

## EFFECT OF SEED TREATMENT AND GROWING CONDITIONS ON GERMINATION, GROWTH AND SURVIVAL OF INDIAN GOOSEBERRY SEEDLINGS (*EMBLICA OFFICINALIS GAERTN*)

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**Abstract:** The study was carried out at Fruit Research Station, Imaliya, Department of Horticulture, college of Agriculture, JNKVV, Jabalpur, (M.P.) during January 2018 to May 2018. The experiment consist of three growing conditions viz. (C<sub>1</sub>) Open condition, (C<sub>2</sub>) net house, (C<sub>3</sub>) poly house condition and six treatments of seed i.e. (S<sub>1</sub>) water soaking, (S<sub>2</sub>) GA<sub>3</sub> 200 ppm, (S<sub>3</sub>) GA<sub>3</sub> 400ppm, (S<sub>4</sub>) GA<sub>3</sub> 600ppm, (S<sub>5</sub>) Thiourea 0.5%, and (S<sub>6</sub>) Thiourea 1% having 18 treatment combinations. Among the growing conditions poly house and among the seed treatment, GA<sub>3</sub> (600ppm) were proved most promising as compare to others. Among the various treatment combination, the C<sub>3</sub>S<sub>4</sub> treatment combination (poly house and 600 ppm GA<sub>3</sub>) was proved most superior over rest of the treatment combinations with respect to germination parameters, growth parameters and survival parameter like days taken to start 1<sup>st</sup> germination (4.00), days taken to 50% germination (21.67), percentage of seeds germination (53.33%), (73.33%) and (73.33%) were noted at 20, 30, 40 days after sowing, height of shoots (4.38, 8.38, 29.05 and 35.14 cm), number of leaves per seedling (5.64, 33.33, 81.73 and 103.73), girth of stem (1.42, 1.53, 1.63 and 1.80 mm) at 30, 60, 90 and 120 DAS respectively and survival percentage 73.33 at 120 DAS.

**Keywords:** Indian gooseberry (*Emblca officinalis*), GA<sub>3</sub>, Thiourea, Growing, Poly house condition

### INTRODUCTION

Aonla (*Emblca officinalis Gaertn*) also known as “Indian goose berry” belongs to family Euphorbiaceae. It is thought to be native of India, Ceylon, Malaysia and China. It thrives well throughout tropical India and is wild or cultivated in the region extending from the base of Himalaya to Ceylon, Malaysia to South China. In India, aonla occupies an area of 88,000 ha. with production of 9,72,000 MT. In M.P., the area under aonla is reported to be 14.85 thousand ha and production 187.07 thousand MT. (Anonymous, 2015-16). Aonla is a branched tree and ranges from 9-12 m in height. Aonla is hardy tree, prolific bearer, highly remunerative even without much care. It can be successfully cultivated in marginal soil and various kinds of wasteland situations such as sodic and saline soil, ravines, dry and semi dry regions including plateau area of central and southern India. Aonla acclaimed as “Amrit phal” in ayurveda and has acquired wide popularity all over the world due to its nutritional and medicinal importance. The aonla fruit is highly nutritive and is one of the richest sources of vitamin 'C'. It contains 309.96 to 583.20 mg of ascorbic acid per 100 g of pulp (Supe *et al.*, 1997). The fruit is also rich in pectin and minerals such as iron, calcium and phosphorus. Aonla is acidic, cooling, diuretic and laxative. Hence, it has got great importance in preparation of *Ayurvedic* medicines. Aonla can be processed into many value added products i.e., murabba, candy, pickles, triphala churna as well as chyavanprash. Aonla can be propagated both by sexual and asexual methods. Sexually, it is propagated by seeds, however, being

the cross pollinated crop, the variability does exist in the seedling population. Hence, seeds are only used for raising seedlings which are further used as rootstocks. As the area under aonla is increasing day by day, the demand of budded plants is also increasing but this demand is not fulfilled because of various factors like poor seed germination and poor seedling growth. The presence of impermeable seed coat acts as barrier to seed germination in aonla (Pawshe *et al.*, 1997). Pre-sowing seed treatments with chemicals like GA<sub>3</sub>, Thiourea, KNO<sub>3</sub> and NAA have been reported to influence the duration of germination, per cent seed germination, seedling height, number of branches and roots (Dhankar and Singh, 1996; Pawshe *et al.*, 1997; Gholap *et al.*, 2000; Rajamanickam *et al.*, 2002).

### MATERIALS AND METHODS

The present experiment “Effect of seed treatment and growing conditions on germination, growth and survival of Indian gooseberry seedling (*Emblca officinalis Gaertn*)” was carried out at Fruit Research Station, Imalia, Department of Horticulture, College of Agriculture, JNKVV, Jabalpur (M.P.) during January 2018 to May 2018. The experiment comprised of three growing conditions viz. (C<sub>1</sub>) Open condition, (C<sub>2</sub>) net house, (C<sub>3</sub>) poly house condition and six treatments of seed i.e. (S<sub>1</sub>) water soaking, (S<sub>2</sub>) GA<sub>3</sub> 200ppm, (S<sub>3</sub>) GA<sub>3</sub> 400ppm, (S<sub>4</sub>) GA<sub>3</sub> 600ppm, (S<sub>5</sub>) Thiourea 0.5%, and (S<sub>6</sub>) Thiourea 1% having 18 treatment combinations. The experiment was laid out in poly bags in factorial completely randomized design with three

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replications. Observations were recorded using standard procedure and statistically analyzed.

#### A. 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 germination till 50 % germination.

**3. Percent of germination** –The percentage of total seeds germination in each treatment was recorded at 20, 30, and 40 days after sowing.

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

#### B. Growth Parameter

The following observations were recorded at 30, 60, 90 and 120 days after sowing. Randomly selected five plants were tagged for following observations.

