The Bioscan 11(1): 389-393, 2016 (Supplement on Agronomy)
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.in

INFLUENCE OF SEED PRIMING TREATMENTS ON GERMINATION AND SEEDLING VIGOUR OF CUSTARD APPLE (*ANNONA SQUAMOSA* L.) CV. LOCAL

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KEYWORDS
Custard apple
seed priming
GA_3, KNO_3,
Thiourea
germination
vigour

Received on :
12.10.2015

Accepted on :
27.01.2016

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ABSTRACT
An investigation was conducted to study the influence of seed priming treatments on germination and seedling vigour of custard apple. The treatments comprised of different concentrations of chemicals (GA_3 @ 100 and 200 mgL^{-1}, KNO_3 @ 1 and 2%, Thiourea @ 500 and 1000 mgl^{-1}), fresh cow dung and urine slurry (1:2 ratio) and hot water treatment. Soaking the seed in GA_3 @ 200 mgL^{-1} for 12 hours recorded the minimum days taken to germinate (24.00 days), maximum germination percentage (63.99 %) and height of seedling (64.87 cm), shoot length (45.90 cm), root length (20.00 cm), fresh and dry weight of seedling (7.27 g and 4.36 g), stem girth (0.73 cm), relative growth rate (0.026 g/day), vigour index-I and II (0.99 and 14.68) at 120 days of sowing. From the above values, GA_3@ 200 mgL^{-1} for 12 hourswas found best seed priming treatment for maximum germination and seedling growth of custard apple.

INTRODUCTION

Custard apple (*Annona squamosa* L.)is commonly known as Sitaphal or sugar apple. It is a minor fruit crop of commercial value. It is a delicious and important fruit crop which is cultivated in tropical and sub tropical climate, under family "Annonaceae" and native of the West Indies. Due to hard and thick seed coat, it requires about 35-50 days for germination (Torres and Sanchez, 1992). To get higher and proper germination with vigorous seedling growth, seed needs pre-treatments before sowing, which helps in promotion of early and higher percentage of seed germination with healthy vigorous seed lings.Treating seeds with GA_3 also helps enhancing their growth (Chadha, 2010). For enhancing seed germination and growth of seedling, seed priming chemicals like GA_3, KNO_3, Thiourea and hot water as well as cow dung slurry in open condition were used. The old seeds lose their germination ability with the passing of time. However it is possible to extend seed germination ability by using some germination promoters. KNO_3 and K_2HPO_4 are used for breaking seed dormancy and promote seed germination. Thiourea promotes growth of seedlings by increasing plasticity of the cell wall followed by the hydrolysis of starch to sugar which reduces the potential in the cell, resulting in the entry of water into the cell causing elongation (Arteca, 1996).Therefore, it is needful to find out the best seed priming treatment for higher germination of seeds,vigorous growth of seedlings and growth and development of custard apple seedlings as affected by different methods of seed priming treatments.

MATERIALS AND METHODS

Seed material and treatment

Custard apple seeds of local variety were obtained from Horticultural Research Farm for sowing in experimental plot. The experiment was conducted at the Horticultural Research Farm, Department of Horticulture, B.A. College of Agriculture, An and Agricultural University, An and during summer season of the year 2012. Experiment treatment comprised of 9 treatments namely, T_1: Soaking the seed in GA_3 @ 100 mgL^{-1} for 12 hours, T_2: Soaking the seed in GA_3 @ 200 mgL^{-1} for 12 hours, T_3: Soaking the seed in KNO_3 @ 1% for 12 hours, T_4: Soaking the seed in KNO_3 @ 2% for 12 hours, T_5: Soaking the seed in Thiourea @ 500 mgl^{-1} for 12 hours, $T_{6:}$ Soaking the seed in Thiourea @ 1000 mgl^{-1} for 12 hours, $T_{7:}$ Soaking the seed in fresh cow dung and urine slurry (1:2 ratio) for 24 hours, T_8: Soaking the seed in hot water (approximately 50 to 60°C) for 24 hours, T_9: Control (without any treatment).

Experiment design and measured parameters

Data were recorded periodically and analyzed statistically following the complete randomized design as outlined by Panse and Sukhatme, 1967. Treatment means were compared with C.D. at 5 per cent level. Number of seeds per treatment was75 seeds per treatment, seed was sown in nursery in

polybag duringFebruary month and size of black polythene bags was 22 x 9 cm.

Days for initiation of germination

The time interval between sowing of seeds and the appearance of first germination in each treatment was counted as days required for initiation of germination.

