**Effect of gibberellic acid (GA3) and organic substances on seed germination and shoot growth of Custard Apple (*Annona squamosa* L.) seedlings under shade net condition**

**Abstract**

The current study, entitled “Effect of gibberellic acid (GA3) and organic substances on seed germination and shoot growth of Custard Apple (*Annona squamosa* L.) seedlings under shade net condition”, was conducted during 2024-2025 at Horticulture nursery, Department of Fruit Science, College of Agriculture, IGKV, Raipur (C.G.). The experimental design utilized was Completely Randomized Design, comprising 13 distinct treatments, each replicated three times. The soaking agents included GA3 and organic substances with specific treatments as follows: T0: Control, T1: Distilled water + 72 hours soaking, T2: GA3 @ 400 ppm + 24 hours soaking, T3: GA3 @ 500 ppm + 24 hours soaking T4: *Azospirillum* @ 5% + 24 hours soaking,T5: *Azospirillum* @ 10% + 24 hours soaking, T6: PSB @ 5% + 24 hours soaking, T7: PSB @ 10% + 24 hours soaking, T8: Cow urine @ 5% + 24 hours soaking, T9: Cow urine @ 10% + 24 hours soaking, T10: Custard Apple Leaf Extract @ 5% + 24 hours soaking, T11: Custard Apple Leaf Extract @ 10% + 24 hours soaking and T12: Cow dung slurry @ 10% + 24 hours soaking. The results of the present investigation demonstrated that among the various pre-soaking treatments, T2 (GA3 @ 400 ppm + 24 hours soaking) was the most effective in enhancing seed germination and shoot growth parameters, followed by T3 (GA3 @ 500 ppm + 24 hours soaking). In contrast, the control treatment (T0) exhibited the lowest performance across all evaluated parameters. Among the organic treatments, T9 (Cow urine @ 10% + 24 hours soaking) produced the most favourable response, followed by T12 (Cow dung slurry @ 10% + 24 hours soaking). Therefore, T9 may serve as a viable alternative to chemical treatments in organic or low-input production systems.

**Key words:** *Azospirillum*, Gibberellic acid, Cow dung slurry, Cow urine, Custard Apple Leaf Extract, Organic substances, PSB.

**Introduction**

Custard Apple (*Annona squamosa* L.) is a highly valued tropical and subtropical fruit crop cultivated primarily in Asia, Africa, and the Americas. Belonging to the family Annonaceae, it is commonly known in India as sitaphal, sugar apple, sharifa, or sweetsop. Maharashtra is the leading producer, followed by Madhya Pradesh, Gujarat, Chhattisgarh, Telangana, Karnataka, Andhra Pradesh, Rajasthan, Kerala and Tamil Nadu (Anonymous, 2022–2023). Custard apple seeds typically require 35–50 days to germinate (Setten and Koek-Noorman, 1992) and germination is often irregular due to dormancy or a hard seed coat. Limited research in India and elsewhere has demonstrated that pre-sowing treatments with GA₃ (150–500 ppm) and other agents can enhance germination (Banker, 1987; Pawashe, 1997; Stino, 1996; Ratan and Reddy, 2004). Pre-treatment of seeds with water, chemical or organic substances is essential for improving germination percentage and seedling vigor. Gibberellic acid (GA₃) facilitates germination by mobilizing endosperm reserves, weakening the endosperm barrier and stimulating embryo growth (Ratan and Reddy, 2004). Due to the increasing cost of synthetic growth regulators, interest has shifted toward accessible, low-cost organic alternatives. Organic substances such as cow dung and cow urine are now gaining attention for their potential to break seed dormancy (Rajput and Sharma, 2020). Additionally, bioinoculants like *Aspergillus* and phosphate-solubilizing bacteria (PSB) can promote germination through the production of plant growth-promoting substances. Moreover, *Annona squamosa* leaves contain essential minerals (P, K, Fe, Ca, Mg, Na, Cu, Se, Zn) and vitamins (A, B₁, B₂, B₃, B₉, C, E), which may support early seed germination (Kumar *et al.,* 2021).

