



# Effect of Seed Treatment and Growing Condition on the Germination and Survivability of Custard Apple (*Annona squamosa* L.) Seedlings

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## Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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## ABSTRACT

The study was carried out during the year 2018-2019 at the Fruit Research Station Imalia and in laboratory of Department of Horticulture, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.). The experiment was laid out in Factorial Complete Randomized Design (FCRD) replicated thrice. The experiment consist of two factor viz. A- Three growing condition (G<sub>3</sub> -

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Poly house, G<sub>2</sub>-net house, G<sub>1</sub>-Open condition) and B- Six seed treatment (S<sub>1</sub> - Water soaking, S<sub>2</sub>- Cowurine, S<sub>3</sub>-GA<sub>3</sub>, S<sub>4</sub>-KNO<sub>3</sub>, S<sub>5</sub>-Thiourea, S<sub>6</sub>-Sodium Thiosulphate) having 18 treatment combinations. Observation were recorded on various aspects like days taken to 1<sup>st</sup> germination, days taken to 50 % germination, height of seedling, girth of stem, number of leaves, fresh weight of shoot and root, dry weight of shoot and root, root length, total length of seedling, number of roots/seedling, survival percent of seedling.

On the basis of present investigation, it is concluded that among the various seed treatments and growing condition, the growing condition of poly house and seed treatment with GA<sub>3</sub> 500 ppm have been proved superior with respect to germination, growth and survival of seedling. Among various treatment combinations, G<sub>3</sub>S<sub>3</sub> treatment combination (Poly house and GA<sub>3</sub> 500ppm) found best over the rest of the treatment combinations with respect to germination parameters like minimum days taken to 1<sup>st</sup> germination (25.33) days taken to 50% germination (45.66), growth parameter like maximum - height of shoots (25.13cm), girth of stem (3.91mm) and number of leaves 18.91 at 160 DAS respectively, root length(15.13cm), number of roots/seedling(45.12), survival percentage of seedling (89.34%).The G<sub>3</sub>S<sub>4</sub> (Polyhouse and KNO<sub>3</sub>) was found next best treatment combination in this respect.

**Keywords:** Custard apple; chemicals; seed treatment; seed germination and survivality; seedlings.

## 1. INTRODUCTION

Custard apple (*Annona squamosa* L.) also known as Sitaphal belongs to the family Annonaceae and is one of the finest fruits introduced in India from tropical America. It is also found in wild form in many parts of India. In India, custard apple occupies an area of 44 thousand ha with production of 367 thousand MT [1]. It is found growing almost in all the tropical and subtropical regions mostly in wild form. Custard apple is rich source of Carbohydrate, Protein, Fiber and Mineral's like Calcium, Phosphorus, Iron and Vitamin. Custard apple appears to possess potent bioactive principles in most of its plant parts (Fruit, Seed and Leaves). The seeds of custard apple have hard endocarp. Due to this hard seed coat, its germination takes longer time 20 days to 6 months in natural conditions [2-4].

The use of plant growth regulators in proper concentration with scarification may regulate seed germination and seedling growth behaviour in many fruit crops. Pre-sowing treatment with growth regulator could lead to increase seed germination and enhancement of seedling growth [5-8]. A low concentration of plant growth regulators may be ineffective. On the other hand, higher concentration may inhibit the growth. Seed without use of growth regulators showed poor response for germination and subsequent growth. Plant growth regulators like GA<sub>3</sub>, IBA, and IAA enhance the germination, growth and survival of seedlings [9,10]. GA<sub>3</sub> are used for weaking of the seed coat so that the emergence of radical and plumule is positively influenced for

root and shoot formation [11-13]. Thus, there is need to develop a suitable technology for improving germination and subsequent growth of seedlings for budding and grafting on it. Efforts for pre- sowing seed treatment with plant growth regulators (GA<sub>3</sub> and NAA), chemicals (KNO<sub>3</sub>, H<sub>2</sub>SO<sub>4</sub>, micronutrients mixture) and hot water treatment have been made with varying germination and subsequent seedling vigour in various fruit crops [14-16]. Chemicals like Thiourea, Potassium nitrate and Sodium Thiosulphate are also used to improve the seed germination. Annonas are mostly grown by seeds either for seedling plants or vegetative propagation. In order to have uniform and prompt germination and to avoid the problem of uneven and irregular germination and to get sapling either for planting or to be used as rootstocks, the seed treatment of custard apple seed is of quite importance.

