



EFFECT OF SEED PRE-SOWING TREATMENT ON GERMINATION OF SWEET POTATO

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Abstract

Sweet potato is an herbaceous, perennial plant belonging to the Convolvulaceae family with a critical role in the global food system, particularly in the developing world, where they rank among the top 10 food crops. Germination of sweet potato seeds is difficult due to thick, very hard and impermeable testa. In order to study the germination rate, seeds were exposed to different treatments such as effect of gibberellic acid, water and acid treatment along with control. The seeds were soaked in water for 24 hrs, 48 hrs, different concentration of GA₃ (50, 100 and 250 ppm) at different time intervals (10, 30, 60 minutes) and acid scarification (sulphuric acid) of seeds for 5, 10 and 15 minutes. All the 15 treatments along with the control were kept for germination in moist petriplate in dark and allowed to germinate. The rate of seed germination was recorded every day and after 5 days maximum seed germination was observed in acid treatment 75-80 % followed by 50 ppm GA₃ for 30 and 10 minutes. From the result it was concluded that the acid treated seeds showed maximum seed germination when compared to other treatments.

Keywords: Germination, gibberellic acid, water treatment, acid treatment

I. INTRODUCTION

Sweet potato (*Ipomoea batatas*) is a hexaploid ($2n = 6x = 90$) dicot, belongs to the family Convolvulaceae. The largest production of sweet potato includes Asia, the producing region and China accounts 76% of world production. In Africa, Uganda is the largest producer and the third-largest grower worldwide (Department of Agriculture and Rural Development, 2011). In India, sweet potato is harvested on an estimated area of 0.1 M Ha with a yield of 0.1 M Hg/Ha and a production of 1 MT [7].

Due to its high yielding potential and flexibility under a wide range of environmental conditions, sweet potato is one of the world's important food crops, grown in the tropics, sub-tropics and warm temperate regions for its edible storage roots. The heterozygous nature of sweet potato clones and the out crossing breeding system allow a wide range of genetic recombinants with natural seed setting. Because of high heterozygosity, the characteristics of seedlings developed from hybridization differ from each other. There are marked variation in leaf shape, skin and flesh colour, tuber shape and other characteristics. A number of superior hybrids had been developed and released for cultivation in different countries by combining the desirable characteristics of two or more selected parents. Incompatibility in sweet potato is sporophytic, and it is the main hindrance to seed production [15, 16].

The fruit of sweet potato is spherical enclosed in a capsule with a terminal tip, and can be pubescent or glabrous measuring 5-10 mm in diameter. Each capsule contains one to four seeds that are slightly flattened. Seeds are black in colour and have a diameter of about 3 mm. However, hand pollinated flowers usually produce capsules with two seeds and open-pollinated produces capsules containing one to three seeds. Large sized seeds germinate more rapidly than smaller ones. Small seeds often symbolize up to 50 per cent of the total number of seeds obtained, depending on the

genotypes involved. If the seeds are exposed to favourable conditions for germination, the embryo develops rapidly. After germination process, the radicle looks first and grows downward, evolving into the primary root system. From the dried fruits, seeds were collected. Since the seed coat is very hard, it interferes the germination of seeds and needs scarification by chemical treatment or mechanical abrasion.

Gibberellic acid (GA_3) is a hormone that stimulates germination in several plants and proposed to control primary dormancy by inducing germination. Germination starts with the uptake of water by the seed-imbibition process and is finished when a part of the embryo, usually the radicle, extends to enter the structures that surround it. Since GA_3 has been shown to be a key factor in monitoring seed dormancy and germination in many plant species together with potatoes [34, 2, 31, 12, 24, 5], GA_3 is frequently used to break seed dormancy and to increase seed germination in many plant species [3, 36, 23, 6, 11, 37].

Immersion in Conc. sulphuric acid (H_2SO_4) has been effectively used as a means of scarifying impervious seeds [30]. Hence, the aim of this experiment was to govern the effect of various concentrations of GA_3 , Conc. sulphuric acid scarification and water soaking treatment on germinability of sweet potato seeds. This present study was carried out to associate the effects of some suggested seed pre-sowing treatments on germination of sweet potato.