Germination percentage at 30 DAS

For germination percent, 75 seeds of each treatment were sown in polyethylene bags. Germinated seeds were counted at 30th day after sowing. Finally, average germination percentage was worked out for each treatment.

Shoot length (cm) at 30, 60, 90 and 120 DAS

The length of shoot of five tagged plants in each net plot were measured in centimeter at 30, 60, 90 and 120 DAS from ground level to the initiation of most leaf. The mean shoot length was worked out and recorded separately for each treatment.

Root length (cm) at 30, 60, 90 and 120 DAS

The length of root of five tagged plants were measured in centimeter at 30, 60, 90 and 120 DAS from below ground level to the tip of root. The mean root length was worked out and recorded separately for each treatment.

Fresh weight of seedling (g) at 30, 60, 90 and 120 DAS

At 30, 60, 90 and 120 days after sowing five plants were taken out from each net plot with roots and washed with water and then after immediately weighed out and average was worked out.

Dry weight of seedling (g) at 30, 60, 90 and 120 DAS

After recording fresh weight of five plants they were air dried under shade in laboratory and then oven dried at 60 °C till constant weight i.e. last two observations were same and average was worked out.

Stem girth (cm) at 30, 60, 90 and 120 DAS

Observation of stem girthat 30, 60, 90 and 120 DAS of five selected plants were measured and then average value was calculated.

Relative growth rate (RGR) (g/day) at 60, 90 and 120 DAS

At 60, 90 and 120 days after sowing relative growth rate was measured by following formula (Pandey and Sinha, 2012).

$$\text{Relative growth rate (RGR) (g/day)} = \frac{\text{Log } W_2 \quad \text{Log } W_1}{t_2 \quad t_1}$$

e.g. For 120 DAS

where W_2 = Total seedling dry weight (at 120 DAS)

W_1 = Total seedling dry weight (at 90 DAS)

t_2 = Time taken for 2nd observation (at 120 DAS)

t_1 = Time taken for 1st observation (at 90 DAS)

Relative growth rate consists the difference of total seedling dry weight between two subsequent intervals to be divided by the difference of days of interval of the total seedlings dry weight taken.

Vigour index-I at 90 and 120 DAS

Vigour index determine the state of the health of seedlings and ultimately the state of the productivity of the plant. Higher the vigour index better will be the plant yield.

For calculating seed vigour index-I, germination percent was divided by seedling length. The readings of seed vigour index-I were recorded at the interval of 90 and 120 DAS.

Vigour index-II at 90 and 120 DAS

For calculating the seed vigour index-II, germination percent was divided by seedling dry weight. The readings of seed vigour index-II were recorded at the interval of 90 and 120 DAS.

RESULTS AND DISCUSSION

Nurserymen are often encountered with problem of germination and poor growth and development of seedling restricts the availability of healthy planting material on large scale. Therefore, it is highly essential to accelerate the rate of seed germination and growth rate by treating the seeds with various chemicals to obtain more germination percentage and healthy seedlings within a short time. Plant growth regulators and some chemicals are widely used in increasing the seed germination percentage and for healthy growth and vigour of seedlings. Now at present organic era, much emphasis is laid on organic approaches in agriculture and horticulture. There are different systems of organic farming which are prevalent in

Table 1 : Influence of seed priming treatments on days taken for initiation of germination ,germination % and seedling length (cm) of custard apple

Treatments	Days for initiation of germination	Germination percentage	Seedling length (cm)			
		30 DAS	30 DAS	60 DAS	90 DAS	120 DAS
T_1	25.00	60.00	4.62	23.43	46.00	64.53
T_2	24.00	63.99	5.30	23.73	48.92	64.87
T_3	28.00	38.66	4.49	20.50	42.07	59.47
T_4	28.00	46.67	4.50	21.10	44.06	58.47
T_5	27.00	48.00	4.59	22.20	44.93	61.37
T_6	26.00	50.67	4.61	22.03	44.55	61.97
T_7	29.00	33.33	3.96	18.40	38.07	55.37
T_8	30.00	32.00	3.57	17.50	34.21	51.47
T_9	30.00	28.00	3.49	16.90	33.64	48.86
S.Em. ±	0.67	0.79	0.15	0.40	1.04	1.30
C.D. at 5 %	2.02	2.37	0.45	1.19	3.11	3.89
C.V. %	4.25	3.07	5.97	3.33	4.30	3.84

Table 2: Influence of seed priming treatments on shoot length (cm) and root length (cm)of custard apple

