Research Article

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Seed priming and environmental effects on germination and seedling vigour in Aonla (*Emblica officinalis Gaertn*.)

Gopika Baby, P. Vinaya Kumar Reddy and Y. Shiny Maria

Deptt. of Fruit Science, College of Horticulture, Dr.Y.S.R. Horticultural University, Venkataramannagudem, West Godavari District, Andhra Pradesh

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ABSTRACT

Aonla, an important indigenous minor fruit crop, is highly valued for its rich nutrient content. However, the increasing demand for its planting material remains unmet due to poor seed germination and seedling growth. Thus, there is an urgent need to standardize techniques to improve seed germination and seedling development. The current study aims to overcome seed dormancy and to enhance germination in aonla seeds. An experiment was carried out at the College of Horticulture, Venkataramannagudem from January 2022 to May 2022, using a Factorial Randomized Block Design with three replications, comprising 16 treatment combinations. Aonla seeds were treated with GA_3 at concentrations of 300, 500, and 700 ppm for soaking periods of 12 and 24 hours under shade net and polyhouse, along with a control treatment that involved soaking in water for 24 hours. The results indicated that the combination of seed priming with GA_3 @ 500 ppm for 24 hours and polyhouse conditions recorded the best outcomes, with minimum number of days to germinate (7.93 days), number of leaves (29.30), seedling diameter (6.36 mm), root length (17.50 cm) and number of roots per seedling (36.00) and survival percentage (89.32%). This study will help boost the commercial cultivation of aonla, providing significant benefits for growers.

Introduction

Aonla (*Emblica officinalis* Gaertn), commonly known as Indian gooseberry, is a significant fruit crop native to India, thriving across various agro-climatic regions of the country. Revered as a sacred tree, it is referred to as Amritphal in ancient texts. Aonla holds a prominent place in Ayurvedic medicine, particularly in the preparation of Triphala and Chyavanprash. Its hardy nature, high productivity, and nutritional and therapeutic benefits, along with its adaptability for value-added products, have elevated its status as a key fruit of the 21st century (Pathak, 2003). The fruit is renowned for its medicinal properties, offering remedies for various ailments and serving as a base for numerous value-added products. Additionally, aonla is processed into powder, which is con-

Corresponding author
Email: vinayreddy26@gmail.com (Dr. P. Vinaya Kumar Reddy)

sidered superior to synthetic vitamin C for treating deficiencies. It is cultivated on an estimated 50,000 hectares, yielding an annual production of 1.5 lakh tonnes (Pathak *et al.*, 2003). Seed priming is an effective method for improving seed germination. Pre-sowing treatments with chemicals like GA_3, thiourea, KNO_3, and NAA have been shown to affect germination duration, seedling height, and root and branch development (Dhankar and Singh, 1996; Pawshe *et al.*, 1997; Gholap *et al.*, 2000 and Rajamanickam *et al.*, 2002). Establishing a nursery is essential for providing quality seedlings, and effective management is crucial for success (Krishnan *et al.*, 2014). Practices like ventilated greenhouses, polyhouses, insect-proof net houses, shade net houses, and plastic tunnels enable controlled crop growth. Understanding how plant life history relates to environmental factors helps predict plant establishment and dominance in specific habitats (Murray *et al.*, 2005; Ferreras *et al.*, 2015 and Jelbert *et al.*, 2015).
As a minor fruit crop, aonla has seen limited research on enhancing seed germination and seedling growth using plant growth regulators under various environmental conditions. To address this gap, the present study aims to investigate the effects of seed priming treatments and different growing conditions on the germination and seedling vigor of aonla.

Material and Methods

The experiment was conducted at the College of Horticulture, Venkataramannagudem, Dr. Y.S.R. Horticultural University, West Godavari District. It was carried out from January 2022 to May 2022, using a factorial randomized block design (RBD) with three replications. The experiment included eight treatments *viz.*, water soaking for 24 hours (G_1), GA_3 300 ppm for 12 hours (G_2), GA_3 300 ppm for 24 hours (G_3), GA_3 500 ppm for 12 hours (G_4), GA_3 500 ppm for 24 hours (G_5), GA_3 700 ppm for 12 hours (G_6), GA_3 700 ppm for 24 hours (G_7), and a control (G_8). These treatments were tested under two environmental conditions: shade net (C_1) and polyhouse (C_2). The experiment includes sixteen treatment combinations. Pre-treated seeds were sown in properly filled and labeled polybags and arranged according to the design. Cultural practices such as regular irrigation and weeding were performed as needed. Various observations on seedling germination and growth parameters were recorded periodically. Light intensity in both the shade net and polyhouse environments was measured regularly from the day of sowing up to 120 days after sowing (DAS) using a lux meter.

