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Effect of chemicals on seed germination and seedling growth of Aonla (*Emblica officinalis* Gaertn.)

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Abstract

The experiment entitled "Effect of chemicals on seed germination and seedling growth of Aonla (*Emblica officinalis* Gaertn.)" was carried out at Regional Horticultural Research Station (RHRS), ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari during 2019-20. The experiment consisted 11 treatments *viz.* control (T_1), water soaking (T_2), thiourea @ 0.5 % (T_3), thiourea @ 1.0 % (T_4), thiourea @ 1.5 % (T_5), KNO_3 @ 0.5 % (T_6), KNO_3 @ 1.0 % (T_7), KNO_3 @ 1.5 (T_8), GA_3 @ 250 mg/l (T_9), GA_3 @ 500 mg/l (T_{10}) and GA_3 @ 750 mg/l (T_{11}). The seeds of aonla were soaked with these chemicals for 24 hours and sown in polybags. The experiment was carried out in completely randomized design and repeated thrice. The effect of different treatments on germination, seedling growth and survival percentage were recorded. The results of experiment showed that aonla seeds treated with GA_3 @ 500 mg/l (T_{10}) gave the highest germination percentage (67.89) along with early emergence (6.20 days) of aonla seeds. Maximum seedling growth *viz.* number of leaves (25.46, 71.93, 106.26 and 119.26), seedling diameter (3.48, 6.40, 7.84 and 8.76 mm) and seedling height (48.60, 90.36, 106.40 and 114.60 cm) were observed with the treatment of GA_3 @ 500 mg/l (T_{10}) at 60, 90, 120 and 180 days after sowing. Highest leaf area (55.50 cm^2), fresh weight of shoot and root (117.86 and 32.06 g), dry weight of shoot and root (15.07 and 3.88 g), shoot : root ratio (3.67), vigour index-I (9839.25 cm) vigour index-II (1627.71 g) and survival percentage (72.12) were also noted in treatment GA_3 @ 500 mg/l (T_{10}) at 180 days after sowing.

Keywords: GA_3, Thiourea, KNO_3, seed germination and survival percentage

Introduction

Aonla or Indian gooseberry (*Emblica officinalis* Gaertn.) belonging to family Euphorbiaceae, is considered as a wonder fruit due to its medicinal and therapeutic properties. It is known by several vernacular names such as *amlica, amra, chukna, nelli, amolphal, sobju* and Indian gooseberry. Aonla is native to tropical South East Asia. In India, othe area under aonla cultivation is 92 thousand hectares with an annual production of 1039 thousand tons (Anon., 2018) [2]. The commercial cultivation of aonla can be observed mainly in Uttar Pradesh, Gujarat, Rajasthan and Tamil Nadu. The Kheda, Anand and Sabarkantha districts are excellent pockets for aonla cultivation in Gujarat. In Gujarat, area, production and productivity is 7335 ha, 73423 t and 10 t/ha respectively (Anon., 2019) [3]. However, day by day the area under aonla cultivation is increasing in arid and semi-arid parts of the state, owing to its hardy nature, ability to survive in various kinds of wastelands (arid, semi-arid, salt-affected, coastal and ravines), nutritive value and its varied uses. Aonla fruits have acrid, diuretic cooling and laxative properties. It is the richest source of ascorbic acid (vitamin C) and also contains tannin, polyphenol, pectin, gallic acid and fiber. About 600–900 mg of vitamin C is found in 100 g of aonla pulp (Pokharkar, 2005) [23]. However, the availability of quality planting material is one of the major problem for the expansion of the area under horticultural crops. Almost all dryland fruit crops are mostly propagated by seeds. Aonla is commercially propagated through patch budding on seedling rootstock in Gujarat and other states. The seedlings are raised from seeds and used as rootstock. Therefore, there is need to know the nursery techniques for improving the seed germination and seedling growth. The seed treatment with chemicals like gibberellic acid, thiourea and potassium nitrate enhances the germination and seedling growth of some tree plant species (Shanmugavelu, 1970) [28]. Hence these chemicals were used in this experiment for aonla seed germination and seedling growth.

