Original Research Article

PRIMING METHODS: ALTERNATIVE STRATEGY TO IMPROVE SEED AND SEEDLING PERFORMANCE OF SOURSOP (*Annona muricata*)

ABSTRACT

The evaluation of seed priming methods on the seed and seedling performance of soursop was conducted January 9 to April 3, 2019 in San Nicolas, Ilocos Norte, Philippines. The study was conducted to investigate the effect of seed priming methods if capable of breaking dormancy; improve germination rate; determine the seed vigor of soursop; and identify the best seed priming method that provide better seedling performance. The experimental treatments (unprimed and three priming methods, hydropriming, halopriming and hormonal priming) were laid out in Completely Randomized Design with three replications. A total of 20 polyethylene bags were used per treatment per replication with one seed sown in every bag.

Alternative way to improve seed and seedling performance is the use of these seed priming methods. The seed and seedling performance of soursop were significantly affected by priming methods. Primed seeds had higher percentage germination rate (PGR) than unprimed seeds. Butt numerically, the highest PGR was hydropriming. Hydropriming Hormonal priming produced significantly produced taller seedlings at 10 and 40 DAE than unprimed seeds and . Likewise, this also produced more number of leaves per seedling at 30 to 50 DAE. Hormonal, hydropriming and halopriming produced significantly higher fresh weight of seedlings than unprimed seeds.

Keywords: hydropriming, halopriming, hormonal priming, seed treatment

1. INTRODUCTION

Soursop *(Annona muricata)* is one fruit crop being propagated in the Philippines particularly in Ilocos Norte. Its fruit is a good sources of essential minerals and nutrients which are beneficial to human health. The crop is commonly propagated through sexual propagation by seed due to its easy procedure. However, the seeds have hard and thick seed coats which restrict the entry of moisture which thus delays the delaying germination and resulted to resulting in uneven maturity (please cite literature here to support statement) [1,2]. Because of this situation, mass propagation is done through vegetative method, which has a shorter waiting time to flower. Still, not all growers have the available and capable capacity to access materials and tools to perform vegetative propagation which entails additional cost on their part Hhence, sexual seed propagation is still economical for them. An alternative way to better improve more the seed and seedling performance of a crop is the utilization of seed priming methods. This is used to break seed dormancy and thus enhance the germination. Among the methods are hydropriming (soaking in water), halopriming (soaking in salt solution) and hormonal priming (soaking in gibberelic acid solution). These methods hydrate the seeds that and reduce seedling emergence time (Nawaz *et al*., 2013) [3] and the procedure is easy to perform.

The following are the effects of seed priming methods: allows some of the metabolic processes necessary for germination to occur without germination taking place; increase germination rate; uniform seedling emergence; enhance crop enzyme rate resulted to increase ration of crop development; and faster and better seedling development (please cite literature here to support these statements) [4;5]. Moreover, those seeds that are different solutions with high osmotic potential prevent the seeds from absorbing in enough water for radicle protrusion which will suspend the seeds in the lag phase (Kaur *et al.,* 2015; Nawaz *et al*., 2013). Since there is faster and better seedling performance, this results to

reduce time between seed sowing and seedling emergence and to synchronize emergence (Parera and Cantliffe, 2010). The faster and better seedling performance is a result of reduced time between seed sowing and seedling emergence and to synchronized emergence (Parera and Cantliffe, 2010).

In order to extend help to the growers, avoid the delay in the germination of the seeds and longer germination period, hence, this experiment was done conducted to improve the performance of soursop at seedling stage. Generally, it aimed to and evaluate the seedling performance of soursop using three seed priming methods.

Specifically, this study aimed to:

1. determine if the seed priming methods are capable of breaking dormancy;
2. determine the seed vigor of soursop; and to
3. identify the best seed priming method that provides better the best seedling performance.

The results of the study were will provided by further information on how to improve the seedling performance of soursop which could help the interested growers. Another advantage is that, If Sseed priming methods shortened the waiting time of to germination and then transplanting will can be done immediately. much earlier

2. MATERIALS AND METHODS

The study was conducted in a partially shaded area in Barangay 14 San Gregorio, San Nicolas, Ilocos Norte in the Philippines. The area is shaded due to trees of sugar apple or sweetsop (*Annona squamosa)*, horse radish (*Armoracia rusticana)* and mango (*Mangifera indica*).