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

**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.

**3. No. of branches per plant** - The total number of branches per plant was counted and the average was calculated.

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

**5. Survival percentage** – The seeds survival percentage in each treatment was recorded at 120 days after sowing.

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

## RESULTS AND DISCUSSION

**Table 1.** (A) Effect of growing conditions and seed treatment on days taken to start 1<sup>st</sup> germination and 50% germination of aonla

|                | Treatments               | Days taken to start 1 <sup>st</sup> germination | Days taken to 50% germination |
|----------------|--------------------------|---|-------------------------------|
|                | <b>Growing condition</b> |   |                               |
| C <sub>1</sub> | Open condition           | 9.44  | 53.06                         |
| C <sub>2</sub> | Net house condition      | 6.56  | 46.94                         |
| C <sub>3</sub> | Poly house condition     | 4.72  | 33.33                         |
|                | S.Em±                    | 0.07  | 0.11                          |
|                | C.D.5% level             | 0.21  | 0.33                          |
|                | <b>Seed Treatment</b>    |   |                               |
| S <sub>1</sub> | Water soaking            | 7.67  | 49.44                         |

#### A- GERMINATION PARAMETERS

**1- Days taken to start 1<sup>st</sup> germination**-The result clearly showed that all the growing condition significantly affected the days taken to start germination. The minimum days (4.72) was recorded with growing condition C<sub>3</sub> (poly house condition) followed by C<sub>2</sub> (6.56) whereas, maximum days (9.44 days) were recorded under C<sub>1</sub>. The data also indicates that the various seed treatment significantly influenced the days taken to start seed germination. The minimum days (6.33) was recorded with treatment S<sub>4</sub> (GA<sub>3</sub> 600 ppm). The maximum days (7.67) were taken to start germination under S<sub>1</sub> (Control).

The interaction effects of growing condition and seed treatments were found to have significant impact on germination. However, minimum days (4.00) taken to start germination was noted under the combination of C<sub>3</sub>S<sub>4</sub> which was found statistically at par with C<sub>3</sub>S<sub>5</sub> (4.33). This is due to high temperature and humidity in poly house coupled with GA<sub>3</sub> which initiated the early germination. Our results are also in the line of Singh *et al.* (2002), Dhankar and Singh (1996) Ratan and Reddy (2004).

**2-The days taken to 50% germination**- The data pertaining to days taken to 50% germination clearly showed that all the growing conditions significantly affected the days taken to 50% germination of seed over C<sub>1</sub> (control). C<sub>3</sub> (poly house) recorded minimum days (33.33) for 50% germination. The maximum days (53.06) to achieve 50% germination were noted under C<sub>1</sub> (open condition). The seed treatments also significantly influenced the germination. The days taken to 50% germination was observed minimum (37.22) in S<sub>4</sub> (GA<sub>3</sub> 600 ppm) followed by S<sub>5</sub> (44.44 days) and maximum days (49.44) under S<sub>1</sub> (control). The interaction effect of growing condition and seed treatments were found to have significant effect. The minimum days (21.67) taken to 50% germination were found in C<sub>3</sub>S<sub>4</sub> (poly house and GA<sub>3</sub> 600 ppm). Our results are also in the line of Ynoue *et al.* (1999).

|   |  |       |       |
|---|--|-------|-------|
| S <sub>2</sub>  | GA <sub>3</sub> 200ppm                 | 6.78  | 45.56 |
| S <sub>3</sub>  | GA <sub>3</sub> 400ppm                 | 7.11  | 45.00 |
| S <sub>4</sub>  | GA <sub>3</sub> 600ppm                 | 6.33  | 37.22 |
| S <sub>5</sub>  | Thiourea 0.5%                          | 6.67  | 44.44 |
| S <sub>6</sub>  | Thiourea 1.0%                          | 6.89  | 45.00 |
|   | S.Em±                                  | 0.10  | 0.16  |
|   | C.D.5% level                           | 0.30  | 0.47  |
| <b>(B) Interaction effect of growing conditions and seed treatment on days taken to start 1<sup>st</sup> germination and 50% germination of aonla</b> |  |       |       |
| C <sub>1</sub> S <sub>1</sub>   | Open condition+ Water soaking          | 10.33 | 56.67 |
| C <sub>1</sub> S <sub>2</sub>   | Open condition+ GA <sub>3</sub> 200ppm | 9.00  | 53.33 |
| C <sub>1</sub> S <sub>3</sub>   | Open condition+ GA <sub>3</sub> 400ppm | 9.33  | 51.67 |
| C <sub>1</sub> S <sub>4</sub>   | Open condition+ GA <sub>3</sub> 600ppm | 9.00  | 48.33 |
| C <sub>1</sub> S <sub>5</sub>   | Open condition+ Thiourea 0.5%          | 9.33  | 55.00 |
| C <sub>1</sub> S <sub>6</sub>   | Open condition+ Thiourea 1.0%          | 9.67  | 53.33 |
| C <sub>2</sub> S <sub>1</sub>   | Net house+ Water soaking               | 7.33  | 55.00 |
| C <sub>2</sub> S <sub>2</sub>   | Net house+ GA <sub>3</sub> 200ppm      | 6.33  | 46.67 |
| C <sub>2</sub> S <sub>3</sub>   | Net house+ GA <sub>3</sub> 400ppm      | 7.00  | 50.00 |
| C <sub>2</sub> S <sub>4</sub>   | Net house+ GA <sub>3</sub> 600ppm      | 7.00  | 41.67 |
| C <sub>2</sub> S <sub>5</sub>   | Net house+ Thiourea 0.5%               | 5.33  | 43.33 |
| C <sub>2</sub> S <sub>6</sub>   | Net house+ Thiourea 1.0%               | 6.33  | 45.00 |
| C <sub>3</sub> S <sub>1</sub>   | Poly house+ Water soaking              | 5.33  | 36.67 |
| C <sub>3</sub> S <sub>2</sub>   | Poly house+ GA <sub>3</sub> 200ppm     | 5.00  | 36.67 |
| C <sub>3</sub> S <sub>3</sub>   | Poly house+ GA <sub>3</sub> 400ppm     | 5.00  | 33.33 |
| C <sub>3</sub> S <sub>4</sub>   | Poly house+ GA <sub>3</sub> 600ppm     | 4.00  | 21.67 |
| C <sub>3</sub> S <sub>5</sub>   | Poly house+ Thiourea 0.5%              | 4.33  | 35.00 |
| C <sub>3</sub> S <sub>6</sub>   | Poly house+ Thiourea 1.0%              | 4.67  | 36.67 |
|   | S.Em±                                  | 0.18  | 0.28  |
|   | C.D.5% level                           | 0.53  | 0.82  |

**3-Percentage of germination at 20, 30 and 40 days after sowing (DAS)**-Data revealed that almost all the condition showed significant effect on percentage of germination maximum percentage of seeds germination (31.67%), (49.44%) and (53.89%) were noted at 20, 30 and 40 days after sowing under C<sub>3</sub> (poly house condition) whereas, the minimum percentage of seeds germination (12.22%), (22.22%) and (23.89%) were noted under C<sub>1</sub> (open condition).