Results and Discussion

Data were recorded on various parameters, including germination and growth metrics, from five randomly selected seedlings at regular intervals. The analyzed data are presented in Tables 1 and 2, with graphical representations shown in Figures 1-4.

Days taken for initiation of seed germination

Seeds treated with GA_3 at 500 ppm and sown in a polyhouse (T_{13}) germinated rapidly (7.93 days) compared to those sown under a shade net without treatment (T_8), which took 13.87 days. The reduced germination time for GA_3 treated seeds is likely because GA_3 activates the hydrolysis of starch and its translocation, facilitating earlier germination. Similar observations were made by Vasantha *et al.* (2014) in tamarind. Schutz (1999) also noted that optimal temperatures in a polyhouse up to 34°C, enhanced seed germination and seedling growth in Carex species.

Number of leaves per seedling

Interaction of growth regulators and growing conditions has shown significant difference on number of leaves at 30, 60, 90 and 120 DAS. The combination of seed priming with GA_3 @ 500 ppm + 24 h + polyhouse conditions (G_5C_2) recorded highest number of leaves per seedling (7.40, 15.62, 21.91 and 29.30 at 30, 60, 90 and 120 DAS respectively). The increase in the number of leaves per seedling due to GA_3 application might be attributed to GA_3 moving into the shoot apex, enhancing cell division and growth, which in turn promotes the development of young leaves (Salisbury and Ross, 1988). Similar results were reported by El-Dengawy (2005) in loquat and Meena and Jain (2005) in papaya. Protected farming in polyhouses shields crops from sudden weather changes and regulates the internal environment (Maikhuri *et al.*, 2001), thereby promoting the production of more leaves.

Seedling diameter (mm)

Treatment T_{13} recorded the maximum seedling diameter at 2.52 mm, 3.69 mm, 5.10 mm, and 6.36 mm at 30, 60, 90, and 120 DAS, respectively, followed by T_5. The lowest diameters were observed in T_8 (G_8C_1), measuring 1.47 mm, 1.73 mm, 2.32 mm, and 2.89 mm at 30, 60, 90, and 120 DAS, respectively. The increase in stem diameter might be due to GA_3 enhancing osmotic nutrient uptake and boosting growth by promoting cell division, elongation, and multiplication in the cambium tissue of the stem (Mistry and Sitapara, 2020). These findings are consistent with results reported by Ramteke *et al.* (2015) in papaya, Joshi *et al.* (2017) in chironji, and Manthri and Bharad (2017) in guava.

Root length (cm)

Maximum root length (17.50 cm) was recorded in T_{13} (GA_3

Table 1. Effect of seed priming and growing conditions on no. of leaves, seedling diameter, root length and no. of roots per seedling

Treatments		Number of leaves per seedling	Seedling diameter (mm)	Root length (cm)	Number of roots per seedling
T_1: G_1C_1	Water soaking for 24 hrs + shade net	20.13	3.40	12.56	30.12
T_2: G_2C_1	GA_3 300 ppm for 12 hrs + shade net	21.98	4.86	13.78	31.47
T_3: G_3C_1	GA_3 300 ppm for 24 hrs + shade net	25.84	5.54	15.60	33.65
T_4: G_4C_1	GA_3 500 ppm for 12 hrs + shade net	27.32	5.85	16.79	34.56
T_5: G_5C_1	GA_3 500 ppm for 24 hrs + shade net	28.60	6.00	17.20	35.40
T_6: G_6C_1	GA_3 700 ppm for 12 hrs + shade net	23.04	5.36	14.10	32.15
T_7: G_7C_1	GA_3 700 ppm for 24 hrs + shade net	24.48	5.11	14.79	31.87
T_8: G_8C_1	Control + Shade net	19.44	2.89	11.22	28.46
T_9: G_1C_2	Water soaking for 24 hrs + polyhouse	20.87	3.61	12.98	30.57
T_{10}:G_2C_2	GA_3 300 ppm for 12 hrs + polyhouse	22.61	5.01	14.01	31.97
T_{11}:G_3C_2	GA_3 300 ppm for 24 hrs + polyhouse	26.54	5.73	15.98	33.87
T_{12}:G_4C_2	GA_3 500 ppm for 12 hrs + polyhouse	27.94	5.84	17.01	35.04
T_{13}:G_5C_2	GA_3 500 ppm for 24 hrs + polyhouse	29.30	6.36	17.50	36.00
T_{14}:G_6C_2	GA_3 700 ppm for 12 hrs + polyhouse	23.77	5.47	14.56	32.65
T_{15}:G_7C_2	GA_3 700 ppm for 24 hrs + polyhouse	24.87	5.20	14.98	32.00
T_{16}:G_8C_2	Control + polyhouse	20.12	2.95	11.36	28.64
	SEm±	0.050	0.024	0.030	0.035
	CD at 5%	0.146	0.069	0.087	0.102

