salts at different concentrations and soaking duration on germination and seedling vigour of wheat. *Annals of Agricultural Research*. 14 (3): 357-359.

Pervez H, Ashraf M, Makhdum MI (2004). Influence of potassium nutrition on gas exchange characteristics and water relations in cotton (*Gossypium hirsutum* L.). *Photosynthetica*. 42: 251 - 255.

Rangaswamy A, Purushothaman S, Devasenapathy P (1993). Seed hardening in relation to seedling quality characters of crops. *Madras Agricultural Journal*. 80: 535-537.

Reddy PVK, Reddy YTN (2017). Effect of $KNO_3$ on germination and vigor of mango rootstocks. *Journal of Research Achraya N. G. Ranga Agricultural University*. 45: 79-84.

Riley JM (1981). Growing rare fruit from seed. California rare fruit growers year book. 13: 1-47.

Sahib MM, Hamzah, NA, Hussein HJ (2014). Effect of seed priming by $KH_2PO_4$ and different temperature on seeds germination behavior of okra (Abelmoschus esculentus L.). *Al-Qadisiyah Journal of Pure Science*. 19(1): 16-24.

Sathish S, Sundareswaran S, Ganesan N (2011). Influence of seed priming on physiological performance of fresh and aged seeds of maize hybrid [COH (M)5] and it's parental lines. *Agricultural and Biological Sciences*. 6(3): 12-17.

Sathish S, Sundareswaran S (2010). Standardisation of seed priming technique in maize hybrid COH(M) 5. *Madras Agricultural Journal*. 97 (10-12): 315-318.

Shaban AEA (2010). Improving seed germination and seedling growth of some mango rootstocks. *American Eurasian Journal of Agricultural and Environmental Science*. 7:535-541.

Shehzad M, Ayub M, Ahmad AHU, Yaseen M (2012). Influence of priming techniques on emergence and seedling growth of forage sorghum (*Sorghum bicolor* L.). *Journal of Animal and Plant Sciences*. 22: 154-58.

Singh R, Bassi G (2016). Response of bitter gourd seed to seed priming treatments under sub-optimal environments. *Indian Journal of Agricultural Sciences.* 86 (7): 935 - 939.

Singh SN, Agrawal SC (1988). Interaction effect of seed dressers and period of expresser on germination and nodulation of soybean. *Indian Journal of Plant Pathology*. 6(1): 63-66.

Tanaka A, Tsuji H (1980). Effect of calcium on chlorophyll synthesis and stability in the early phase of greening in cucumber cotyledons. *Plant Physiology*. 65: 1211-1215.

Thiruppathi M, Mullaimaran S (2020). Effect of seed treatments on germination, growth and vigour of papaya (*Carica papaya* L.) cv. Red Lady. *International Journal of Chemical Studies*. 8(4): 3528-3531.

Tsialtas IT, Shabala S, Baxevanos D, Matsi T (2016). Effect of potassium fertilization on leaf physiology, fiber yield and quality in cotton (*Gossypium hirsutum* L.) under irrigated Mediterranean conditions. *Field Crops Research*. 193: 94 - 103.

Waraich EA, Rashid F, Ahmad Z, Ahmad R, Ahmad M (2020). Foliar applied potassium stimulate drought tolerance in canola under water deficit conditions. *Journal of Plant Nutrition*. 1 - 12.

Yahiro M (1979). Effects of seed pre-treatments on the promotion of germination in papaya (*Carica papaya* L). Memoris of the faculty of Agriculture, Kagoshima University. 15:49-54.

Yanglem SD, Ram V, Rangappa K, Premaradhya, Deshmukh N(2021). Effects of seed priming on root- shoot behaviour and stress tolerance of pea. *Bangladesh Journal of Botany*. 50(2): 199-208.

Yari L, Aghaalikani M, Khazaei F (2010). Effect of seed priming duration and temperature on seed germination behavior of wheat (*Triticum aestivum* L.). *Journal of Agricultural and Biological Science*. 5(1): 1 - 6.