Ripe soursop fruits were bought from the public market of Laoag City, Ilocos Norte. The seeds were freshly removed from the ripe fruits. Extracted seeds were soaked in water for a minute to see if they float or not. All floating seeds which are immature one were discarded. The seeds were stored in a refrigerator to avoid rapid drying of the seeds.

Seeds were scarified by removing a small portion of the seed coat using a nail cutter before they are were sown. All the seeds were soaked in separate treatments such as hydropriming (water), halopriming (salt solution) and hormonal priming (GA_3) for 24 hours. For GA_3, the concentration used was 500 ppm (Singh and Maheswari, 2017). For hydropriming method, tap water was used to soak the seeds. Four teaspoons or 19.7 grams of salt was dissolved in 500ml of water for the salt solution priming method. Untreated seeds served as the control. All treatments were replicated --- times.

Equal parts of garden soil, carbonized rice hull, and organic fertilizer were placed in polyethylene bag (2x6 inches size) used to grow the soursop seeds. One seed was sown for every polyethylene bag (2x6 inches size) at 2-3 cm depth and irrigation was followed after sowing. A total of 20 polyethylene bags were used per treatment per replication giving an overall total of 240bags?

Complete fertilizer (5 g per bag) was dissolved in a liter of water and applied through fertigation after germination and at 21 days after germination (Pinto and Silva, 1994). Irrigation was done after fertilizer application. Follow-up irrigation was done depending on the soil and weather conditions.

All data (please itemize ALL the data collected here and also explain how seed vigor index is computed. Measuring root length must have involved some destructive sampling; please indicate this also. In addition state when fresh wt and oven dry wt were taken) gathered was analyzed using analysis of variance of in a Completely Randomized Design. Where F-test showed was significant results at 5%(P=.05) or 1% (P = .01), treatment mean difference was further tested using Least Significant Difference (LSD) test at (P=.05?). Statistical analysis was done using STAR program.

3. RESULTS AND DISCUSSION

3.1 Percent Germination Rate

Seed priming methods significantly (P = .01) affected the percent germination rate (PGR) at 10 days after emergence (DAE). Table 1 shows that primed seeds had higher PGR irrespective of priming methods than unprimed seeds. According to Nawaz *et al.,* (2013) priming improves germination. There was no significant difference between priming methods but numerically, hydropriming (52%) had the highest PGR among the priming methods. Moreover, the although germination rate was increased from 20 to 50DAE even though there are were no significant differences between primed and unprimed seeds. from 20 to 50 DAE. According to Nawaz *et al.,* (2013) priming improves germination. Percent germination is was increased and shortens shortened the seed germination period in Judas tree (*Cercis siliquastrum)* with the use of halopriming (Haroni *et al*., 2015). Furthermore, hydropriming improved improve seed germination and enhanced seedling emergence of soursop (Okoli *et al.,* 2013). However, numerically, hydropriming had the highest PGR with 10% difference from halopriming and hormonal priming. In the case of chickpea (*Cicer arietinum),* percent emergence is distributed through water absorption process and the alpha amylase enzyme activity is inhibited due to osmotic pressure (Shariatmadari *et al.,* 2017). According to El-Barghathi and El-Bakosh (2005) the external application of GA_3 enhances the seed germination of Kemes oaks (*Quercus coccifera*). Same Similar results were reported by with Gonzalez *et al*. (2005) and Singh and Maheswari (2017). Singh and Maheswari (2017) and Gonzalez *et al*. (2005) that seeds soaked in 500 ppm GA_3 had best and highest seed germination of soursop. Moreover, seeds of tomato soaked in 900 mg L^{-1} GA_3 gave high percentage germination (Balaguera-Lopez *et al.,* 2009). But based on Also the experiment of Armin *et al.* (2010) on watermelon, KNO_3 increased germination and germination rate.

Table 1. Effect of seed priming methods on percent germination rate of soursop at different observation periods.