The maximum percentage of seeds germination (31.11%), (45.56%) and (50.00%) were noted in seeds treated with S<sub>4</sub> (GA<sub>3</sub> 600 ppm) at 20, 30 and 40 days after sowing, whereas, the minimum percentage of seeds germination (14.44%), (24.44%) and (26.67%) were noted in S<sub>1</sub> (control). The maximum percentage of seeds germination (53.33%), (73.33%) and (73.33%) were noted at 20, 30, 40 days after sowing under interaction of C<sub>3</sub>S<sub>4</sub> (poly house

condition and GA<sub>3</sub> 600 ppm) whereas, the minimum percentage of seeds germination (10.00%), (13.33%), (13.33%) were noted under C<sub>1</sub>S<sub>1</sub> (open condition and control). It might be due to GA<sub>3</sub> which accelerate the activity of specific enzymes such as  $\alpha$ -amylase,

which have brought an increase in availability of starch assimilation resulting in an early germination. Our results are also in the line of Wagh *et al.* (1998), Dhankar *et al.* (1996, 1997) Pawshe *et al.* (1997).

**Table 2.** (A) Effect of growing conditions and seed treatment on percentage of germination of aonla

|  | Treatments                             | Percentage of germination |         |         |
|--|--|---------------------------|---------|---------|
|  |  | 20 days                   | 30 days | 40 days |
| <b>Growing condition</b>   |  |                           |         |         |
| C <sub>1</sub>   | Open condition                         | 12.22                     | 22.22   | 23.89   |
| C <sub>2</sub>   | Net house condition                    | 17.78                     | 27.78   | 33.89   |
| C <sub>3</sub>   | Poly house condition                   | 31.67                     | 49.44   | 53.89   |
|  | S.Em±                                  | 0.56                      | 0.24    | 0.10    |
|  | C.D.5% level                           | 1.61                      | 0.71    | 0.30    |
| <b>Seed treatment</b>  |  |                           |         |         |
| S <sub>1</sub>   | Water soaking                          | 14.44                     | 24.44   | 26.67   |
| S <sub>2</sub>   | GA <sub>3</sub> 200ppm                 | 20.00                     | 31.11   | 34.44   |
| S <sub>3</sub>   | GA <sub>3</sub> 400ppm                 | 18.89                     | 34.44   | 37.78   |
| S <sub>4</sub>   | GA <sub>3</sub> 600ppm                 | 31.11                     | 45.56   | 50.00   |
| S <sub>5</sub>   | Thiourea 0.5%                          | 17.78                     | 34.44   | 40.00   |
| S <sub>6</sub>   | Thiourea 1.0%                          | 21.11                     | 28.89   | 34.44   |
|  | S.Em±                                  | 0.79                      | 0.34    | 0.15    |
|  | C.D.5% level                           | 2.28                      | 1.00    | 0.43    |
| <b>(B) Interaction effect of growing conditions and seed treatment on percentage of germination of aonla</b> |  |                           |         |         |
| C <sub>1</sub> S <sub>1</sub>  | Open condition+ Water soaking          | 10.00                     | 13.33   | 13.33   |
| C <sub>1</sub> S <sub>2</sub>  | Open condition+ GA <sub>3</sub> 200ppm | 10.00                     | 20.00   | 20.00   |
| C <sub>1</sub> S <sub>3</sub>  | Open condition+ GA <sub>3</sub> 400ppm | 13.33                     | 26.67   | 30.00   |
| C <sub>1</sub> S <sub>4</sub>  | Open condition+ GA <sub>3</sub> 600ppm | 16.67                     | 30.00   | 33.33   |
| C <sub>1</sub> S <sub>5</sub>  | Open condition+ Thiourea 0.5%          | 13.33                     | 26.67   | 30.00   |
| C <sub>1</sub> S <sub>6</sub>  | Open condition+ Thiourea 1.0%          | 10.00                     | 16.67   | 16.67   |
| C <sub>2</sub> S <sub>1</sub>  | Net house+ Water soaking               | 13.33                     | 20.00   | 23.33   |
| C <sub>2</sub> S <sub>2</sub>  | Net house+ GA <sub>3</sub> 200ppm      | 20.00                     | 30.00   | 33.33   |
| C <sub>2</sub> S <sub>3</sub>  | Net house+ GA <sub>3</sub> 400ppm      | 16.67                     | 30.00   | 30.00   |
| C <sub>2</sub> S <sub>4</sub>  | Net house+ GA <sub>3</sub> 600ppm      | 23.33                     | 33.33   | 43.33   |
| C <sub>2</sub> S <sub>5</sub>  | Net house+ Thiourea 0.5%               | 16.67                     | 26.67   | 40.00   |
| C <sub>2</sub> S <sub>6</sub>  | Net house+ Thiourea 1.0%               | 16.67                     | 26.67   | 33.33   |
| C <sub>3</sub> S <sub>1</sub>  | Poly house+ Water soaking              | 20.00                     | 40.00   | 43.33   |
| C <sub>3</sub> S <sub>2</sub>  | Poly house+ GA <sub>3</sub> 200ppm     | 30.00                     | 43.33   | 50.00   |
| C <sub>3</sub> S <sub>3</sub>  | Poly house+ GA <sub>3</sub> 400ppm     | 26.67                     | 46.67   | 53.33   |
| C <sub>3</sub> S <sub>4</sub>  | Poly house+ GA <sub>3</sub> 600ppm     | 53.33                     | 73.33   | 73.33   |
| C <sub>3</sub> S <sub>5</sub>  | Poly house+ Thiourea 0.5%              | 23.33                     | 50.00   | 50.00   |
| C <sub>3</sub> S <sub>6</sub>  | Poly house+ Thiourea 1.0%              | 36.67                     | 43.33   | 53.33   |
|  | S.Em±                                  | 1.37                      | 0.60    | 0.26    |
|  | C.D.5% level                           | 3.95                      | 1.73    | 0.75    |

## Growth Parameter

### 1. Height of plants (cm) at 30, 60, 90 and 120 DAS

The data showed that almost all the growing conditions and treatments have significant effect on height of plant. The maximum plant height of 4.01, 7.92, 27.00 and 33.43 cm were noted under C<sub>3</sub> (poly house condition) at 30, 60, 90 and 120 DAS respectively. The minimum plant height 2.27, 4.66, 7.29 and 13.19 cm were recorded under C<sub>1</sub> (open condition) at 30, 60, 90 and 120 DAS. The maximum plant height of 3.99, 7.39, 16.77 and 27.39 cm were noted with S<sub>4</sub> (GA<sub>3</sub> 600 ppm) at 30, 60, 90 and 120