## 2. MATERIALS AND METHODS

The present investigation was carried out at Fruit Research Station Imalia, Department of Horticulture, Collage of Agriculture, JNKVV, Jabalpur (M.P.) during the year 2018-19. The experiment comprised of Factor A (Three Growing conditions) Open condition G<sub>1</sub>/Net house, G<sub>2</sub>Poly house and G<sub>3</sub>. Factor B (Seed treatment) Water soaking (S<sub>1</sub>), Cow Urine(S<sub>2</sub>), GA<sub>3</sub> 500 ppm (S<sub>3</sub>), KNO<sub>3</sub> 1% (S<sub>4</sub>), Thiourea1% (S<sub>5</sub>), Sodium Thiosulphate 250 ppm (S<sub>6</sub>) having 18 treatment combinations. The experiment was laid out in poly bags in factorial completely randomized design with three replications. Observations were recorded using standard

procedure and statistically analysed (Panse and Sukhatme (1963).

## 2.1 Germination Parameters

- 1. Days taken to Start First Germination:** Date of emergence of cotyledonary leaves was recorded and calculated from date of sowing.
- 2. Days taken to 50% Germination:** The number of days were counted from the start of germination till 50% germination.
- 3. Percent of Germination:** The percentage of total seeds germination in each treatment was recorded at 60 days after sowing.

$$\text{Germination (\%)} = \frac{\text{No. of germinated seed}}{\text{Total no. of seeds sown}} \times 100$$

## 2.2 Growth Parameters

- 1. Height of Seedling (cm):** Height was measured from ground level to the tip of opened leaf at 80, 100, 120, 140, 160 (DAS).
- 2. Girth of Stem (mm):** The girth of stem was measured with the help of digital vernier calipers just above the ground surface and the average was calculated at 80, 100, 120, 140, 160 (DAS).
- 3. Number of Leaves /Seedling:** The total number of leaves per seedling was counted and the average was calculated, matured leaves were taken into account at 80, 100, 120, 140, 160 (DAS).
- 4. Survival Percent of Seedlings:** The survival percentage of each treatment was recorded at 160 days after seed sowing. The survival percentage was calculated by using formula as given below:

$$\text{Survival percentage of seedling} = \left( \frac{\text{No. of seedling survived}}{\text{Total no. of seedlings}} \right) \times 100$$

## 3. RESULTS AND DISCUSSION

### 3.1 Days Taken to 1<sup>st</sup> Germination

The minimum (29.66) days was required for seed germination under G<sub>3</sub> (Poly house) while, it was maximum (55.16) days under G<sub>1</sub> (Open condition). This is due to high temperature and humidity in poly house which initiated the early germination. Different seed treatment also

significantly affected the initiation of seed germination. The minimum days taken to initiate the germination was recorded with S<sub>3</sub> (GA<sub>3</sub> 500 ppm) while, the maximum days in S<sub>1</sub> (water soaking) i.e. seed soaking in water alone. Our results are also in the line of Rajamanickam et al. [17], Ratan and Reddy [3]. The interaction of growing conditions and seed treatment showed significant effect on initiation of seed germination. The maximum days (60.66) days taken to 1<sup>st</sup> germination of seed were recorded under G<sub>1</sub>S<sub>1</sub> (water soaking and open condition) and the minimum (25.33) days taken to initiate germination under the treatment combination G<sub>3</sub>S<sub>3</sub> (poly house and GA<sub>3</sub> 500 ppm). It is probably due to the synergistic combination of both the factors. Our results are also in the line of Verma et al. [6].

### 3.2 Days Taken to 50 % Germination

The present research reveals that the growing conditions and seed treatment showed significant effect on germination of seed. The minimum days (51.16) were taken to 50% germination under the growing conditions G<sub>3</sub> (Poly house) and maximum (66.61) were taken under the condition G<sub>1</sub> (open condition). Initiation of seed germination was significantly affected by seed treatment. The minimum (53.44) were taken to 50% germination with S<sub>3</sub> (GA<sub>3</sub> 500ppm) while, the maximum days (76.27) in S<sub>1</sub> (Water soaking). Our results are also in the line of Rajamanickam et al [5]. The interaction effect of growing condition and seed treatment were found to have significant effect on 50% germination. The maximum days (72.00) taken to 50% germination were noted under the treatment combination of G<sub>1</sub>S<sub>1</sub> (Open condition and water soaking). However, the minimum days (45.66) taken to 50 % germination were noted under the treatment combination of G<sub>3</sub>S<sub>3</sub> (Poly house and GA<sub>3</sub> 500 ppm). It is probably due to the synergistic combination of both the factors. Our results are also in the line of Verma et al. [18].