Materials and Methods

The study was conducted Regional Horticultural Research Station, under shade net condition on plot no. E-8, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari, during 2019-20. The present experiment was carried out to study the effect of different chemicals on seed germination and seedling growth of aonla. The experimental design was CRD and there were eleven treatments which are replicated thrice. The treatment details are control (T_1), water soaking (T_2), thiourea @ 0.5 % (T_3), thiourea @ 1.0 % (T_4), thiourea @ 1.5 % (T_5), KNO_3 @ 0.5 % (T_6), KNO_3 @ 1.0 % (T_7), KNO_3 @ 1.5 (T_8), GA_3 @ 250 mg/l (T_9), GA_3 @ 500 mg/l (T_{10}) and GA_3 @ 750 mg/l (T_{11}). The seeds of aonla were soaked with these chemicals as per treatments, the seeds were removed from respective solutions after 24 hours in the morning, dried in shade on tissue paper for 15 minutes and then immediately used for sowing. The seeds were sown on 26th april in polythene bags of 7″×9″ size containing media mixture of red soil + FYM + vermicompost (1:1:1) at the depth of about 2 to 3 cm, covered by a shallow layer of media and watered immediately using rose can. The observations were recorded for days required for initiation of germination, germination percentage, number of leaves per seedling, stem diameter, seedling height, leaf area per plant, fresh weight of shoot, fresh weight of root, dry weight of shoot, dry weight of root, shoot to root ratio, vigour index-I, vigour index-II and survival percentage. The experimental data collected relating to different parameters were statistically analyzed by Completely Randomized Design (CRD) and results were analyzed as per the guide lines suggested by Panse and Sukhatme (1985) [20].

Results and Discussion

Germination attributes and survival percentage

The minimum days required for initiation of germination (6.20) and maximum germination (67.89 %) were found under the treatment T_{10} (GA_3 @500 mg/l). The maximum days (11.9) taken for initiation of germination and minimum seed germination (53.97 %) were found under the control treatment (Table 1). The higher seed germination percentage in GA_3 was due to stimulating action of GA_3 for germination of seeds. GA_3 induces the de novo synthesis of proteolytic enzymes like α-amylase and ribonuclease. Amylases in turn hydrolyse starch in the endosperm, providing the essential sugars for the initiation of growth processes (Copeland and Mc-Donald, 1995) [7]. GA_3 treatment is also known to over-rule the photo dormancy, thermo-dormancy, dormancy imposed by incomplete embryo development, mechanical barriers and presence of germination inhibitors (Diaz and Martin, 1971) [9]. The result was in agreement with findings of Praveen *et al*., (2006) in custard apple and Muralidhara *et al*., (2015) [17] in mango. It might be also due to the fact that GA_3 acts directly on embryo relieving them from dormancy through promoting protein synthesis and elongation of coleoptiles and leaves also helps in the production of ethylene. This ethylene invokes the synthesis of hydrolases, especially amylase, which favours the seed germination. Thus, the enhanced enzymatic reactions along with the suppression of inhibitors by these growth substances might have acted in faster germination (Stewart and Freebairn, 1969) [29]. The other reasons for increased germination percentage with GA_3 may be attributed to the diffusion of endogenous auxin and gibberellin like substances. GA_3 conferred enhanced seed germination because it might have antagonized the effect of inhibitors present in seeds (Wareing *et al*., 1968) [33]. This result is in close conformity of that obtained by Wagh *et al*. (1998) [32] in aonla; Ramchandra and Govind (1990) [25] in guava. It was also observed that with increasing the GA_3 concentration from 250 to 500 ppm there was a significant increase in seed germination but further increase in GA_3 concentration from 500 to 750 ppm, resulted in decreased seed germination. These findings replicate the findings of those obtained by Dhankhar and Santhosh (1996) [8] in aonla; Borle (1991) [5] and Yelure (1992) [34] in charoli and custard apple, respectively.

The seeds treated with GA_3 @ 500 mg/1 (T_4) recorded the highest survival percentage (72.12) (Table 1). Early germination of seeds in GA_3 @500 mg/l which helps in successful acclimatization of seedlings in field conditions and vigour of seedlings ultimately leads to better growth, thus, less mortality *i.e.* higher survival percentage of seedlings. This might also be due to the overall performance concerning growth parameters were good in the same treatment which ultimately increased the survival percentage. The observation analogues to these findings were reported by Barche *et al*. (2010) [4] in papaya; Prajapati Dixita (2014) [24] in jackfruit and Manekar *et al*. (2011) [15] in aonla.

Growth parameters

Considering the effect of seed treatment, aonla seeds treated with GA_3 @500 mg/l gave the maximum number of leaves (25.46, 71.93, 106.26 and 119.26), stem diameter (3.48, 6.40, 7.84 and 8.76 mm) and seedling height (48.60, 90.36, 106.40 and 114.60 cm) at 60, 90, 120 and 180 days after sowing, respectively and maximum leaf area per plant (55.50 cm^2) at 180 days after sowing. (Table 2)

The increase in number of leaves and leaf area as results of GA_3 application might be due to fact that activity of GA_3 at apical meristem resulting in more nucleoprotein responsible for increasing leaf initiation and expansion. It may be also due to the vigorous growth induced by the GA_3 treatment, more number of branches which facilitates better harvest of sunshine by the plants to produce more number of leaves. Results obtained on this aspect are in agreement with Muralidhara *et al*., (2015) [17]; Manekar *et al*. (2011) [15] and Rashmi Kumari *et al*. (2007) [26] in aonla; Singh *et al*. (1989) in citrus; Nimbalkar *et al*. (2012) in karonda; Meshram *et al*. (2015) [16] in acid lime and Jadhav *et al*. (2015) [13] in custard apple; Patil *et al.* (2017) [22] in jamun.