DAS respectively and the minimum plant height 2.67, 5.67, 14.12 and 25.08 cm were recorded in S<sub>1</sub> (control) at 30, 60, 90 and 120 DAS. The maximum plant height 4.38, 8.38, 29.05 and 35.14 cm were noted under C<sub>3</sub>S<sub>4</sub> (poly house condition and GA<sub>3</sub> 600 ppm) at 30, 60, 90 and 120 DAS, whereas, the minimum height 1.35, 3.92, 6.61 and 12.03 cm were recorded under in C<sub>1</sub>S<sub>1</sub> (open condition and control). Our results are also in the line of Ngullie and Biswas (2017). 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>. It might be due to GA<sub>3</sub> effect on elongation of

internodes, as GA<sub>3</sub> is known to enhance cell elongation. Our results are also in the line of Chandra and Govind (1990) and Singh *et al.* (2002), Pampanna *et al.* (1995).

**Table 3.** (A) Effect of growing conditions and seed treatment on height (cm) of aonla seedlings

|  | Treatments                             | Height of seedlings (cm) at |         |         |          |
|--|--|-----------------------------|---------|---------|----------|
|  |  | 30 days                     | 60 days | 90 days | 120 days |
|  | <b>Growing condition</b>               |                             |         |         |          |
| C <sub>1</sub>   | Open condition                         | 2.27                        | 4.66    | 7.29    | 13.19    |
| C <sub>2</sub>   | Net house condition                    | 3.64                        | 6.76    | 13.08   | 31.59    |
| C <sub>3</sub>   | Poly house condition                   | 4.01                        | 7.92    | 27.00   | 33.43    |
|  | S.Em±                                  | 0.008                       | 0.009   | 0.24    | 0.09     |
|  | C.D.5% level                           | 0.02                        | 0.026   | 0.70    | 0.26     |
|  | <b>Seed treatment</b>                  |                             |         |         |          |
| S <sub>1</sub>   | Water soaking                          | 2.67                        | 5.67    | 14.12   | 25.08    |
| S <sub>2</sub>   | GA <sub>3</sub> 200ppm                 | 3.17                        | 6.74    | 16.12   | 26.45    |
| S <sub>3</sub>   | GA <sub>3</sub> 400ppm                 | 2.98                        | 6.12    | 15.90   | 26.30    |
| S <sub>4</sub>   | GA <sub>3</sub> 600ppm                 | 3.99                        | 7.39    | 16.77   | 27.39    |
| S <sub>5</sub>   | Thiourea 0.5%                          | 3.52                        | 6.28    | 15.89   | 25.76    |
| S <sub>6</sub>   | Thiourea 1.0%                          | 3.50                        | 6.49    | 15.94   | 25.44    |
|  | S.Em±                                  | 0.01                        | 0.01    | 0.34    | 0.12     |
|  | C.D.5% level                           | 0.03                        | 0.03    | 0.99    | 0.36     |
| <b>(B) Interaction effect of growing conditions and seed treatment on height (cm) of aonla seedlings</b> |  |                             |         |         |          |
| C <sub>1</sub> S <sub>1</sub>  | Open condition+ Water soaking          | 1.35                        | 3.92    | 6.61    | 12.03    |
| C <sub>1</sub> S <sub>2</sub>  | Open condition+ GA <sub>3</sub> 200ppm | 2.10                        | 4.63    | 7.08    | 12.84    |
| C <sub>1</sub> S <sub>3</sub>  | Open condition+ GA <sub>3</sub> 400ppm | 1.50                        | 4.13    | 7.43    | 13.84    |
| C <sub>1</sub> S <sub>4</sub>  | Open condition+ GA <sub>3</sub> 600ppm | 3.50                        | 6.09    | 8.02    | 14.58    |
| C <sub>1</sub> S <sub>5</sub>  | Open condition+ Thiourea 0.5%          | 2.57                        | 5.04    | 7.57    | 13.34    |
| C <sub>1</sub> S <sub>6</sub>  | Open condition+ Thiourea 1.0%          | 2.57                        | 4.17    | 7.00    | 12.51    |
| C <sub>2</sub> S <sub>1</sub>  | Net house+ Water soaking               | 3.18                        | 5.47    | 12.60   | 31.04    |
| C <sub>2</sub> S <sub>2</sub>  | Net house+ GA <sub>3</sub> 200ppm      | 3.39                        | 7.60    | 13.13   | 31.70    |
| C <sub>2</sub> S <sub>3</sub>  | Net house+ GA <sub>3</sub> 400ppm      | 3.60                        | 6.50    | 13.21   | 31.67    |
| C <sub>2</sub> S <sub>4</sub>  | Net house+ GA <sub>3</sub> 600ppm      | 4.08                        | 7.70    | 13.23   | 32.45    |
| C <sub>2</sub> S <sub>5</sub>  | Net house+ Thiourea 0.5%               | 3.67                        | 6.13    | 13.17   | 31.48    |
| C <sub>2</sub> S <sub>6</sub>  | Net house+ Thiourea 1.0%               | 3.93                        | 7.17    | 13.10   | 31.16    |
| C <sub>3</sub> S <sub>1</sub>  | Poly house+ Water soaking              | 3.48                        | 7.63    | 23.14   | 32.18    |
| C <sub>3</sub> S <sub>2</sub>  | Poly house+ GA <sub>3</sub> 200ppm     | 4.03                        | 7.99    | 28.13   | 34.81    |

|                               |                                    |      |      |       |       |
|-------------------------------|------------------------------------|------|------|-------|-------|
| C <sub>3</sub> S <sub>3</sub> | Poly house+ GA <sub>3</sub> 400ppm | 3.83 | 7.72 | 27.06 | 33.38 |
| C <sub>3</sub> S <sub>4</sub> | Poly house+ GA <sub>3</sub> 600ppm | 4.38 | 8.38 | 29.05 | 35.14 |
| C <sub>3</sub> S <sub>5</sub> | Poly house+ Thiourea 0.5%          | 4.32 | 7.67 | 26.91 | 32.44 |
| C <sub>3</sub> S <sub>6</sub> | Poly house+ Thiourea 1.0%          | 4.00 | 8.14 | 27.71 | 32.65 |
|                               | S.Em±                              | 0.02 | 0.02 | 0.59  | 0.22  |
|                               | C.D.5% level                       | 0.05 | 0.06 | 1.72  | 0.64  |