Table 2. Effect of seed priming and growing conditions on days taken for initiation of germination and seedling survival percentage

Treatments		Days taken for initiation of germination (days)	Survival per cent of seedlings (%)
T_1: G_1C_1	Water soaking for 24 hrs + shade net	12.56	76.84
T_2: G_2C_1	GA_3 300 ppm for 12 hrs + shade net	11.54	80.12
T_3: G_3C_1	GA_3 300 ppm for 24 hrs + shade net	10.41	85.10
T_4: G_4C_1	GA_3 500 ppm for 12 hrs + shade net	9.52	87.86
T_5: G_5C_1	GA_3 500 ppm for 24 hrs + shade net	8.44	89.11
T_6: G_6C_1	GA_3 700 ppm for 12 hrs + shade net	11.98	82.42
T_7: G_7C_1	GA_3 700 ppm for 24 hrs + shade net	11.03	81.89
T_8: G_8C_1	Control + Shade net	13.87	74.60
T_9: G_1C_2	Water soaking for 24 hrs + polyhouse	12.33	79.43
T_{10}:G_2C_2	GA_3 300 ppm for 12 hrs + polyhouse	11.02	80.75
T_{11}:G_3C_2	GA_3 300 ppm for 24 hrs + polyhouse	10.02	85.40
T_{12}:G_4C_2	GA_3 500 ppm for 12 hrs + polyhouse	8.79	88.25
T_{13}:G_5C_2	GA_3 500 ppm for 24 hrs + polyhouse	7.93	89.32
T_{14}:G_6C_2	GA_3 700 ppm for 12 hrs + polyhouse	11.65	83.10
T_{15}:G_7C_2	GA_3 700 ppm for 24 hrs + polyhouse	10.75	82.03
T_{16}:G_8C_2	Control + polyhouse	13.41	75.40
	SEm±	0.027	0.075
	CD at 5%	0.078	0.217