### 3.3 Height of Seedling (cm)

Growing condition had significant effect on attaining maximum height of shoots (i.e. 7.40, 8.41, 12.35, 16.33 and 21.33 cm) respectively at 80, 100, 120, 140 and 160 DAS under the growing condition G<sub>3</sub> (poly house). Our result, are also in the line of Nguilie and Biswas (2017). As regards the seed treatment, maximum height of shoots (6.23, 7.06, 8.55, 11.76, and 14.02 cm) was recorded with S<sub>3</sub> (GA<sub>3</sub> 500 ppm) at 80, 100,

120, 140 and 160 DAS, respectively. Basically, Plant height is a genetically controlled character but several studies have indicated that plant height can be increased by application of synthetic plant growth regulators. However, in the present investigation, a significant difference in plant height was noticed by the application of different concentration of GA<sub>3</sub> is known to enhance cell elongation. Our results are also in the line of Singh et al. [19]. Interaction effect of growing condition and seed treatment showed maximum height of shoot i.e. 8.26, 9.40, 15.11, 18.91 and 25.13 at 80, 100, 120, 140 and 160 days after sowing, respectively at successive growth period under treatment combination G3S3 (poly house and GA<sub>3</sub>). Whereas, minimum height was recorded under G1S1 (open condition and water soaking). It may be due to synergistic effect of both factors. Our results are also in the line of Verma et al. [18].

### 3.4 Girth of Stem (mm)

Significantly maximum girth of stem (1.11, 2.33, 2.75, 3.14 and 3.42 mm) was recorded at 80, 100, 120, 140 and 160 DAS in G3 (poly house) whereas, minimum girth under treatment G1 (open condition and water soaking). As regards seed treatment, the significantly maximum girth of stem (0.91, 2.01, 2.50, 2.82 and 2.85 mm) was recorded with S3 (GA<sub>3</sub> and 500 ppm) and minimum girth of stem was recorded in S1 (water soaking). Our result is also in the line of Singh et al. (2004) and Meena and Jain (2005), Verma et al. [18]. Interaction effect of growing conditions and seed treatment showed significant effect on girth of stem. The maximum girth of stem 1.30, 2.72, 3.01, 3.51, 3.91 was noted under the combination of growing condition and seed treatment G3S3 (poly house and GA<sub>3</sub>). Whereas, minimum girth of stem 0.75, 1.73, 2.11, 2.12, 2.53 was noted under the combination of growing condition and seed treatment G1S1 (open condition and water soaking). It may be due to synergistic effect of both factors. Our results are also in the line of finding of Verma et al. [18].

### 3.5 Number of Leaves /Seedling

The data regarding number of leaves per seedling as influenced by different growing conditions and seed treatment indicated that the maximum mean number of leaves per seedling was produced by the seedlings grown in G3 (poly house) (6.92, 9.47, 11.31, 13.80 and 16.37 at 80, 100, 120, 140 and 160 days after sowing. Whereas, treatment G1 (water soaking) recorded minimum mean number of leaves per seedling at

all the stage of observations. Among different seed treatments, S3 (GA<sub>3</sub> 500ppm) encouraged leaf production and gave significantly maximum (7.38, 9.68, 10.67, 13.54 and 16.25) number of leaves /seedling at 80, 100, 120, 140 and 160 days after sowing respectively. The production of more number of leaves in GA<sub>3</sub> treatments may be due to the vigorous growth and more number of branches induced by GA<sub>3</sub> which facilitates better harvest of sunshine by the plants to produce more number of leaves. Similar findings were also reported by Chandore et al. (2016), Thamer HR and AL Falahy [20]. It may be due to synergistic effect of both factors. Our results are also in the line of Verma et al. [18].

### 3.6 Root Length (cm)

The growing conditions significantly influenced the mean root length and the maximum (12.127) root length was recorded under conditions G3 (poly house condition) followed by treatments G2 (11.26) and minimum (10.42) in treatment G1 (Control).

The seed treatment also influenced root length of at 160 days after seed sowing. Among the treatments, S3 (GA<sub>3</sub> 500 ppm) recorded maximum (14.12) root length followed by treatment S4 KNO<sub>3</sub> 1% (13.38). The treatment S1 (Control) recorded minimum (9.15) root length of seed.

The data regarding interaction effects showed that the maximum (15.13) root length was recorded under the treatment combination of G3S3 (poly house condition and (GA<sub>3</sub> 500 ppm). The minimum (8.47) was recorded under the treatment combination G1S1 (open condition and water soaking).

### 3.7 Number of Roots /Seedling

The growing conditions significantly influenced the mean number of roots/seedling and the maximum (40.34) was recorded under conditions G3 (poly house condition) followed by treatments G2 (37.11) and minimum (31.02) in treatment G1 (Control).