### 1. Girth of stem (mm) at 30, 60, 90 and 120 DAS

The maximum stem girth of 1.19, 1.43, 1.44 and 1.73 mm were noted under C<sub>3</sub> (poly house condition) at 30, 60, 90 and 120 DAS respectively. The minimum stem girth 1.05, 1.13, 1.43 and 1.71 mm were recorded under C<sub>1</sub> (open condition) at 30, 60, 90 and 120 DAS. The maximum stem girth of 1.27, 1.29, 1.54 and 1.76 mm were noted with S<sub>4</sub> (GA<sub>3</sub> 600 ppm) at 30, 60, 90 and 120 DAS respectively. The

minimum stem girth 0.97, 1.16, 1.34 and 1.61 mm were recorded in S<sub>1</sub> (control) at 30, 60, 90 and 120 DAS. The maximum stem girth 1.42, 1.53, 1.63 and 1.80 mm were noted under C<sub>3</sub>S<sub>4</sub> (poly house condition and GA<sub>3</sub> 600 ppm) at 30, 60, 90 and 120 DAS and minimum were recorded under 0.95, 1.04, 1.21 and 1.52 mm in C<sub>1</sub>S<sub>1</sub> (open condition and control). Our results are also in the line of Singh *et al.* (2004) and Meena and Jain (2005).

**Table 4. (A) Effect of growing conditions and seed treatment on girth of stem (mm) of aonla seedlings**

| Treatments  |  | Girth of stem (mm) at |         |         |          |
|---|--|-----------------------|---------|---------|----------|
|   |  | 30 days               | 60 Days | 90 days | 120 days |
|   | <b>Growing conditions</b>              |                       |         |         |          |
| C <sub>1</sub>  | Open condition                         | 1.05                  | 1.13    | 1.43    | 1.71     |
| C <sub>2</sub>  | Net house condition                    | 1.10                  | 1.10    | 1.43    | 1.63     |
| C <sub>3</sub>  | Poly house condition                   | 1.19                  | 1.43    | 1.44    | 1.73     |
|   | S.Em±                                  | 0.01                  | 0.006   | 0.001   | 0.001    |
|   | C.D.5% level                           | 0.04                  | 0.01    | 0.003   | 0.003    |
|   | <b>Seed treatment</b>                  |                       |         |         |          |
| S <sub>1</sub>  | Water soaking                          | 0.97                  | 1.16    | 1.34    | 1.61     |
| S <sub>2</sub>  | GA <sub>3</sub> 200ppm                 | 1.05                  | 1.18    | 1.44    | 1.68     |
| S <sub>3</sub>  | GA <sub>3</sub> 400ppm                 | 1.16                  | 1.20    | 1.40    | 1.71     |
| S <sub>4</sub>  | GA <sub>3</sub> 600ppm                 | 1.27                  | 1.29    | 1.54    | 1.76     |
| S <sub>5</sub>  | Thiourea 0.5%                          | 1.10                  | 1.23    | 1.43    | 1.71     |
| S <sub>6</sub>  | Thiourea 1.0%                          | 1.12                  | 1.25    | 1.44    | 1.68     |
|   | S.Em±                                  | 0.02                  | 0.01    | 0.002   | 0.001    |
|   | C.D.5% level                           | 0.06                  | 0.03    | 0.005   | 0.004    |
| <b>(B) Interaction effect of growing conditions and seed treatment on girth of stem (mm) of aonla seedlings</b> |  |                       |         |         |          |
| C <sub>1</sub> S <sub>1</sub>   | Open condition+ Water soaking          | 0.95                  | 1.04    | 1.21    | 1.52     |
| C <sub>1</sub> S <sub>2</sub>   | Open condition+ GA <sub>3</sub> 200ppm | 0.99                  | 1.09    | 1.47    | 1.72     |
| C <sub>1</sub> S <sub>3</sub>   | Open condition+ GA <sub>3</sub> 400ppm | 1.03                  | 1.13    | 1.40    | 1.74     |
| C <sub>1</sub> S <sub>4</sub>   | Open condition+ GA <sub>3</sub> 600ppm | 1.22                  | 1.18    | 1.54    | 1.77     |
| C <sub>1</sub> S <sub>5</sub>   | Open condition+ Thiourea 0.5%          | 1.03                  | 1.16    | 1.41    | 1.68     |

|                               |                                    |      |      |       |       |
|-------------------------------|------------------------------------|------|------|-------|-------|
| C <sub>1</sub> S <sub>6</sub> | Open condition+ Thiourea 1.0%      | 1.08 | 1.17 | 1.40  | 1.70  |
| C <sub>2</sub> S <sub>1</sub> | Net house+ Water soaking           | 0.95 | 1.06 | 1.41  | 1.65  |
| C <sub>2</sub> S <sub>2</sub> | Net house+ GA <sub>3</sub> 200ppm  | 1.13 | 1.06 | 1.43  | 1.58  |
| C <sub>2</sub> S <sub>3</sub> | Net house+ GA <sub>3</sub> 400ppm  | 1.10 | 1.08 | 1.41  | 1.67  |
| C <sub>2</sub> S <sub>4</sub> | Net house+ GA <sub>3</sub> 600ppm  | 1.16 | 1.16 | 1.45  | 1.71  |
| C <sub>2</sub> S <sub>5</sub> | Net house+ Thiourea 0.5%           | 1.15 | 1.14 | 1.43  | 1.70  |
| C <sub>2</sub> S <sub>6</sub> | Net house+ Thiourea 1.0%           | 1.12 | 1.11 | 1.44  | 1.61  |
| C <sub>3</sub> S <sub>1</sub> | Poly house+ Water soaking          | 1.02 | 1.38 | 1.38  | 1.65  |
| C <sub>3</sub> S <sub>2</sub> | Poly house+ GA <sub>3</sub> 200ppm | 1.04 | 1.38 | 1.43  | 1.73  |
| C <sub>3</sub> S <sub>3</sub> | Poly house+ GA <sub>3</sub> 400ppm | 1.34 | 1.39 | 1.40  | 1.71  |
| C <sub>3</sub> S <sub>4</sub> | Poly house+ GA <sub>3</sub> 600ppm | 1.42 | 1.53 | 1.63  | 1.80  |
| C <sub>3</sub> S <sub>5</sub> | Poly house+ Thiourea 0.5%          | 1.12 | 1.39 | 1.45  | 1.75  |
| C <sub>3</sub> S <sub>6</sub> | Poly house+ Thiourea 1.0%          | 1.17 | 1.48 | 1.48  | 1.72  |
|                               | S.Em±                              | 0.03 | 0.01 | 0.003 | 0.002 |
|                               | C.D.5% level                       | 0.10 | 0.04 | 0.008 | 0.007 |