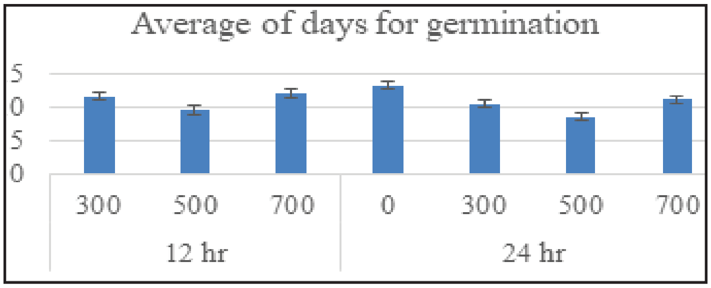

Fig. 1. Effect on average days for germination under shade net

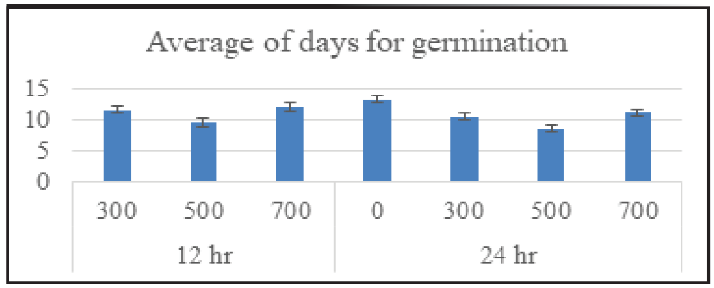

Fig. 2. Effect on survival (%) of seedlings under shade net

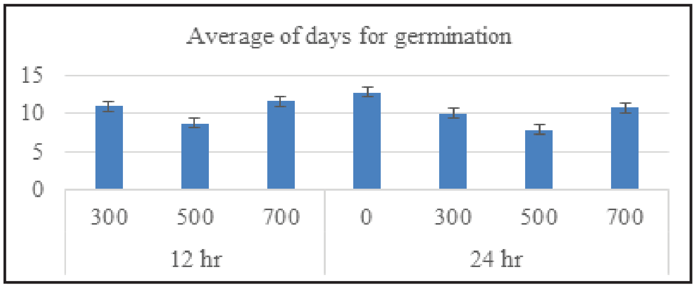

Fig. 3. Effect on average days for germination under polyhouse

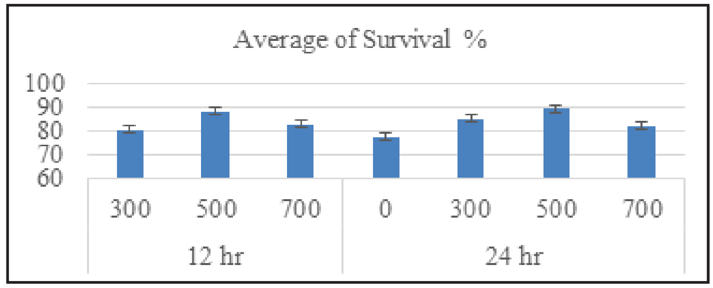

Fig. 4. Effect on survival (%) of seedlings under polyhouse

500 ppm for 24 hrs + polyhouse) whereas, minimum root length (11.22 cm) was recorded in the control T_8 (no soaking + shade net). Seed priming with GA_3 may enhance photosynthetic activity, accelerate translocation, and improve the efficiency of utilizing photosynthetic products, leading to cell elongation and rapid cell division in the growing portions of roots (Surakshitha *et al*., 2014). The highest root length observed in polyhouse seedlings can be attributed to the favorable growth conditions provided by the polyhouse environment. These findings align with those of Ramdas *et al.* (2011), who reported maximum germination and seedling growth of Picrorhiza kurroa under polyhouse conditions compared to open field conditions.

Number of roots per seedling

The combination of seed priming and growing conditions demonstrated a significant difference in the number of roots. Seed priming treatment G_5C_2 recorded the highest number of roots: 14.12, 23.97, 30.02, and 36.00 at 30, 60, 90, and 120 DAS, respectively, followed by G_5C_1. The lowest number of roots, 7.06, 17.60, 23.01, and 28.46 at 30, 60, 90, and 120 DAS, respectively, was observed in G_8C_1. The application of GA_3 enhances the growth rate and promotes the development of hairy roots. The above results are in conformity with findings of Dilip *et al.* (2017a & b) in Kagzi lime and Rangpur lime. The higher number of roots observed in seedlings grown in polyhouses may be attributed to the increased availability of light intensity under polyhouse conditions, which facilitates enhanced growth and development of the plants (Marcelis and Hofman-Eijer, 1993). These results were in confirmatory with earlier findings of Muhammad *et al.* (2004) in guava.

Light intensity (k lux)

The study revealed that light intensity inside the polyhouse was higher compared to that in the shade net. In the polyhouse, maximum light intensity (44280 lux) was observed in May, while minimum (24700 lux) occurred in January. In contrast, in the shade net, maximum light intensity (36250 lux) was recorded in March, with minimum (17450 lux) in January during the study period. Photosynthesis, which produces plant matter, occurs when chlorophyll absorbs light in the green parts of the plant, primarily the leaves (Umesha *et al*., 2011). The greater incidence of solar radiation under polyhouse conditions is attributed to the superior roof design, enhancing microclimatic conditions that positively influence seedling growth and vigor. These findings are consistent with observations in tomato by Mintu (2018) and in aonla by Verma *et al.* (2019).

Survival per cent of seedlings (%)

The highest seedling survival rate (89.32%) was observed with GA_3 treatment at 500 ppm for 24 hours combined with a polyhouse treatment (T_{13}) which might be due to favourable environmental conditions (Brijwal and Kumar, 2013). These results align with the findings of Supe *et al.* (2012) and Manekar *et al.* (2011) in aonla. However, the lowest survival rate (74.60%) was recorded in the control group under shade net (T_8). The increase in germination percentage and seedling vigor index due to house's interior maintained an optimal temperature (around 28°C), promoting seedling growth and development by gradually increasing air temperature due to the greenhouse effect, which led to higher seedling survival rates (Kumari *et al*., 2014). These results are consistent with the findings of Verma *et al*. (2019) in aonla.

Conclusion

Based on the results of this experiment, it can be concluded that seeds treated with GA_3 at 500 ppm for 24 hours and sown in a polyhouse (T_{13}) showed the best results in terms of germination parameters, growth parameters, production of vigorous seedlings, and higher survival percentage compared to other seed treatments and growing conditions.

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