The seed treatment also influenced number of roots/seedling at 160 days after seed sowing. Among the treatments, S3 (GA<sub>3</sub> 500 ppm) recorded maximum (39.80) number of roots/seedling followed by treatment S4 KNO<sub>3</sub> 1% (33.89). The treatment S1 (Control) recorded minimum (32.89) number of roots/seedling.

**Table 1. Effect of Seed Treatment and Growing Condition on Days Taken to Start 1<sup>st</sup> Germination and 50% Germination of Custard Apple**

Treatments		Days Taken to Start 1 <sup>st</sup> Germination	Days Taken to 50% Germination
<b>Growing Condition</b>			
G <sub>1</sub>	Open condition	55.16	66.61
G <sub>2</sub>	Net house condition	43.88	56.77
G <sub>3</sub>	Poly house condition	29.66	51.16
	SE(m)±	0.23	0.15
	CD at 5% level	0.67	0.44
<b>Seed Treatment</b>			
S <sub>1</sub>	Water soaking	47.88	76.27
S <sub>2</sub>	Cow urine	44.22	61.22
S <sub>3</sub>	GA <sub>3</sub> 500 ppm	37.33	53.44
S <sub>4</sub>	KNO <sub>3</sub> 1%	41.11	55.00
S <sub>5</sub>	Thiourea(1%)	43.11	57.33
S <sub>6</sub>	Sodium thiosulphate 250 ppm	43.77	59.33
	SE(m)±	0.33	0.21
	CD at 5% level	0.95	0.62
<b>Interaction</b>			
G <sub>1</sub> S <sub>1</sub>	Open condition + Water soaking	60.66	72.00
G <sub>1</sub> S <sub>2</sub>	Open condition + Cow urine	58.00	70.33
G <sub>1</sub> S <sub>3</sub>	Open condition + GA <sub>3</sub> 500 ppm	48.33	61.66
G <sub>1</sub> S <sub>4</sub>	Open condition + KNO <sub>3</sub> (1%)	52.66	63.33
G <sub>1</sub> S <sub>5</sub>	Open condition+ Thiourea(1%)	55.00	65.00
G <sub>1</sub> S <sub>6</sub>	Open condition + Sodium Thiosulphate 250 ppm	56.33	67.33
G <sub>2</sub> S <sub>1</sub>	Net house + Water soaking	48.00	60.33
G <sub>2</sub> S <sub>2</sub>	Net house+Cow urine	46	59.33
G <sub>2</sub> S <sub>3</sub>	Net house +GA <sub>3</sub> 500 ppm	38.33	53.00
G <sub>2</sub> S <sub>4</sub>	Net house +KNO <sub>3</sub> (1%)	42.33	54.00
G <sub>2</sub> S <sub>5</sub>	Net house+ Thiourea (1%)	43.66	56.33
G <sub>2</sub> S <sub>6</sub>	Net house+ Sodium Thiosulphate 250 ppm	45.00	57.66
G <sub>3</sub> S <sub>1</sub>	Poly house+Water soaking	35.00	56.00
G <sub>3</sub> S <sub>2</sub>	Poly house +Cow urine	28.66	54.00
G <sub>3</sub> S <sub>3</sub>	Poly house +GA <sub>3</sub> 500 ppm	25.33	45.66
G <sub>3</sub> S <sub>4</sub>	Poly house+ KNO <sub>3</sub> (1%)	28.33	47.66
G <sub>3</sub> S <sub>5</sub>	Polyhouse + Thiourea (1%)	30.66	50.66
G <sub>3</sub> S <sub>6</sub>	Polyhouse + Sodium thiosulphate 250 ppm	30.00	53.00
	<b>SE(m)±</b>	<b>0.57</b>	<b>0.37</b>
	<b>CD at 5% level</b>	<b>1.647</b>	<b>1.08</b>

The data regarding interaction effects showed that the maximum (45.12) no. of roots/seedling was recorded under the treatment combination of G<sub>3</sub>S<sub>3</sub> (poly house condition and (GA<sub>3</sub> 500 ppm). The minimum (26.16) was recorded under the treatment combination G<sub>1</sub>S<sub>1</sub> (open condition and control).

### 3.8 Survival Percentage of Seedling

The growing conditions significantly influenced the mean survival percentage of seedling and the

maximum (85.28) was recorded under conditions G<sub>3</sub> (poly house condition) followed by treatments G<sub>2</sub> (82.50) and minimum (76.83) in treatment G<sub>1</sub> (Control).

The seed treatment also influenced survival percentage of seedling at 160 days after seed sowing. Among the treatments, S<sub>3</sub> (GA<sub>3</sub> 500 ppm) recorded maximum (39.80) survival percentage of seedling followed by treatment S<sub>4</sub> KNO<sub>3</sub> 1% (38.32). The treatment S<sub>1</sub> (Control)

recorded minimum (32.89) survival percentage of seedling.