Treatments	Shoot length (cm)				Root length (cm)			
	30 DAS	60 DAS	90 DAS	120 DAS	30 DAS	60 DAS	90 DAS	120 DAS
T_1	2.90	12.23	33.97	44.97	1.72	11.20	12.03	18.63
T_2	3.22	12.33	34.95	45.90	2.08	11.40	13.97	20.00
T_3	3.00	10.70	31.14	41.07	1.49	9.80	10.93	18.40
T_4	2.60	11.10	31.73	38.67	1.90	10.00	12.33	19.80
T_5	2.78	11.80	32.90	42.87	1.81	10.40	12.03	18.50
T_6	2.70	11.93	32.02	41.97	1.91	10.10	12.53	19.90
T_7	2.39	10.10	26.74	36.57	1.57	8.30	11.33	18.80
T_8	2.30	9.70	25.27	35.07	1.27	7.80	8.93	16.40
T_9	2.25	9.60	23.81	31.63	1.24	7.30	9.83	17.23
S.Em. ±	0.08	0.37	0.97	1.16	0.04	0.12	0.35	0.69
C.D. at 5 %	0.24	1.10	2.90	3.47	0.11	0.36	1.04	2.08
C.V. %	5.25	5.73	5.53	5.02	3.74	2.18	5.21	6.45

Table 3: Influence of seed priming treatments on fresh weight and dry weight of seedling (g) of custard apple

Treatments	Fresh weight of seedling (g)				Dry weight (g)			
	30 DAS	60 DAS	90 DAS	120 DAS	30 DAS	60 DAS	90 DAS	120 DAS
T_1	0.65	1.80	4.00	6.97	0.12	0.83	2.40	4.18
T_2	0.68	1.88	4.30	7.27	0.13	0.92	2.58	4.36
T_3	0.54	1.44	3.00	6.37	0.08	0.56	1.80	3.82
T_4	0.61	1.54	3.20	6.57	0.09	0.54	1.92	3.94
T_5	0.62	1.56	3.60	6.97	0.10	0.49	2.16	4.18
T_6	0.63	1.61	3.70	7.07	0.10	0.45	2.22	4.24
T_7	0.54	1.34	2.70	6.07	0.08	0.38	1.62	3.64
T_8	0.52	1.30	2.60	5.97	0.07	0.38	1.56	3.58
T_9	0.52	1.25	2.50	5.87	0.07	0.34	1.50	3.52
S.Em. ±	0.01	0.05	0.10	0.22	0.005	0.03	0.06	0.11
C.D. at 5 %	0.02	0.16	0.31	0.66	0.01	0.10	0.18	0.33
C.V. %	1.89	2.80	5.36	5.80	8.81	10.22	5.16	4.82

our country, such as nature farming, ecological agriculture, organic, biodynamic, homa, agnihotra, rishi krishi etc. Under holistic approach of organic like cow dung slurry is being prepared and used. Thus, utilization of organic based substances could be better for improving bio-physical attributes of plant and bio-chemical properties of soil, which may turn increase quality production technology of fruit crops including custard apple.

The results of an experiment of seed priming treatments on germination and seedling vigour of custard apple (*Annona squamosa* L.) cv. Local had beneficial effect.

Seed germination parameters

The data pertaining to germination percentage at 30 DAS were influenced with different seed priming treatments. Soaking the seeds in GA_3@ 200 mgl^{-1} for 12 hours recorded the maximum germination percentage (63.99 %) at 30 DAS as compared to rest of the treatments. GA_3 helped to increase the germination percentage probably due to its effect to bring about a favourable internal condition (breaking of seed dormancy) for maximum germination. These results are in agreement with the findings of Ferreira *et al*. (1998) in custard apple, Ono *et al*. (1995) in Citrumelo, Bertocci *et al*. (1997) in papaya for initial germination, Joshi *et al*. (2010) in Pyracantha, Wani *et al*. (2014) in apple, Agawane and Parhe (2015) in soyabean,. (Table 1)

Seedling growth and development parameters

Seedling length (cm)

Seedling length at 30 DAS were influenced with different seed priming treatments. Soaking the seeds in GA_3@ 200 mgL^{-1} for 12 hours (T_2) recorded the maximum seedling length *i.e.* 5.30 cm at 30 DAS as compared to rest of the treatments. Similarly, at 60, 90 and 120 DAS, treatment T_2 (Soaking the seeds in GA_3 @ 200 mgL^{-1} for 12 hours) recorded significantly the maximum seedling length *i.e.* 23.73, 48.92 and 64.87 cm, respectively as compared to the rest of the treatments. The increase in height of seedling with application of GA_3 treatment might be due to cell division and quick cell elongation (Shanmugavalli, 2007). This result is corroborated with Pawshe *et al*.(1997) in aonla, Patil and Patel (2010) in okra, Gharge *et al*. (2011) in custard apple, , Gurung *et al*. (2014) in passion fruit, Patel and Mankad (2014) in Tithonia, Joshi *et al*. (2010) in Pyracantha. (Table 1)