II. MATERIALS AND METHODS

A) Seed Collection

1125 open pollinated seeds were collected from the polycross nursery of sweet potato field from ICAR-Central Tuber Crops Research Institute (CTCRI), Thiruvananthapuram, Kerala, India.

B) Viability test

For the viability test the collected seeds were carried out using floating method. The separation of viable seeds from those that may be immature or non-viable, is easily made by putting the seeds into a glass or plastic container with water. The solution is then stirred in a circular way producing a whirlpool to sub-merge all seeds. After some time, all the floating seeds were discarded from the solution. The seeds that stay at the bottom are then dispensed into a plastic mesh and placed on a paper towel to dry. Only the well-shaped and matured seeds were stored (CIP).

C) Germination experiments

The treatment includes control (untreated seeds), soaking the seeds in water for 1 day, 2 day, in different concentration of GA_3 (50 ppm, 100 ppm and 250 ppm) at different time intervals (10, 30, 60 minutes) and acid scarified seeds for 5, 10 and 15 minutes.

Table 1. Different pretreatments on seed germination

Treatment	Abbreviation	Germination percentage
Control	T1	00
1 day water soaking (24 hrs)	T2	28
2 day water soaking (48 hrs)	T3	16
Acid treatment for 5 min	T4	24
Acid treatment for 10 min	T5	72
Acid treatment for 15 min	T6	60
GA_3 treatment at 50 ppm for 10 min	T7	28
GA_3 treatment at 50 ppm for 30 min	T8	32
GA_3 treatment at 50 ppm for 60 min	T9	28
GA_3 treatment at 100 ppm for 10 min	T10	24
GA_3 treatment at 100 ppm for 30 min	T11	16
GA_3 treatment at 100 ppm for 60 min	T12	08
GA_3 treatment at 250 ppm for 10 min	T13	12
GA_3 treatment at 250 ppm for 30 min	T14	12
GA_3 treatment at 250 ppm for 60 min	T15	08

Germination experiments were tested using three replications of 25 seeds per each treatment. All the treated seeds and the control were kept for germination in moist petri plate in dark and allowed to germinate. Recorded for the radicle formation and noted the number of seeds germinated for each treatment. Germinated seeds were counted every day and the rotted seeds were removed. A seed was considered germinated when the tip of the radicle had grown free of the seed coat. Then the germinated seeds were sown in the field and the growth of the seeds was recorded. For each experiment, a batch of untreated seeds was used as control (Table 1).

D) Germination treatments

1. Control

Untreated seeds were used as control for the experiment. The seeds were placed in moist petri plates and sown in raised bed for germination.

2. Effect of Water Treatment

Seeds were soaked in running water for one day (24 hrs) and two days (72 hrs) and then transferred to the germination test process.

3. Effect of GA₃

Seeds were kept in different concentration of GA₃ (50 ppm, 100 ppm and 250 ppm) at different time intervals (10, 30, 60 minutes) and transferred to the germination test process.

4. Effect of Acid Treatment

4.1 Acid scarification- chemical treatment

It includes scarification of seeds in concentrated sulphuric acid until the acid starts turning dark (5-10 minutes) and filtered with plastic mesh and rinse in running tap water 2-3 times. After scarification, around 25 seeds were placed on a petridish containing moist filter paper and the plates were kept in a dark room. Then the plates were evaluated for every 7 days for 3 weeks and registered the germination date for each accession.

E) Germination Parameter

Germination percentage (GP) - the number of germinated seeds as a percentage of the total number of tested seeds given as Germination percentage was calculated as [(the number of germinated seeds)/the number of sampled seeds] ×100%.

F) Statistical analysis

The germination results were arc sine transformed and statistically analyzed by a one-way analysis of variance (ANOVA) using SAS system version 9 [27]. The data were analyzed using a randomized complete design and LSD test was used to determine if there were significant ($p < 0.05$) differences among treatment means. Box plot diagram was drawn using the package R- environment for statistics [25].