The data regarding interaction effects showed that the maximum (89.34) survival percentage

of seedling was recorded under the treatment combination of G3S3 (poly house condition and (GA<sub>3</sub> 500 ppm). The minimum (73.80) was recorded under the treatment combination G1S1 (open condition and control.

**Table 2. Effect of Seed Treatment and Growing Condition on Height (cm) of Custard Apple Seedlings**

Treatments		Height of Seedlings (cm) at Different Stage				
		80 days	100 days	120 days	140 days	160 days
<b>Growing Condition</b>						
G <sub>1</sub>	Open condition	6.21	6.75	7.63	10.88	12.33
G <sub>2</sub>	Net house condition	6.66	7.71	9.161	12.35	16.29
G <sub>3</sub>	Poly house condition	7.40	8.41	12.35	16.33	21.33
	SE(m)±	0.06	0.03	0.02	0.03	0.04
	CD at 5% level	0.18	0.10	0.06	0.09	0.13
<b>Seed Treatment</b>						
S <sub>1</sub>	Water soaking	6.23	7.06	8.55	11.76	14.02
S <sub>2</sub>	Cow urine	6.52	7.17	8.88	12.01	14.60
S <sub>3</sub>	GA <sub>3</sub> 500 ppm	7.46	7.17	11.51	15.38	20.13
S <sub>4</sub>	KNO <sub>3</sub> 1%	7.05	7.96	10.53	14.59	19.01
S <sub>5</sub>	Thiourea (1%)	6.74	7.68	9.64	13.15	19.01
S <sub>6</sub>	Sodium thiosulphate	6.55	7.35	9.16	12.31	15.46
	SE(m)±	0.09	0.05	0.03	0.048	0.06
	CD at 5% level	0.25	0.15	0.09	0.138	0.18
<b>Interaction</b>						
G <sub>1</sub> S <sub>1</sub>	Open condition + Water soaking	5.66	6.26	6.83	9.66	10.12
G <sub>1</sub> S <sub>2</sub>	Open condition + Cow urine	6.06	6.40	7.00	10.16	10.71
G <sub>1</sub> S <sub>3</sub>	Open condition +GA <sub>3</sub> 500 ppm	6.76	7.70	9.06	12.13	15.14
G <sub>1</sub> S <sub>4</sub>	Open condition + KNO <sub>3</sub> (1%)	6.10	6.90	7.93	11.67	15.12
G <sub>1</sub> S <sub>5</sub>	Open condition+ Thiourea	6.40	6.73	7.66	11.00	13.12
G <sub>1</sub> S <sub>6</sub>	Open condition + Sodium Thiosulphate 250ppm	6.30	6.53	7.30	10.66	11.12
G <sub>2</sub> S <sub>1</sub>	Net house +Water soaking	6.03	7.03	8.16	10.66	14.03
G <sub>1</sub> S <sub>2</sub>	Net house + Cow urine	6.23	7.20	8.80	10.86	14.18
G <sub>2</sub> S <sub>3</sub>	Net house + GA <sub>3</sub> 500ppm	7.36	8.46	10.36	15.11	20.13
G <sub>2</sub> S <sub>4</sub>	Net house +KNO <sub>3</sub> (1%)	7.16	8.20	9.46	14.19	18.14
G <sub>2</sub> S <sub>5</sub>	Net house+ Thiourea (1%)	6.63	7.83	9.13	12.13	16.12
G <sub>2</sub> S <sub>6</sub>	Net house+ Sodium Thiosulphate 250ppm	6.56	7.56	9.03	11.15	15.12
G <sub>3</sub> S <sub>1</sub>	Poly house+Water soaking	7.00	7.90	10.66	14.95	17.91
G <sub>3</sub> S <sub>2</sub>	Poly house +Cow urine	7.26	7.93	10.86	15.00	18.91
G <sub>3</sub> S <sub>3</sub>	Poly house +GA <sub>3</sub> 500 ppm	8.26	9.40	15.11	18.91	25.13
G <sub>4</sub> S <sub>4</sub>	Poly house+ KNO <sub>3</sub> (1%)	7.90	8.80	14.19	17.93	23.78
G <sub>5</sub> S <sub>5</sub>	Poly house + Thiourea (1%)	7.20	8.50	12.13	16.33	22.14
G <sub>6</sub> S <sub>6</sub>	Poly house + Sodium thiosulphate 250ppm	6.80	7.96	11.15	15.11	20.13
	SE(m)±	0.15	0.09	0.05	0.08	0.11
	CD at 5% level	0.44	0.26	0.16	0.23	0.11