Shoot length (cm)

At 30, 60, 90 and 120 DAS, shoot length was significantly influenced with seed priming treatments. Soaking the seeds in GA_3 @ 200 mgL^{-1} for 12 hours (T_2) recorded the significantly the maximum shoot length (3.22 cm) at 30 DAS as compared to rest of the treatments. Similarly at 60, 90 and 120 DAS, T_2 (Soaking the seed in GA_3 @ 200 mgL^{-1} for 12 hours) recorded significantly the maximum shoot length i.e. 12.33, 34.95 and 45.90 cm, respectively. GA_3 treated seed gave early and fast germination as result of boosting the growth of seedling by increasing cell multiplication and cell enlargement which ultimately result into shoot length. It is but natural that when

Table 4: Influence of seed priming treatments on stem girth (cm) and relative growth rate (RGR) of custard apple

Treatments	Stem girth (cm)				Relative growth rate (RGR)		
	30 DAS	60 DAS	90 DAS	120 DAS	60 DAS	90 DAS	120 DAS
T_1	0.27	0.37	0.50	0.67	0.023	0.052	0.059
T_2	0.30	0.40	0.53	0.73	0.026	0.055	0.059
T_3	0.20	0.30	0.40	0.57	0.016	0.041	0.067
T_4	0.20	0.30	0.40	0.57	0.015	0.046	0.067
T_5	0.20	0.30	0.40	0.60	0.013	0.046	0.067
T_6	0.30	0.37	0.50	0.67	0.011	0.049	0.067
T_7	0.20	0.30	0.37	0.57	0.010	0.041	0.067
T_8	0.20	0.27	0.33	0.53	0.10	0.039	0.067
T_9	0.20	0.23	0.33	0.50	0.009	0.039	0.067
S.Em. ±	0.01	0.02	0.02	0.02	0.001	0.010	0.010
C.D. at 5 %	0.03	0.06	0.07	0.07	0.003	NS	NS
C.V. %	8.38	11.64	9.20	6.51	11.32	10.41	15.86

Table 5: Influence of seed priming treatments on vigour index-I and vigour index-II of custard apple

Treatments	Vigour index-I		Vigour index-II	
	90 DAS	120 DAS	90 DAS	120 DAS
T_1	1.31	0.94	24.8	14.35
T_2	1.32	0.99	25.0	14.68
T_3	0.93	0.65	21.5	10.12
T_4	1.08	0.80	24.3	11.82
T_5	1.08	0.79	22.2	11.48
T_6	1.14	0.82	22.8	11.95
T_7	0.88	0.60	20.6	9.16
T_8	0.94	0.62	20.5	8.94
T_9	0.85	0.59	18.7	7.95
S.Em. ±	0.03	0.02	0.37	0.31
C.D. at 5 %	0.08	0.07	1.12	0.93
C.V. %	4.24	5.32	4.38	6.64

treatment has boosted the growth of seedling above ground, it might have given the same effect of below ground. *i.e.* in the shoot and root as suggested by Dhaka and Pal (2009) in case of lime with 500 mgL^{-1} GA_3. The results corroborate with the finding of Singh *et al*. (2007) in guava, Nelson *et al*. (2008) on *Bixa*spp. (Table 2)

Root length (cm)

At 30, 60, 90 and 120 DAS, root length was significantly influenced with different seed priming treatments. Soaking the seeds in GA_3 @ 200 mgl^{-1} for 12 hours (T_2) recorded the significantly the maximum root length (2.08 cm) at 30 DAS as compared to rest of the treatments. Similarly at 60, 90 and 120 DAS, treatment T_2 recorded significantly the maximum root length *i.e.* 11.40, 13.97 and 20.00 cm, respectively. GA_3 increases the shoot length by boosting the growth of seedlings above ground, it might have given the same effect of below ground. *i.e.* on root length. This results corroborate with the finding of Singh *et al*. (2007) in guava, Nelson *et al*. (2008) on *Bixa*spp.,Agawane, R. B. and Parhe (2015) in soyabean. (Table 2)

Fresh weight of seedling (g)