The increase in seedling height with GA_3 treatment was because this hormone increased osmotic uptake of nutrients, causing cell multiplication and cell elongation in the cambium tissue of the internodal region and thus increased height of the plant (Shanmugavelu, 1970) [28] and stem diameter also increased due to gibberellic acid promoting cell division and cell elongation in the collar region. The increased height in 500 ppm GA_3 treated seeds may be attributed to the reason that the endogenous levels of GA_3 synthesized by the aonla seedling might not be sufficient and external application of GA_3 might have boosted growth by increasing cell multiplication and cell elongation resulting in better plant growth (Dhankar and Santosh, 1996 and Wagh *et al*., 1998) [32]. The results are in accordance with the results of Choudhary and Chakrawar (1980) [6] in Kagzi lime; Kumar *et al*. (2008) and Shaban (2010) [27] in mango; Pampanna and Sulikeri, (1999) [28] in sapota; Harshavardhan and Rajasekhar (2012) in jackfruit and Vasantha *et al*. (2014) [30] in tamarind.

Fresh and dry weight

Results of an experiment proved that different seed treatments significantly affected on fresh weight of shoot, fresh weight of roots, dry weight of shoot, dry weight of roots, vigour index-I, and vigour index-II. The results of the present investigation revealed that the maximum fresh weight of shoot (117.86 g), fresh weight of roots (32.06 g), dry weight of shoot (15.07 g), dry weight of roots (3.88 g), vigour index-I (9839.25 cm), and vigour index-II (1627.71 g) were recorded when seeds were soaked in GA_3 @ 500 mg/l (T_4) (Table 3).

The biomass produced by the plant is the net gain of inter play between various anabolic and catabolic processes in plants. Plant growth regulators, particularly GA_3 exhibited profound influence on dry matter accumulation in different plant parts, which could be due to its effect in stimulating cell division, cell elongation, auxin metabolism, cell wall plasticity and permeability of cell membrane leading to enhanced growth. The highest seedling vigour in GA_3 was attributed to enlarged embryos, higher rate of metabolic activity and respiration, better utilization and mobilization of metabolites to growing points and higher activity of enzymes. Enzymatic and hormonal mechanism stimulate metabolic process such as sugar mobilization, protein hydrolysis, oxidation *etc.* (Earlplus and Lambeth, 1974) [10], which leads to increase in root length, shoot length and seedling dry weight which in turn increase in seedling vigour.

The increase in fresh and dry weight of shoot and roots with GA_3 treatment might be due to overall growth of the seedling resulted in higher fresh and dry weight of shoot and roots. Thus increased growth is a consequence of increased dry matter accumulation. The results are in close conformity with findings of Vasantha *et al.* (2014) [30] in tamarind, Anburani and Shakila (2010) [1] in papaya; Parmar *et al.* (2016) [21] in custard apple; Patil *et al.* (2017) [22] in jamun; Joshi *et al.* (2017) in chironji; Kadam *et al.* (2010) [14] in Kagzi Lime; Pampanna and Sulikeri (1999) [6, 14] in sapota; Venkatarao and Reddy (2005) [31]; Muralidhara *et al.* (2015) [17] in mango and Gurung *et al.* (2014) [11] in passion fruit.

Table 1: Effect of chemicals on days to germination, germination percentage and survival percentage of aonla seedling

Treatments	Days to Germination	Germination (%)	Survival Percentage
Control	11.900	53.97 (65.44)	57.59 (71.26)
Water soaking	10.060	55.35 (67.69)	57.95 (71.80)
Thiourea @ 0.5 %	9.900	56.91 (70.21)	59.36 (74.07)
Thiourea @ 1 %	7.000	66.03 (83.51)	69.00 (87.14)
Thiourea @ 1.5 %	9.660	63.24 (79.75)	59.21 (73.83)
KNO_3 @ 0.5 %	9.260	62.11 (78.12)	63.15 (79.65)
KNO_3 @1 %	8.260	65.02 (82.21)	65.24 (82.44)
KNO_3 @ 1.5 %	8.330	60.95 (76.46)	62.84(79.20)
GA_3 @ 250 mg/l	7.830	63.58 (80.23)	65.19 (82.41)
GA_3 @ 500 mg/l	6.200	67.89 (85.85)	72.12 (90.59)
GA_3 @ 750 mg/l	8.060	61.03 (76.58)	59.39 (74.01)
S.Em.±	0.220	0.690	1.060
C.D. 5 %	0.670	2.020	3.110
C.V.	4.540	1.950	2.930