**Table 3. Effect of Seed Treatment and Growing Condition on Girth of Stem (mm) of Custard Apple Seedlings**

Treatment		Girth of Stem (mm) at Different Days				
		80 Days	10 Days	120 Days	140 Days	160 Days
<b>Growing Condition</b>						
G <sub>1</sub>	Open condition	0.93	2.15	2.53	2.98	2.95
G <sub>2</sub>	Net house condition	1.00	2.27	2.65	2.96	3.14
G <sub>3</sub>	Poly house condition	1.11	2.33	2.75	3.14	3.42
	SE(m)±	0.009	0.006	0.004	0.005	0.004
	CD at 5% level	0.02	0.01	0.01	0.01	0.01
<b>Seed Treatment</b>						
S <sub>1</sub>	Water soaking	0.83	1.91	2.20	2.49	2.80
S <sub>2</sub>	Cow urine	0.91	2.01	2.50	2.82	2.85
S <sub>3</sub>	GA <sub>3</sub> 500 ppm	1.15	2.65	2.95	3.43	3.62
S <sub>4</sub>	KNO <sub>3</sub> 1%	1.14	2.60	2.89	3.20	3.36
S <sub>5</sub>	Thiourea	1.05	2.27	2.75	3.15	3.25
S <sub>6</sub>	Sodium thiosulphate	1.00	2.05	2.58	3.08	3.14
	SE(m) ±	0.01	0.009	0.006	0.007	0.006
	CD 5% level	0.03	0.02	0.01	0.02	0.01
<b>Interaction</b>						
G <sub>1</sub> S <sub>1</sub>	Open condition + Water soaking(24 hrs)	0.75	1.73	2.11	2.12	2.53
G <sub>1</sub> S <sub>2</sub>	Open condition + Cow urine	0.88	1.83	2.29	3.05	2.32
G <sub>1</sub> S <sub>3</sub>	Open condition +GA <sub>3</sub> 500 ppm	1.01	2.60	2.89	3.32	3.46
G <sub>1</sub> S <sub>4</sub>	Open condition + KNO <sub>3</sub> (1%)	1.07	2.58	2.83	3.19	3.18
G <sub>1</sub> S <sub>5</sub>	Open condition+ Thiourea	0.95	2.23	2.60	3.15	3.11
G <sub>1</sub> S <sub>6</sub>	Open condition + Sodium Thiosulphate 250 ppm	0.91	1.94	2.46	3.08	3.09
G <sub>2</sub> S <sub>1</sub>	Net house +Water soaking	0.80	2.00	2.17	2.65	2.73
G <sub>2</sub> S <sub>2</sub>	Net house+Cow urine	0.84	2.07	2.48	2.32	3.09
G <sub>2</sub> S <sub>3</sub>	Net house +GA <sub>3</sub> 500ppm	1.15	2.65	2.96	3.46	3.50
G <sub>2</sub> S <sub>4</sub>	Net house + KNO <sub>3</sub> (1%)	1.13	2.60	2.91	3.18	3.24
G <sub>2</sub> S <sub>5</sub>	Net house + Thiourea (1%)	1.06	2.26	2.84	3.11	3.18
G <sub>2</sub> S <sub>6</sub>	Net house + Sodium Thiosulphate 250 ppm	1.01	2.07	2.54	3.06	3.11
G <sub>3</sub> S <sub>1</sub>	Poly house + Water soaking	0.93	2.05	2.31	2.71	3.13
G <sub>3</sub> S <sub>2</sub>	Poly house +Cow urine	1.00	2.11	2.73	3.08	3.14
G <sub>3</sub> S <sub>3</sub>	Poly house +GA <sub>3</sub> 500 ppm	1.30	2.72	3.01	3.51	3.91
G <sub>3</sub> S <sub>4</sub>	Poly house+ KNO <sub>3</sub> (1%)	1.24	2.63	2.92	3.23	3.65
G <sub>3</sub> S <sub>5</sub>	Poly house + Thiourea (1%)	1.15	2.32	2.81	3.19	3.45
G <sub>3</sub> S <sub>6</sub>	Poly house + Sodium thiosulphate 250ppm	1.08	2.15	2.75	3.11	3.24
	SE(m)±	<b>0.009</b>	<b>0.015</b>	<b>0.010</b>	<b>0.013</b>	<b>0.011</b>
	CD at 5% level	<b>0.02</b>	<b>0.04</b>	<b>0.03</b>	<b>0.03</b>	<b>0.03</b>