TREATMENT	10DAE**	20DAE^{ns}	30DAE^{ns}	40DAE^{ns}	50DAE^{ns}
	**	ns	ns	ns	ns
Unprimed	22^{b}	65	67	75	78
Hydropriming (water)	52^{a}	72	75	77	80
Halopriming (salt solution)	42^{a}	67	75	88	88
Hormonal priming (GA_3)	42^{a}	70	73	80	80
CV (%)	22.42	9.45	9.55	11.55	9.52

CV – coefficient of variance
** - significant at 1% level
ns – not signfiicant

3.2 Days to Emergence and Seed Vigor Index

There was no significant difference (P = .01) in effect of between primed and unprimed seeds on the days to emergence and seed vigor index of soursop was comparable with each other (Table 2). Numerically, earliest seed emergence was observed from hormonal priming while unprimed seeds were the latest emerged last

Table 2. Effects of seed priming methods on days to emergence and seed vigor index of soursop.

TREATMENT	DAYS TO EMERGENCE^{ns}	SEED VIGOR INDEX^{ns}
	ns	ns
Unprimed	32	2
Hydropriming (water)	30	3
Halopriming (salt solution)	30	3
Hormonal priming (GA_3)	29	2
CV (%)	4.45	9.97

CV – coefficient of variance
ns – not significant

3.3 Plant Height

Plant height at 10 and 40DAE was significantly (P = .01) and P = .05) affected by priming methods At 10DAE plant height was highly significantly affected (P = .01) by priming methods while at 40DAE, plant height was significantly (P = .05) affected by priming methods (Table 3). AT 10DAE, primed seeds primed with the use of hormonal priming hormone (GA_3) produced highly significantly taller (P = .01) produced taller seedlings than the other methods and unprimed seeds. The plant height of hydropriming and halopriming were comparable with unprimed seed. Heights of plants from hydroprimed and haloprimed seeds did not differ significantly from those of unprimed seeds

At 40DAE, hormonal and halopriming priming methods seeds had the significantly tallest taller (P = .05) seedlings than the unprimed seeds. But the former had comparable plant height with halopriming. Same observation is noted with Prasad *et al.* (2002) noted that gladioli are taller with the use of hormonal priming. This means that if the seedlings are taller, it could be transplanted early in the field.

Table 3. Effect of seed priming methods on plant height (cm) of soursop at different observation periods.

TREATMENT	10 DAE**	20 DAE^{ns}	30 DAE^{ns}	40 DAE*	50 DAE^{ns}
	**	ns	ns	*	ns
Unprimed	6.60^{b}	10.13	11.46	12.14^{b}	16.18

Hydropriming (water)	5.48[b]	10.15	11.99	12.87[b]	15.95
Halopriming (salt solution)	6.52[b]	11.43	12.43	13.88[al]	14.18
Hormonal priming (GA_3)	8.98[a]	12.89	13.85	15.48[a]	15.28
CV (%)	11.92	10.66	7.69	8.03	8.88

CV – coefficient of variance
* - significant at 5% level
** - significant at 1% level
* - significant at 5% level
ns – not significant

3.4 Number of Leaves per Seedling

The number of leaves per seedling at 30 (P = .01) and 50 DAE (P = .05) was significantly higher by the use of priming methods than unprimed (Table 4). Generally, hormonal priming consistently produced higher number of leaves per seedling at 30 and 50 DAE than the other priming methods. According to Prasad *et al.* (2002), hormonal priming (250 ppm GA_3) increased the number of leaves in gladioli. If there is high number of leaves, there will be higher photosynthetic activity which will have a result in faster growth and development.

Table 4. Effect of seed priming methods on number of leaves per seedling of soursop at different observation periods.

TREATMENT	20 DAE[ns]	30 DAE[**]	40 DAE[ns]	50 DAE[*]
	ns	**	ns	*
Unprimed	2	3[b]	4	6[b]
Hydropriming (water)	3	3[b]	5	6[b]
Halopriming (salt solution)	3	4[b]	5	7[ab]
Hormonal priming (GA_3)	4	6[a]	6	8[a]
CV (%)	20.38	20.41	17.04	9.33

CV – coefficient of variance
* - significant at 5% level
** - significant at 1% level
* - significant at 5% level
ns – not significant

3.5 Leaf Length

Primed and unprimed seeds had comparable leaf length at different observation periods There was no significant difference in length of leaves produced by primed and unprimed seeds over the period (Table 5) though Numerically, hormonal priming was

consistently had the longest leaf length. Leaf length of gladioli is increased with the use of 500 ppm GA_3, hormonal priming (Prasad *et al.,* 2002).