III. RESULT AND DISCUSSION

Seed dormancy occurs in many plant species to varying degrees [21]. Various pre-treatment methods have been promoted to reduce dormancy and to accelerate germination in most of the species and the studies were published. In order to study and enhance the seed germination of sweet potato seeds certain pre-treatments were conducted.

Seed Germination

Seed germination was observed in all treatments and from the observed results, it was found that GA₃ treated seeds enhanced the length of shoot formation than the normally treated seeds. The acid treatment gave highest germination percentage within shortest time interval specifies that the more quickly the seed coat is ruptured, the faster the rate of germination. The cause of seed dormancy is the presence of hard seed coat which prevents the entrance of water, exchange of gases and mechanically constrained the embryo [17]. From the above experiment, it was concluded that acid scarification for 10 minutes increased the percentage of germination (75-80%) compared to control (0%) (Table 1, Fig. 1, Fig. 2).

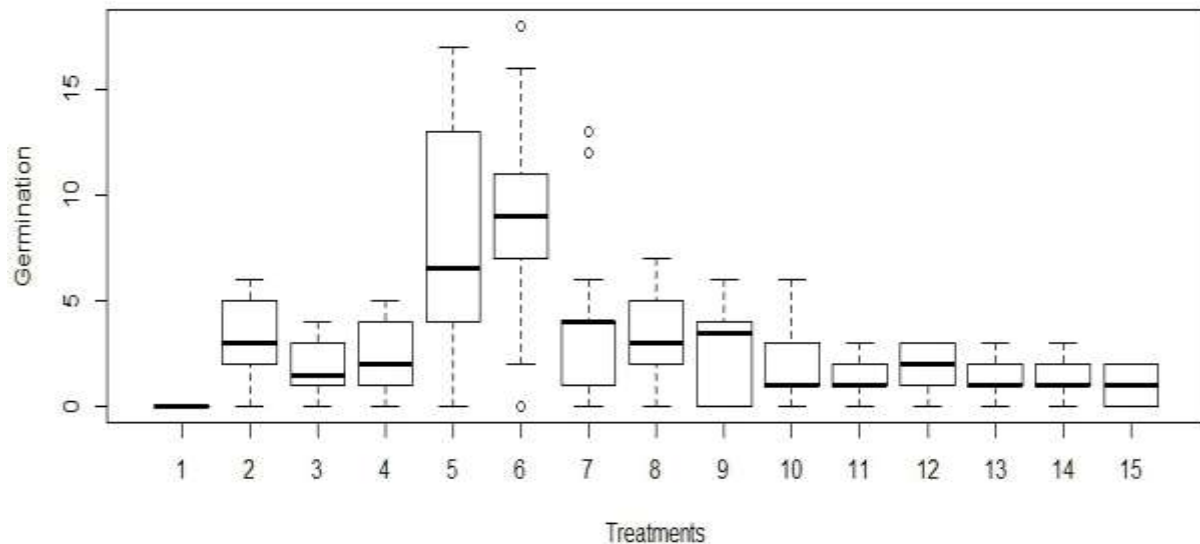


Figure. 1. Effect of different treatments on germination of seeds



Figure. 2. Sweet potato seeds

Effect of different Soaking Period in Water Treatment

When compared to control, the effect of water treatment on the seeds of sweet potato could be described as adverse. The germination percentage of 28% was recorded for the seeds soaked in water for 24 h (T2). Seeds subjected to 48 h (T3) water treatment gave a very low germination of 16%.

The effect of water treatment on seed germination was evident from the studies of kleingrass [32] and weeping lovegrass [33] respectively. The previous studies showed that soaking seed in water had little effect on germination which clearly supports the present study. It was also found that germination decreases when seeds were allowed in water for more than 2 days, suggesting that embryo may get destroyed on contact with water for a prolonged period [20].