Table 2: Effect of seed treatments on growth parameters of aonla seedling

Treatments	Number of Leaves				Stem diameter				Seedling height				Leaf area
	60 DAS	90 DAS	120 DAS	180 DAS	60 DAS	90 DAS	120 DAS	180 DAS	60 DAS	90 DAS	120 DAS	180 DAS	180 DAS
Control	18.10	43.73	68.93	78.46	2.70	4.83	6.56	7.84	39.06	70.33	87.00	98.00	29.460
Water soaking	19.66	45.60	69.66	76.33	2.82	5.02	6.67	7.86	39.46	75.03	87.73	99.33	31.060
Thiourea @ 0.5%	21.13	54.73	73.00	81.13	3.04	5.68	6.96	7.88	42.97	78.46	86.30	100.26	31.260
Thiourea @ 1%	24.00	69.86	103.60	115.53	3.32	6.23	7.80	8.74	48.20	89.63	103.50	113.30	54.130
Thiourea @ 1.5%	18.86	50.80	78.93	82.86	2.83	5.85	7.00	8.30	40.13	76.33	98.33	106.33	40.700
KNO_3 @ 0.5%	19.73	53.13	70.00	80.60	3.07	5.91	7.18	7.87	42.06	79.86	96.00	108.20	40.300
KNO_3 @ 1%	23.30	61.06	100.20	113.40	3.25	6.08	7.76	8.72	47.33	88.30	102.96	112.06	53.130
KNO_3 @ 1.5 %	22.23	52.93	86.00	94.93	3.02	5.87	7.10	7.96	41.80	77.73	99.40	107.60	32.120
GA_3 @ 250 mg/l	23.13	60.80	99.40	113.00	3.22	6.07	7.66	8.65	46.46	87.93	102.80	111.13	52.960
GA_3 @ 500 mg/l	25.46	71.93	106.26	119.26	3.48	6.40	7.84	8.76	48.60	90.36	106.40	114.60	55.500
GA_3 @ 750 mg/l	20.13	57.06	73.66	89.26	3.07	5.90	7.27	8.25	40.90	85.16	91.26	102.73	40.220
S.Em.±	0.62	0.74	1.03	1.59	0.11	0.15	0.12	0.10	1.09	1.26	1.27	1.25	0.870
C.D. 5 %	1.82	2.17	3.02	4.66	0.33	0.45	0.35	0.30	3.21	3.70	3.72	3.67	2.570
C.V.	5.02	2.27	2.11	2.90	6.47	4.68	2.88	2.19	4.38	2.68	2.28	2.04	3.620

Table 3: Effect of seed treatments on fresh and dry weight of root and shoot and vigour index of aonla seedling

Treatments	Fresh weight of Shoot (g)	Fresh weight of Root (g)	Dry weight of Shoot (g)	Dry weight of Root (g)	Shoot to root ratio	Vigour Index-I	Vigour Index-II
Control	33.600	18.360	5.160	2.300	1.830	6414.180	487.810
Water soaking	36.790	18.530	6.030	2.430	1.980	6722.760	574.060
Thiourea @ 0.5 %	41.570	19.800	6.970	2.630	2.100	7043.250	674.230
Thiourea @ 1 %	113.300	31.160	14.580	3.850	3.630	9460.390	1539.770
Thiourea @ 1.5 %	53.930	23.460	8.110	2.800	2.300	8480.690	870.420
KNO_3 @ 0.5 %	67.870	26.200	9.120	3.040	2.600	8452.740	949.480
KNO_3 @ 1 %	105.330	29.260	13.810	3.750	3.600	9214.450	1443.720
KNO_3 @ 1.5 %	46.140	18.800	10.450	3.200	2.480	8226.640	1044.290
GA_3 @ 250 mg/l	97.730	29.330	12.420	3.500	3.330	8917.140	1277.980
GA_3 @ 500 mg/l	117.860	32.060	15.070	3.880	3.670	9839.250	1627.710
GA_3 @ 750 mg/l	82.830	27.800	11.090	3.300	2.980	7868.200	1101.980
S.Em.±	1.390	0.840	0.220	0.060	0.080	156.260	25.710
C.D. 5 %	4.090	2.480	0.660	0.190	0.250	458.340	75.430
C.V.	3.330	5.880	3.850	3.660	5.520	3.280	4.230

Conclusion
On the basis of results obtained, it was concluded that aonla seeds soaking with GA_3 @ 500 mg/l for 24 hours minimized days required for initiation of germination as well as enhance germination percentage and growth of seedling. The same treatment also recorded maximum survival percentage of aonla seedling at 180 days after sowing.

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