**Materials and Method**

 The present experiment, entitled “Effect of gibberellic acid (GA3) and organic substances on seed germination of Custard Apple (*Annona squamosa* L.) seedlings under shade net condition”, was conducted during 2024-2025 at Horticulture nursery, Department of Fruit Science, College of Agriculture, IGKV, Raipur (C.G.). The treatment details included: T0: Control, T1: Distilled water + 72 hours soaking, T2: GA3 @ 400 ppm + 24 hours soaking, T3: GA3 @ 500 ppm + 24 hours soaking T4: *Azospirillum* @ 5% + 24 hours soaking,T5: *Azospirillum* @ 10% + 24 hours soaking, T6: PSB @ 5% + 24 hours soaking, T7: PSB @ 10% + 24 hours soaking, T8: Cow urine @ 5% + 24 hours soaking, T9: Cow urine @ 10% + 24 hours soaking, T10: Custard Apple Leaf Extract @ 5% + 24 hours soaking, T11: Custard Apple Leaf Extract @ 10% + 24 hours soaking and T12: Cow dung slurry @ 10% + 24 hours soaking. The pre-soaked seeds were placed in black poly bags filled with soil, FYM and sand in the ratio 2:1:1, at a depth of 5 cm (one seed per bag) and they were lightly watered daily until germination, with regular watering maintained for the water table and pesticide applied for healthy seedlings, observations on germination parameters were recorded daily and growth parameters recorded after 30,60,90 and 120 days after sowing.

**Result and Discussion**

**A: Seed germination parameters**

The results indicated that seeds treated with T2 (GA3 @ 400 ppm + 24 hours soaking) exhibited the most rapid germination, initiating at 19.09 days, followed by T3 (GA3 @ 500 ppm + 24 hours soaking) at 20.29 days. In contrast, T0 (Control) recorded the highest number of days to germination (26.29 days). These findings align closely with those reported by Singh *et al.* (2023)*.* This improvement can be attributed to GA₃ role in stimulating enzyme production and activating food reserve mobilization, both of which are critical for initiating early germination (Heden *et al*., 2012).

The shortest time to achieve 50% germination (28.06 days) was recorded under treatment T2 (GA3 @ 400 ppm + 24 hours soaking), followed by T3 (GA3 @ 500 ppm + 24 hours soaking) at 33.56 days. The longest duration was observed in T0 (Control), taking 45.57 days. These findings align closely with those reported by Martinez *et al.* (2016). The enhanced germination response may be attributed to role of GA3 in stimulating α-amylase activity, which facilitates the hydrolysis of starch into simpler sugars, thereby releasing energy required for the activation of embryonic cells (Anjanawe *et al*., 2013).

The highest germination percentage was recorded in T2 (GA3 @ 400 ppm + 24 hours soaking) 82.23%, which was statistically *at par* with T3 (GA3 @ 500 ppm + 24 hours soaking) 79.09%. The lowest germination percentage was observed in T0 (Control), 52.24%. These findings align closely with those reported by Panherkar *et al.* (2021). The increase in germination percentage may be attributed to GA₃ induced stimulation of α-amylase activity, which promotes starch hydrolysis into simple sugars, providing the energy required for embryo activation.

In terms of survival percentage, T2 (GA3 @ 400 ppm + 24 hours soaking) recorded the highest value 84.43%, followed by T3 (GA3 @ 500 ppm + 24 hours soaking) 80.47%, while T0 (Control) showed the lowest survival rates 67.07%. These findings align closely with those reported by Lawhale *et al.* (2020). The improved survival rate is due to GA₃ role in increasing seedling dry weight through enhanced cell elongation and expansion, resulting in better root and shoot development (Madgaonkar, 2013).

The germination index was also maximum in T2 (GA3 @ 400 ppm + 24 hours soaking) 3.40, followed by T3 (GA3 @ 500 ppm + 24 hours soaking) 2.84, whereas the lowest germination index was recorded in T0 (Control) 1.47. These findings align closely with those reported by Patel *et al.* (2017). The enhancement in germination index is due to the role of GA₃ in initiating enzyme production and activating food reserve mobilization, both of which are essential for promoting early and uniform germination (Heden *et al.,* 2012).