An appraisal of data pertaining to fresh weight of seedling at 30, 60, 90 and 120 DAS were significantly influenced with seed priming treatments. Soaking the seeds in GA_3 @ 200 mgL^{-1} for 12 hours (T_2) recorded the significantly the maximum fresh weight of seedling (0.68 g) at 30 DAS as compared to rest of the treatments. Similarly at 60, 90 and 120 DAS, treatment T_2 also recorded significantly the maximum fresh weight of seedling *i.e.* 1.88, 4.30 and 7.27 g. GA_3 increase in fresh weight of seedling by mobilizing the water and nutrient transport at higher rate from rooting medium during the period of cell elongation which might have promote more production of photosynthetic product and translocated them to various plant parts which might have resulted in better growth of the seedling. The present findings is also comfirmation with Anburani and Shakila (2010) in papaya. (Table 3)

Dry weight of seedling (g)

An appraisal of data pertaining to dry weight of seedling at 30, 60, 90 and 120 DAS were significantly influenced with seed priming treatments. Soaking the seeds in GA_3 @ 200 mgL^{-1} for 12 hours (T_2) recorded the significantly the maximum dry weight of seedling (0.13 g) at 30 DAS as compared to rest of the treatments. Similarly at 60, 90 and 120 DAS, treatment T_2 recorded significantly the maximum dry weight of seedling *i.e.* 0.92, 2.58 and 4.36 g, respectively as compared to the rest of the treatments. The dry weight increased due to more fresh weight of seedlings. Gibberellic acid initiate quick germination, increased fresh weight of seedling due to more seedling height and number of leaves and more accumulation of dry matter which resulted in increase in dry weight. These findings are in agreement with the results obtained by Lay *et. al*. (2015) in papaya, Saxena *et al*. (1987), Choudhary and Chakarwar (1982) in Rangpur lime and Singh *et al*. (1989) in sweet orange.(Table 3)

Stem girth (cm)

At 30, 60, 90 and 120 DAS, data pertaining to stem girth were significantly influenced with seed priming treatments. Soaking the seeds in GA_3 @ 200 mgL^{-1} for 12 hours (T_2) recorded the significantly the maximum stem girth (0.30 cm) at 30 DAS as compared to rest of the treatments. Similarly at 60, 90 and 120 DAS, treatment T_2 recorded significantly the maximum stem girth *i.e.* 0.40, 0.53 and 0.73 cm, respectively. GA_3 increased girth of stem which might be due to stimulation of cambium and its immediate cell progeny by the process of enhancing the rate of cell multiplication. The rate increase in the dimension of the cell both in pith and cortex region is faster than number of cells per unit area. This type of result was also observed by Agha *et al*. (1990) in sour orange and citrange and Vijaykumar *et al*. (1991) in guava.(Table 4)

Relative growth rate (g/day) and root: shoot ratio (dry weight basis)

Relative growth rate (RGR) at 60, 90 and 120 DAS, and root : shoot ratio (dry weight basis) were influenced with seed priming treatments. Soaking the seeds in GA_3 @ 200 mgL^{-1} for 12 hours (T_2) recorded the significantly the maximum relative growth rate *i.e.* 0.026 g/day at 60 DAS while root : shoot ratio (dry weight basis) was found to be non-significant. At 90 and 120 DAS, different seed priming treatments recorded non-significant differences with respect to relative growth rate. The more relative growth rate might be due to restorer of apical dominance which promotes root initiation, more nutrient uptake and cell elongation reported by Shanmugavelu (1970).The increase in relative growth rate with the application of GA_3 treatment might be due to cell division and quick cell elongation which resulted into more relative growth of seedling (Shanmugavalli, 2007), Pawshe *et al*. (1997) in aonla. (Table 4)

Vigour index- I and Vigour index- II

Vigourindex- I and II at 90 DAS were influenced with seed priming treatments. Soaking the seeds in GA_3 @ 200 mgL^{-1} for 12 hours (T_2) recorded the significantly the maximum vigour index-I and II *i.e.*1.32 and 25.00, respectively at 90 DAS. Similar result was also found at 120 DAS for vigour index–I and II *i.e.* 0.99 and 14.68 with treatment T_2, respectively as compared to rest of the treatments. Gibberellic acid initiate quick germination, increased seedling length and fresh weight of seedling due to more seedling height and number of leaves and more accumulation of dry matter which resulted in increase in vigour index. These findings are in agreement with the results obtained by Lay *et al*. (2015) in papaya, Gurung *et al*., in passion fruit (2014)and Patel and Mankad (2014) in Tithonia, Joshi *et al*. (2010) in Pyracantha (Table 5).

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