**Table 4. Effect of Seed Treatment and Growing Condition on No. of Leaves (mm) of Custard Apple Seedlings**

Treatment		No. of Leaves/Seedling at Different Days				
		80 days	100 days	120 days	140 days	160 days
<b>Growing Condition</b>						
G <sub>1</sub>	Open condition	6.48	7.64	8.25	9.99	12.66
G <sub>2</sub>	Net house condition	6.52	8.23	9.47	11.40	13.93
G <sub>3</sub>	Poly house condition	6.92	9.47	11.31	13.80	16.37
	SE(m)±	0.03	0.02	0.02	0.07	0.03
	CD at 5% level	0.08	0.07	0.07	0.21	0.09

Treatment	No. of Leaves/Seedling at Different Days					
	80 days	100 days	120 days	140 days	160 days	
<b>Seed Treatment</b>						
S <sub>1</sub>	Water soaking	6.08	7.48	8.81	10.36	13.18
S <sub>2</sub>	Cow urine	6.22	8.01	9.21	10.60	14.57
S <sub>3</sub>	GA <sub>3</sub> 500 ppm	7.38	9.68	10.67	13.54	16.25
S <sub>4</sub>	KNO <sub>3</sub> (1%)	7.06	8.69	10.08	12.58	15.03
S <sub>5</sub>	Thiourea (1%)	6.61	8.53	9.68	11.8	14.02
S <sub>6</sub>	Sodium thiosulphate 250 ppm	6.48	8.29	9.54	11.44	12.88
	SE(m)±	0.04	0.03	0.03	0.10	0.04
	CD at 5% level	0.12	0.10	0.10	0.29	0.13
<b>Interaction</b>						
G <sub>1</sub> S <sub>1</sub>	Open condition + Water soaking(24 hrs)	6.03	6.83	7.5	8.23	10.83
G <sub>1</sub> S <sub>2</sub>	Open condition + Cow urine	6.13	7.06	7.9	9.0	13.89
G <sub>1</sub> S <sub>3</sub>	Open condition +GA <sub>3</sub> 500 ppm	7.03	9.10	9.12	12.08	14.37
G <sub>1</sub> S <sub>4</sub>	Open condition + KNO <sub>3</sub> (1%)	6.76	7.90	8.82	11.08	13.08
G <sub>1</sub> S <sub>5</sub>	Open condition+ Thiourea (1%)	6.53	7.66	8.16	10.08	12.33
G <sub>1</sub> S <sub>6</sub>	Open condition + Sodium Thiosulphate 250ppm	6.40	7.30	8.00	9.5	11.50
G <sub>2</sub> S <sub>1</sub>	Net house +Water soaking	6.13	7.20	8.40	10.53	13.77
G <sub>1</sub> S <sub>2</sub>	Net house+Cow urine	5.99	7.86	9.11	10.80	14.83
G <sub>2</sub> S <sub>3</sub>	Net house +GA <sub>3</sub> 500ppm	7.30	9.56	10.37	13.08	15.46
G <sub>2</sub> S <sub>4</sub>	Net house + KNO <sub>3</sub> (1%)	7.13	8.43	9.75	11.66	14.08
G <sub>2</sub> S <sub>5</sub>	Net house+ Thiourea (1%)	6.36	8.23	9.70	11.20	13.41
G <sub>2</sub> S <sub>6</sub>	Net house+ Sodium Thiosulphate 250 ppm	6.23	8.10	9.47	11.16	12.04
G <sub>3</sub> S <sub>1</sub>	Poly house + Water soaking	6.23	8.40	10.53	12.33	14.95
G <sub>3</sub> S <sub>2</sub>	Poly house +Cow urine	6.53	9.11	10.80	12.00	15.00
G <sub>3</sub> S <sub>3</sub>	Poly house +GA <sub>3</sub> 500 ppm	7.83	10.37	12.53	15.46	18.91
G <sub>3</sub> S <sub>4</sub>	Poly house+ KNO <sub>3</sub> (1%)	7.30	9.75	11.66	15.00	17.19
G <sub>3</sub> S <sub>5</sub>	Poly house + Thiourea (1%)	6.93	9.70	11.20	14.33	16.33
G <sub>3</sub> S <sub>6</sub>	Poly house + Sodium thiosulphate 250 ppm	6.83	9.47	11.16	13.67	15.11
	SE(m)±	0.07	0.06	0.06	0.17	0.03
	CD at 5% level	0.21	0.18	0.17	0.51	0.09

Table 5. Effect of Seed Treatment and Growing Condition on Custard Apple Seedlings