**B: Shoot growth parameters**

The maximum seedling height at 30, 60, 90 and 120 days after sowing were recorded in T2 (GA3 @ 400 ppm + 24 hours soaking) with 7.01, 8.57, 11.07 and 14.57 cm, respectively, while the lowest values were observed in the T0 (Control) with 3.21, 4.71, 7.21 and 9.68 cm. These findings align closely with those reported by Sunder *et al.* (2024). This increase in plant height may be attributed to the role of GA₃ at various stages, as it promotes internode elongation and is known to enhance cell elongation (Heden *et al.*, 2012).

The highest number of leaves (6.74, 8.30, 11.54 and 12.54) at 30, 60, 90 and 120 DAS, respectively, was recorded in T2 (GA3 @ 400 ppm + 24 hours soaking), while the lowest (2.44, 3.83, 6.30 and 7.30) was observed in the T0 (Control). These findings align closely with those reported by Rana *et al.* (2020). This The increase in leaf number is the GA₃ activity in apical meristem, which enhances nucleoprotein synthesis and promotes leaf initiation (Heden *et al.,* 2012).

The maximum collar diameter (1.91, 2.65, 3.40 and 3.70 mm) at 30, 60, 90 and 120 DAS was recorded in T2 (GA3 @ 400 ppm + 24 hours soaking), while the minimum (0.78, 1.44, 2.19 and 2.49 mm) was observed in the T0 (Control). These findings align closely with those reported by Rajput and Sharma (2020). The increase in collar diameter is GA₃ induced stimulation of cell division and elongation in stem tissues, likely through enhanced cambial activity (Dhankar and Singh, 1996).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Treatment notations** | **Treatment details** | **Days taken to initiate germination** | **Days taken for 50% germination** | **Germination %** | **Survival %** | **Germination Index** |
| **T0** | Control | 26.29 | 45.57 |  52.24 | 67.07 | 1.47 |
| **T1** | Distilled water + 72 hours soaking |  24.98 |  43.55 |  68.43 |  71.44 |  2.16 |
| **T2** | GA3 @ 400 ppm + 24 hours soaking | 19.09 | 28.06 |  82.23 | 84.43 | 3.40 |
| **T3** | GA3 @ 500 ppm + 24 hours soaking | 20.29 | 33.56 | 79.09 | 80.47 | 2.84 |
| **T4** | *Azospirillum* @ 5% + 24 hours soaking |  22.74 |  40.27 |  72.46 |  74.42 |  2.41 |
| **T5** | *Azospirillum* @ 10% + 24 hours soaking |  21.65 | 39.04 | 74.00 | 78.04 | 2.60 |
| **T6** | PSB @ 5% + 24 hours soaking |  22.96 |  41.08 |  71.54 | 74.22 | 2.35 |
| **T7** | PSB @ 10% + 24 hours soaking |  22.24 | 39.26 |  73.36 | 76.71 | 2.52 |
| **T8** | Cow urine @ 5% + 24 hours soaking |  22.56 |  40.03 | 73.00 | 75.60 |  2.46 |
| **T9** | Cow urine @ 10% + 24 hours soaking |  20.85 |  37.11 |  78.26 | 79.21 |  2.81 |
| **T10** | Custard Apple Leaf Extract @ 5% + 24 hours soaking |  23.55 |  42.23 |  69.06 |  72.74 |  2.21 |
| **T11** | Custard Apple Leaf Extract @ 10% + 24 hours soaking |  23.23 |  42.02 |  71.09 |  72.83 |  2.31 |
| **T12** | Cow dung slurry @ 10% + 24 hours soaking |  21.39 |  38.23 |  75.22 |  78.16 |  2.68 |
|  | **SE (m) ±** | **0.28** | **0.58** | **1.26** | **1.03** | **0.03** |
| **C.D. at 5%** | **0.81** | **1.68** | **3.67** | **2.98** | **0.09** |