**1. No. of branches / plant at 30, 60, 90 and 120 DAS**

The maximum no. of branches /plant of 2.55, 6.32, 8.70 and 13.58 were noted under C<sub>3</sub> (poly house condition) at 30, 60, 90 and 120 DAS respectively. The minimum no. of branches / plant 2.04, 4.68, 6.65 and 9.44 were recorded under C<sub>1</sub> (open condition) at 30, 60, 90 and 120 DAS. The maximum no. of branches / plant of 2.55, 5.88 statistically at par with S<sub>5</sub> (5.83) at 60 days, 8.03 and 13.01 were noted with S<sub>4</sub> (GA<sub>3</sub> 600 ppm) at 30, 60, 90 and 120 DAS respectively. The minimum no. of branches / plant

1.91, 4.94, 7.18 and 11.30 were recorded in S<sub>1</sub> (control) at 30, 60, 90 and 120 DAS. The maximum no. of branches / plant 2.82 statistically at par with C<sub>3</sub>S<sub>5</sub> (2.76), C<sub>3</sub>S<sub>2</sub> (2.66) at 30 days, 7.04 statistically at par with C<sub>3</sub>S<sub>5</sub> (6.98) at 60 days, 9.53 and 13.97 statistically at par with C<sub>3</sub>S<sub>5</sub> (13.73), C<sub>3</sub>S<sub>2</sub> (13.90), C<sub>2</sub>S<sub>6</sub> (13.670), C<sub>2</sub>S<sub>4</sub> (13.87) at 120 days were noted under C<sub>3</sub>S<sub>4</sub> (poly house condition and GA<sub>3</sub> 600 ppm) at 30, 60, 90 and 120 DAS and minimum 1.42, 4.27, 6.40 and 8.73 were recorded under in C<sub>1</sub>S<sub>1</sub> (open condition and control).

**Table 5.** (A) Effect of growing conditions and seed treatment on number of branches /plant of aonla seedlings

|                | Treatments                | No. of branches /plant at |         |         |          |
|----------------|---------------------------|---------------------------|---------|---------|----------|
|                |                           | 30 days                   | 60 days | 90 days | 120 days |
|                | <b>Growing conditions</b> |                           |         |         |          |
| C <sub>1</sub> | Open condition            | 2.04                      | 4.68    | 6.65    | 9.44     |
| C <sub>2</sub> | Net house condition       | 2.28                      | 5.41    | 7.43    | 13.43    |
| C <sub>3</sub> | Poly house condition      | 2.55                      | 6.32    | 8.70    | 13.58    |
|                | S.Em±                     | 0.04                      | 0.03    | 0.06    | 0.04     |
|                | C.D.5% level              | 0.11                      | 0.09    | 0.18    | 0.12     |
|                | <b>Seed treatment</b>     |                           |         |         |          |
| S <sub>1</sub> | Water soaking             | 1.91                      | 4.94    | 7.18    | 11.30    |
| S <sub>2</sub> | GA <sub>3</sub> 200ppm    | 2.22                      | 5.30    | 7.66    | 12.41    |
| S <sub>3</sub> | GA <sub>3</sub> 400ppm    | 2.38                      | 5.33    | 7.44    | 11.89    |

|  |  |      |      |      |       |
|--|--|------|------|------|-------|
| S <sub>4</sub>   | GA <sub>3</sub> 600ppm                 | 2.55 | 5.88 | 8.03 | 13.01 |
| S <sub>5</sub>   | Thiourea 0.5%                          | 2.38 | 5.83 | 7.64 | 12.09 |
| S <sub>6</sub>   | Thiourea 1.0%                          | 2.28 | 5.53 | 7.60 | 12.21 |
|  | S.Em±                                  | 0.05 | 0.05 | 0.09 | 0.06  |
|  | C.D.5% level                           | 0.16 | 0.14 | 0.27 | 0.18  |
| <b>(B) Interaction effect of growing conditions and seed treatment on number of branches /plant of aonla seedlings</b> |  |      |      |      |       |
| C <sub>1</sub> S <sub>1</sub>  | Open condition+ Water soaking          | 1.42 | 4.27 | 6.40 | 8.73  |
| C <sub>1</sub> S <sub>2</sub>  | Open condition+ GA <sub>3</sub> 200ppm | 1.92 | 4.33 | 6.73 | 10.00 |
| C <sub>1</sub> S <sub>3</sub>  | Open condition+ GA <sub>3</sub> 400ppm | 2.22 | 4.80 | 6.67 | 8.93  |
| C <sub>1</sub> S <sub>4</sub>  | Open condition+ GA <sub>3</sub> 600ppm | 2.33 | 4.97 | 6.77 | 11.20 |
| C <sub>1</sub> S <sub>5</sub>  | Open condition+ Thiourea 0.5%          | 2.16 | 4.92 | 6.73 | 9.00  |
| C <sub>1</sub> S <sub>6</sub>  | Open condition+ Thiourea 1.0%          | 2.17 | 4.80 | 6.60 | 8.77  |
| C <sub>2</sub> S <sub>1</sub>  | Net house+ Water soaking               | 2.04 | 5.07 | 7.07 | 12.93 |
| C <sub>2</sub> S <sub>2</sub>  | Net house+ GA <sub>3</sub> 200ppm      | 2.09 | 5.37 | 7.37 | 13.33 |
| C <sub>2</sub> S <sub>3</sub>  | Net house+ GA <sub>3</sub> 400ppm      | 2.48 | 5.60 | 7.53 | 13.27 |
| C <sub>2</sub> S <sub>4</sub>  | Net house+ GA <sub>3</sub> 600ppm      | 2.50 | 5.62 | 7.80 | 13.87 |
| C <sub>2</sub> S <sub>5</sub>  | Net house+ Thiourea 0.5%               | 2.27 | 5.58 | 7.53 | 13.53 |
| C <sub>2</sub> S <sub>6</sub>  | Net house+ Thiourea 1.0%               | 2.31 | 5.20 | 7.27 | 13.67 |
| C <sub>3</sub> S <sub>1</sub>  | Poly house+ Water soaking              | 2.28 | 5.48 | 8.07 | 12.23 |
| C <sub>3</sub> S <sub>2</sub>  | Poly house+ GA <sub>3</sub> 200ppm     | 2.66 | 6.20 | 8.87 | 13.90 |
| C <sub>3</sub> S <sub>3</sub>  | Poly house+ GA <sub>3</sub> 400ppm     | 2.45 | 5.60 | 8.13 | 13.47 |
| C <sub>3</sub> S <sub>4</sub>  | Poly house+ GA <sub>3</sub> 600ppm     | 2.82 | 7.04 | 9.53 | 13.97 |
| C <sub>3</sub> S <sub>5</sub>  | Poly house+ Thiourea 0.5%              | 2.76 | 6.98 | 8.67 | 13.73 |
| C <sub>3</sub> S <sub>6</sub>  | Poly house+ Thiourea 1.0%              | 2.37 | 6.60 | 8.93 | 13.20 |
|  | S.Em±                                  | 0.09 | 0.08 | 0.15 | 0.11  |
|  | C.D.5% level                           | 0.27 | 0.24 | 0.45 | 0.32  |