Treatments	Root Length (cm)	No. of Roots / Seedling	Survival % of Seedling	
<b>Growing Condition</b>				
G <sub>1</sub>	Open condition	10.42	31.02	76.83
G <sub>2</sub>	Net house condition	11.26	37.11	82.50
G <sub>3</sub>	Poly house condition	12.12	40.34	85.28
	SE(m)±	0.011	0.060	0.057
	CD at 5% level	0.032	0.174	0.164
<b>Seed Treatment</b>				
S <sub>1</sub>	Water soaking	9.15	32.89	78.35
S <sub>2</sub>	Cow urine	9.54	33.89	79.14
S <sub>3</sub>	GA <sub>3</sub> 500 ppm	14.12	39.80	85.00
S <sub>4</sub>	KNO <sub>3</sub> 1%	13.38	38.32	83.75
S <sub>5</sub>	Thiourea (1%)	11.35	36.91	82.46
S <sub>6</sub>	Sodium Thiosulphate 250 ppm	10.06	35.14	80.49
	SE(m)±	0.01	0.08	0.11
	CD at 5% level	0.04	0.24	0.23

Treatments		Root Length (cm)	No. of Roots / Seedling	Survival % of Seedling
<b>Interaction</b>				
G <sub>1</sub> S <sub>1</sub>	Open condition + Water soaking(24 hrs)	8.46	26.13	73.80
G <sub>1</sub> S <sub>2</sub>	Open condition + Cow urine	9.16	28.14	74.19
G <sub>1</sub> S <sub>3</sub>	Open condition +GA <sub>3</sub> 500 ppm	13.12	35.15	80.54
G <sub>1</sub> S <sub>4</sub>	Open condition + KNO <sub>3</sub> (1%)	12.12	34.13	79.14
G <sub>1</sub> S <sub>5</sub>	Open condition+ Thiourea(1%)	10.13	32.46	78.15
G <sub>1</sub> S <sub>6</sub>	Open condition + Sodium Thiosulphate 250ppm	9.53	30.13	75.14
G <sub>2</sub> S <sub>1</sub>	Net house +Water soaking	9.13	35.14	80.14
G <sub>2</sub> S <sub>2</sub>	Net house+ Cow urine	9.46	35.11	81.12
G <sub>2</sub> S <sub>3</sub>	Net house +GA <sub>3</sub> 500ppm	14.13	39.14	85.12
G <sub>2</sub> S <sub>4</sub>	Net house +KNO <sub>3</sub> (1%)	13.26	39.050	84.01
G <sub>2</sub> S <sub>5</sub>	Net house+ Thiourea (1%)	11.56	38.130	82.80
G <sub>2</sub> S <sub>6</sub>	Net house+ Sodium Thiosulphate 250 ppm	10.03	36.117	81.79
G <sub>3</sub> S <sub>1</sub>	Poly house Water soaking	9.86	37.41	81.12
G <sub>3</sub> S <sub>2</sub>	Poly house +Cow urine	10.00	38.41	82.11
G <sub>3</sub> S <sub>3</sub>	Poly house +GA <sub>3</sub> 500 ppm	15.13	45.12	89.34
G <sub>3</sub> S <sub>4</sub>	Poly house+ KNO <sub>3</sub> (1%)	14.76	41.79	88.11
G <sub>3</sub> S <sub>5</sub>	Poly house + Thiourea (1%)	12.36	40.15	86.43
G <sub>3</sub> S <sub>6</sub>	Poly house + Sodium Thiosulphate 250 ppm	10.63	39.17	84.55
	<b>SE(m)±</b>	<b>0.02</b>	<b>0.14</b>	<b>0.13</b>
	<b>CD at 5% level</b>	<b>0.07</b>	<b>0.42</b>	<b>0.40</b>

#### 4. CONCLUSION

On the basis of present investigation ,it is concluded that among the various seed treatments and growing condition, the growing condition of poly house and seed treatment with GA<sub>3</sub> 500 ppm have been proved superior with respect to germination, growth and survival of seedling. Among various treatment combinations, G<sub>3</sub>S<sub>3</sub> treatment combination (Poly house and GA<sub>3</sub> 500 ppm) found best over the rest of the treatment combinations with respect to germination parameters like minimum days taken to 1<sup>st</sup> germination(25.33) days taken to 50% germination(45.66), growth parameter like maximum - height of shoots (8.26, 9.40, 15.11, 18.91 and 25.13cm), girth of stem (1.30, 2.72, 3.01,3.51 and 3.91 mm) and number of leaves 8.26, 9.40,15.11, 18.91 and 25.13 at 80, 100,120, 140 and 160 DAS, respectively, root length(15.13cm), number of roots/seedling(45.12), survival percentage of seedling (89.34%). The G<sub>3</sub>S<sub>4</sub> (Poly house and KNO<sub>3</sub>) was found next best treatment combination.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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