**Table 1:** Effect of GA3 and organic substances on seed germination parameters of custard apple seedlings

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Treatment notations** |  **Treatment details** | **Seedling height (cm)** | **Number of leaves** |  **Collar diameter (mm)** |
| **30 DAS** | **60 DAS** | **90 DAS** | **120 DAS** | **30 DAS** | **60 DAS** | **90 DAS** | **120 DAS** | **30 DAS** | **60 DAS** | **90 DAS** | **120 DAS** |
| **T0** |  Control | 3.21 | 4.71 | 7.21 | 9.68 | 2.44 | 3.83 | 6.30 | 7.30 | 0.78 | 1.44 |  2.19 |  2.49 |
| **T1** |  Distilled water + 72 hours soaking | 5.50 | 7.15 | 9.65 | 12.43 | 4.03 | 6.02 | 8.05 | 9.04 | 1.19 | 2.06 |  2.81 |  3.11 |
| **T2** |  GA3 @ 400 ppm + 24 hours soaking | 7.01 | 8.57 | 11.07 | 14.57 |  6.74 | 8.30 | 11.54 | 12.54 | 1.91 | 2.65 |  3.40 | 3.70 |
| **T3** |  GA3 @ 500 ppm + 24 hours soaking | 6.61 | 8.28 | 10.78 | 14.28 |  6.35 |  7.65 | 10.70 | 11.71 | 1.78 | 2.52 |  3.27 |  3.57 |
| **T4** |  *Azospirillum* @ 5% + 24 hours soaking | 5.87 | 7.54 | 10.04 | 13.54 |  4.73 |  7.09 | 8.73 | 9.72 | 1.52 |  2.28 |  3.03 |  3.33 |
| **T5** |  *Azospirillum* @ 10% + 24 hours soaking | 6.34 | 8.04 | 10.51 | 14.04 |  5.43 |  7.23 | 9.62 | 10.54 | 1.63 |  2.38 |  3.11 |  3.41 |
| **T6** |  PSB @ 5% + 24 hours soaking | 5.73 | 7.49 | 10.00 | 13.40 |  4.55 |  6.81 | 8.55 | 9.54 | 1.46 |  2.27 |  3.02 |  3.32 |
| **T7** |  PSB @ 10% + 24 hours soaking | 6.27 | 8.01 | 10.44 | 14.01 |  5.32 |  7.20 | 9.34 | 10.35 | 1.59 | 2.34 |  3.09 |  3.39 |
| **T8** |  Cow urine @ 5% + 24 hours soaking | 6.10 | 7.76 | 10.26 | 13.76 |  5.13 |  7.11 | 9.15 | 10.15 | 1.55 | 2.30 |  3.05 |  3.35 |
| **T9** |  Cow urine @ 10% + 24 hours soaking | 6.54 | 8.21 | 10.71 | 14.21 |  6.09 | 7.41 | 10.53 | 11.52 | 1.72 | 2.46 |  3.21 |  3.51 |
| **T10** |  Custard Apple Leaf Extract @ 5% + 24 hours soaking | 5.60 | 7.25 | 9.75 | 13.23 | 4.15 |  6.22 | 8.14 | 9.13 | 1.32 | 2.16 |  2.91 |  3.21 |
| **T11** |  Custard Apple Leaf Extract @ 10% + 24 hours soaking | 5.70 | 7.35 | 9.83 | 13.35 |  4.51 |  6.62 | 8.55 | 9.33 | 1.30 |  2.26 |  3.01 |  3.31 |
| **T12** |  Cow dung slurry @ 10% + 24 hours soaking | 6.44 | 8.11 | 10.61 | 14.11 |  5.76 |  7.23 | 9.72 | 10.73 | 1.65 | 2.38 |  3.13 |  3.43 |
|  | **SE (m) ±** | **0.09** | **0.09** | **0.15** | **0.18** | **0.09** | **0.09** | **0.15** | **0.18** | **0.03** | **0.04** | **0.05** | **0.06** |
| **C.D. at 5%** | **0.27** | **0.27** | **0.43** | **0.53** | **0.25** | **0.27** | **0.44** | **0.54** | **0.08** | **0.10** | **0.14** | **0.16** |

**Table 2:** Effect of GA3 and organic substances on shoot growth parameters of custard apple seedlings

**Conclusion**

The application of GA3 @ 400 ppm + 24 hours soaking (T2) significantly improved germination by reducing the time to initiation and 50% germination, while enhancing germination percentage, survival rate, germination index, seedling height, number of leaves and collar diameter in custard apple seedlings. Among organic treatments, T9 (Cow urine @ 10% + 24 hours soaking) proved most effective, followed by T12 (Cow dung slurry @ 10% + 24 hours soaking) and T5 (*Azospirillum* @ 10% + 24 hours soaking), indicating their potential as suitable alternatives where chemical use is not preferred.

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