### 1. Number of leaves at 30, 60, 90 and 120 DAS

The maximum number of leaves 5.04, 29.19, 77.47 and 100.71 were noted under C<sub>3</sub> (Poly house condition) at 30, 60, 90, 120 DAS, respectively. The minimum no. of leaves of 3.97, 12.83, 34.16 and 68.03 leaves were recorded under C<sub>1</sub> (Open condition) at 30, 60, 90 and 120 DAS respectively. The maximum number of leaves 5.10, 21.72, 64.42 and 92.97 were noted under S<sub>4</sub> (GA<sub>3</sub> 600 ppm) at 30, 60, 90 and 120 DAS, respectively. The minimum no. of leaves of 3.80, 17.22, 58.81 and 87.39 leaves were recorded under S<sub>1</sub> (control) at 30, 60, 90 and 120 DAS respectively. The maximum no. of leaves 5.64

statistically at par with C<sub>3</sub>S<sub>5</sub> (5.55) at 30 days, 33.33, 81.73, 103.73 were noted under C<sub>3</sub>S<sub>4</sub> (poly house condition and GA<sub>3</sub> 600 ppm) at 30, 60, 90, 120 DAS. However, the minimum 2.83, 10.65, 32.40, 64.73 leaves were recorded under C<sub>1</sub>S<sub>1</sub> (open condition and control). 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 (2014).

**Table 6. (A)** Effect of growing conditions and seed treatment on number of leaves /seedling of aonla seedlings

|                          | Treatments             | No. of leaves /seedling at |         |         |          |
|--------------------------|------------------------|----------------------------|---------|---------|----------|
|                          |                        | 30 days                    | 60 days | 90 days | 120 days |
| <b>Growing condition</b> |                        |                            |         |         |          |
| C <sub>1</sub>           | Open condition         | 3.97                       | 12.83   | 34.16   | 68.03    |
| C <sub>2</sub>           | Net house condition    | 4.49                       | 15.67   | 72.82   | 100.44   |
| C <sub>3</sub>           | Poly house condition   | 5.04                       | 29.19   | 77.47   | 100.71   |
|                          | S.Em±                  | 0.01                       | 0.05    | 0.29    | 0.02     |
|                          | C.D.5% level           | 0.04                       | 0.15    | 0.85    | 0.06     |
| <b>Seed treatment</b>    |                        |                            |         |         |          |
| S <sub>1</sub>           | Water soaking          | 3.80                       | 17.22   | 58.81   | 87.39    |
| S <sub>2</sub>           | GA <sub>3</sub> 200ppm | 4.38                       | 18.16   | 60.93   | 90.12    |
| S <sub>3</sub>           | GA <sub>3</sub> 400ppm | 4.72                       | 18.84   | 62.09   | 89.97    |
| S <sub>4</sub>           | GA <sub>3</sub> 600ppm | 5.10                       | 21.72   | 64.42   | 92.97    |
| S <sub>5</sub>           | Thiourea 0.5%          | 4.55                       | 19.56   | 61.87   | 89.32    |
| S <sub>6</sub>           | Thiourea 1.0%          | 4.43                       | 19.88   | 60.78   | 88.60    |
|                          | S.Em±                  | 0.02                       | 0.07    | 0.41    | 0.03     |
|                          | C.D.5% level           | 0.06                       | 0.21    | 1.19    | 0.09     |

**(B) Interaction effect of growing conditions and seed treatment on number of leaves /seedling of aonla seedlings**

|                               |  |      |       |       |        |
|-------------------------------|--|------|-------|-------|--------|
| C <sub>1</sub> S <sub>1</sub> | Open condition+ Water soaking          | 2.83 | 10.65 | 32.40 | 64.73  |
| C <sub>1</sub> S <sub>2</sub> | Open condition+ GA <sub>3</sub> 200ppm | 3.83 | 11.60 | 32.60 | 69.30  |
| C <sub>1</sub> S <sub>3</sub> | Open condition+ GA <sub>3</sub> 400ppm | 4.58 | 12.53 | 33.93 | 68.33  |
| C <sub>1</sub> S <sub>4</sub> | Open condition+ GA <sub>3</sub> 600ppm | 4.67 | 14.88 | 36.13 | 72.40  |
| C <sub>1</sub> S <sub>5</sub> | Open condition+ Thiourea 0.5%          | 3.89 | 14.52 | 34.33 | 66.57  |
| C <sub>1</sub> S <sub>6</sub> | Open condition+ Thiourea 1.0%          | 4.00 | 12.80 | 35.53 | 66.83  |
| C <sub>2</sub> S <sub>1</sub> | Net house+ Water soaking               | 4.00 | 14.40 | 68.40 | 99.20  |
| C <sub>2</sub> S <sub>2</sub> | Net house+ GA <sub>3</sub> 200ppm      | 4.22 | 14.68 | 73.40 | 100.60 |
| C <sub>2</sub> S <sub>3</sub> | Net house+ GA <sub>3</sub> 400ppm      | 4.77 | 15.73 | 74.27 | 100.53 |
| C <sub>2</sub> S <sub>4</sub> | Net house+ GA <sub>3</sub> 600ppm      | 5.00 | 16.93 | 75.40 | 103.07 |
| C <sub>2</sub> S <sub>5</sub> | Net house+ Thiourea 0.5%               | 4.20 | 16.87 | 74.33 | 100.67 |
| C <sub>2</sub> S <sub>6</sub> | Net house+ Thiourea 1.0%               | 4.73 | 15.40 | 71.13 | 100.20 |
| C <sub>3</sub> S <sub>1</sub> | Poly house+ Water soaking              | 4.55 | 26.60 | 75.63 | 98.23  |
| C <sub>3</sub> S <sub>2</sub> | Poly house+ GA <sub>3</sub> 200ppm     | 5.08 | 28.20 | 76.80 | 100.47 |
| C <sub>3</sub> S <sub>3</sub> | Poly house+ GA <sub>3</sub> 400ppm     | 4.82 | 28.25 | 78.07 | 101.03 |
| C <sub>3</sub> S <sub>4</sub> | Poly house+ GA <sub>3</sub> 600ppm     | 5.64 | 33.33 | 81.73 | 103.73 |
| C <sub>3</sub> S <sub>5</sub> | Poly house+ Thiourea 0.5%              | 5.55 | 27.31 | 76.93 | 100.43 |
| C <sub>3</sub> S <sub>6</sub> | Poly house+ Thiourea 1.0%              | 4.57 | 31.44 | 75.67 | 98.77  |
|                               | S.Em±                                  | 0.03 | 0.12  | 0.72  | 0.05   |
|                               | C.D.5% level                           | 0.10 | 0.36  | 2.08  | 0.16   |