Please place Table 5 here

3.6 Shoot Length and Root Length

Priming methods were not significantly affected the shoot and root length of soursop Priming methods did not significantly affect the shoot and root length of soursop seedlings (Table 6). According to However Matsushima and Sakagami (2013) found that the shoot length of rice increased using hydropriming due to rapid supply of nutrient required for cell growth. Balaguera-Lopez *et al.,* 2009, also reported that Moreover, seeds of tomato soaked in 900 mg L^{-1} GA_3 gave high root length (Balaguera-Lopez *et al.,* 2009).

Please place Table 6 here

Table 5. Effect of seed priming methods on leaf length (cm) of soursop at different observation periods.

TREATMENT	20 DAE^{ns}	30 DAE^{ns}	40 DAE^{ns}	50 DAE^{ns}
	ns	ns	ns	ns
Unprimed	2.98	3.60	3.99	4.62
Hydropriming (water)	2.93	4.04	4.35	5.32
Halopriming (salt solution)	3.84	4.15	4.65	5.24
Hormonal priming (GA_3)	4.62	6.14	4.95	5.69
CV(%)	22.29	28.37	12.32	8.87

CV – coefficient of variance
ns – not significant

Table 6. Effect of seed priming methods on shoot length and root length of soursop.

TREATMENT	SHOOT LENGTH^{ns} (cm)	ROOT LENGTH^{ns} (cm)
	ns	ns
Unprimed	12.67	11.83
Hydropriming (water)	12.70	12.73
Halopriming (salt solution)	12.63	12.43
Hormonal priming (GA_3)	11.60	12.73
CV(%)	5.39	10.81

CV – coefficient of variance
ns – not significant

3.7. Seedling Length

Seeds either primed or unprimed had comparable seedling length (Table 7). Numerically, hormonal priming had the lowest seedling length and seedling vigor index. KNO_3 has the most effective impact on the seedling growth compared with unprimed, PEG 6000 3%, HCL 0.1N, and NaCl 1.5N (Armin *et al., 2010*).

Table 7. Effect of seed priming methods on seedling length (cm) of soursop.

TREATMENT	SEEDLING LENGTH (cm)
	ns
Unprimed	25
Hydropriming (water)	25
Halopriming (salt solution)	25
Hormonal priming (GA_3)	24
CV(%)	5.85

CV – coefficient of variance

3.8 Fresh Weight and Oven Dry Weight

Priming methods had significant (P = .05) influence on the seedling fresh weight but not for on dry weight compared to unprimed seeds (Table 8). Primed seeds produced significantly higher seedling fresh weight than unprimed seeds. Among priming methods, hormonal priming had the highest seedling fresh weight. but comparable with halopriming method. High fresh weight of hormonal priming has means higher biomass than the other treatments.

Table 8. Effect of seed priming methods on fresh weight and oven dry weight of soursop.

TREATMENT	FRESH WEIGHT (g)	OVEN DRY WEIGHT(g)
	*	ns
Unprimed	3^{b}	1
Hydropriming (water)	4^{b}	1
Halopriming (salt solution)	4^{ab}	1
Hormonal priming (GA_3)	5^{a}	1
CV(%)	15.64	19.92

CV – coefficient of variance
* - significant at 5% level

4. CONCLUSION

It can be concluded that priming methods significantly affected the seed and seedling performance of soursop. The seeds of soursop were able to break the

dormancy either unprimed or primed but it took taking 29 to 30 32days to emerge. The One advantage was that primed seeds produced significantly produced higher percent germination rate than unprimed seeds by 10days after emergence. But among the priming methods, especially with hydropriming had the highest numerically. Both primed and unprimed seeds had the same seed vigor index. However hormonal priming had the best effective impact due to significant influence and because it consistently produced taller seedlings, more number of leaves per seedling, and comparable seedling fresh weight with halopriming other priming methods.

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