**1. Survival Percentage (%)**

The data revealed that growing conditions and seed treatments significantly influenced the survival percentage of seedling at 120 DAS. The maximum survival percentage of 65.00 was recorded under C<sub>3</sub> (poly house) whereas, minimum percentage (60.00) was noted under C<sub>2</sub> (net house). The maximum survival percentage (70.00) was recorded with S<sub>4</sub>

(GA<sub>3</sub> 600 ppm) and minimum (54.44) under S<sub>1</sub> (control) at 120 days after seed sowing. Maximum survival percentage 73.33 was recorded under C<sub>3</sub>S<sub>4</sub> (poly house and GA<sub>3</sub> 600 ppm) and it was minimum 50.00 under C<sub>2</sub>S<sub>1</sub> (net house condition and control). These findings are supported by Jain *et al.* (2017). It may be due to synergistic effect of both factors.

**Table 7. (A)** Effect of growing conditions and seed treatment on aonla seedlings

|                          | Treatments     | Survival (%) |
|--------------------------|----------------|--------------|
| <b>Growing condition</b> |                |              |
| C <sub>1</sub>           | Open condition | 61.11        |

|   |  |       |
|---|--|-------|
| C <sub>2</sub>  | Net house condition                    | 60.00 |
| C <sub>3</sub>  | Poly house condition                   | 65.00 |
|   | S.Em±                                  | 0.57  |
|   | C.D.5% level                           | 1.66  |
|   | <b>Seed treatment</b>                  |       |
| S <sub>1</sub>  | Water soaking                          | 54.44 |
| S <sub>2</sub>  | GA <sub>3</sub> 200ppm                 | 60.00 |
| S <sub>3</sub>  | GA <sub>3</sub> 400ppm                 | 60.00 |
| S <sub>4</sub>  | GA <sub>3</sub> 600ppm                 | 70.00 |
| S <sub>5</sub>  | Thiourea 0.5%                          | 62.22 |
| S <sub>6</sub>  | Thiourea 1.0%                          | 65.56 |
|   | S.Em±                                  | 0.81  |
|   | C.D.5% level                           | 2.35  |
| <b>(B) Interaction effect of growing conditions and seed treatment on aonla seedlings</b> |  |       |
| C <sub>1</sub> S <sub>1</sub>   | Open condition+ Water soaking          | 56.67 |
| C <sub>1</sub> S <sub>2</sub>   | Open condition+ GA <sub>3</sub> 200ppm | 60.00 |
| C <sub>1</sub> S <sub>3</sub>   | Open condition+ GA <sub>3</sub> 400ppm | 60.00 |
| C <sub>1</sub> S <sub>4</sub>   | Open condition+ GA <sub>3</sub> 600ppm | 66.67 |
| C <sub>1</sub> S <sub>5</sub>   | Open condition+ Thiourea 0.5%          | 60.00 |
| C <sub>1</sub> S <sub>6</sub>   | Open condition+ Thiourea 1.0%          | 63.33 |
| C <sub>2</sub> S <sub>1</sub>   | Net house+ Water soaking               | 50.00 |
| C <sub>2</sub> S <sub>2</sub>   | Net house+ GA <sub>3</sub> 200ppm      | 60.00 |
| C <sub>2</sub> S <sub>3</sub>   | Net house+ GA <sub>3</sub> 400ppm      | 53.33 |
| C <sub>2</sub> S <sub>4</sub>   | Net house+ GA <sub>3</sub> 600ppm      | 70.00 |
| C <sub>2</sub> S <sub>5</sub>   | Net house+ Thiourea 0.5%               | 63.33 |
| C <sub>2</sub> S <sub>6</sub>   | Net house+ Thiourea 1.0%               | 63.33 |
| C <sub>3</sub> S <sub>1</sub>   | Poly house+ Water soaking              | 56.67 |
| C <sub>3</sub> S <sub>2</sub>   | Poly house+ GA <sub>3</sub> 200ppm     | 60.00 |
| C <sub>3</sub> S <sub>3</sub>   | Poly house+ GA <sub>3</sub> 400ppm     | 66.67 |
| C <sub>3</sub> S <sub>4</sub>   | Poly house+ GA <sub>3</sub> 600ppm     | 73.33 |
| C <sub>3</sub> S <sub>5</sub>   | Poly house+ Thiourea 0.5%              | 63.33 |
| C <sub>3</sub> S <sub>6</sub>   | Poly house+ Thiourea 1.0%              | 70.00 |
|   | S.Em±                                  | 1.41  |
|   | C.D.5% level                           | 4.07  |

## CONCLUSION

On the basis of present investigation, it is concluded that among the various treatment combinations, C<sub>3</sub>S<sub>4</sub> treatment combination (poly house and 600 ppm

GA<sub>3</sub>) proved superior to rest of the treatment combinations with respect to germination parameters, growth parameters and survival parameter like Days taken to start 1<sup>st</sup> germination, days taken to 50% germination, percentage of seeds

germination, height of shoots, girth of stem, number of leaves per seedling and Survival percentage (%). However, among the growing conditions poly house and among the seed treatment GA<sub>3</sub> (600ppm) were proved most promising as compare to others.

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