Effect of GA₃ Treatment on germination

Application of gibberellic acid on seeds affects the germination response. The role of gibberellic acids in promoting germination is highly variable among taxa [14]. A significant improvement of seed germination within a range of 27-47% with 50 ppm, 23-31% with 100 ppm and 16-28 % with 250 ppm concentration was observed for GA₃ treated seeds over untreated seeds (Table 2). From the result obtained, it was found that the seed started germinating from the 2nd day itself for all the GA₃ treatments and obtained highest germination percentage of (47%) at the 10th day (T7). Among all the GA₃ treatments, concentration of 50 ppm for 30 min had the highest germination (32%) and at the concentration of 250 ppm GA₃ induced germination significantly than other GA₃ treatments (Table 2, Fig. 3). Similar results were obtained from studies carried out on other species, such as *Ferula gummosa* [18], *Sesamum indicum* [10], *Rumex dentatus* [1].

Table 2. Effect of seed pretreatment on mean germination percentage

Treatment Name	Mean Germination Percentage					
	Day2	Day3	Day4	Day5	Day6	Day10
Control	-0.00	-0.00 ^e	0.00 ^f	0.00 ^e	0.00 ^e	0.00 ^d
1 day water soaking (24 hrs)	0.29	0.29 ^{bcd}	0.42 ^{cd}	0.33 ^b	0.37 ^{cd}	0.27 ^{bc}
2 day water soaking (48 hrs)	0.25	0.25 ^{bcd}	0.25 ^{de}	0.23 ^{bcd}	0.35 ^{cd}	0.30 ^{bc}
Acid treatment for 5 min	0.19	0.30 ^{bcd}	0.34 ^{cde}	0.33 ^b	0.30 ^{cd}	0.36 ^{bc}
Acid treatment for 10 min	0.36	0.70 ^a	0.93 ^a	0.60 ^a	0.66 ^{ab}	0.68 ^a
Acid treatment for 15 min	0.44	0.49 ^{ab}	0.69 ^b	0.54 ^a	0.69 ^a	0.70 ^a
GA ₃ treatment (50 ppm for 10 min)	0.39	0.41 ^{bc}	0.46 ^c	0.12 ^{cde}	0.46 ^{bc}	0.47 ^{ab}
GA ₃ treatment (50 ppm for 30 min)	0.37	0.37 ^{bcd}	0.48 ^c	0.28 ^{bc}	0.40 ^{cd}	0.40 ^{bc}
GA ₃ treatment (50 ppm for 60 min)	0.22	0.29 ^{bcd}	0.37 ^{cde}	0.21 ^{bcd}	0.27 ^{cd}	0.27 ^{bc}
GA ₃ treatment (100 ppm for 10 min)	0.25	0.25 ^{bcd}	0.33 ^{cde}	0.13 ^{cde}	0.32 ^{cd}	0.25 ^{bcd}
GA ₃ treatment (100 ppm for 30 min)	0.19	0.26 ^{bcd}	0.33 ^{cde}	0.07 ^{de}	0.23 ^d	0.23 ^{bcd}
GA ₃ treatment (100 ppm for 60 min)	0.25	0.25 ^{bcd}	0.23 ^e	0.26 ^{bc}	0.33 ^{cd}	0.31 ^{bc}
GA ₃ treatment (250 ppm for 10 min)	0.13	0.13 ^{de}	0.23 ^e	0.16 ^{bcd}	0.28 ^{cd}	0.28 ^{bc}
GA ₃ treatment (250 ppm for 30 min)	0.13	0.13 ^{de}	0.26 ^{de}	0.16 ^{bcd}	0.28 ^{cd}	0.28 ^{bc}
GA ₃ treatment (250 ppm for 60 min)	0.16	0.16 ^{cde}	0.26 ^{de}	0.07 ^{de}	0.23 ^d	0.16 ^{cd}
General mean	0.24	0.29	0.37	0.23	0.34	0.33
p-value	0.1443	0.0034	<.0001	<.0001	0.0002	0.0013
CV (%)	65.76	55.01	28.44	43.48	38.29	48.19
SE(d)	0.130	0.129	0.087	0.083	0.108	0.131
LSD at 5%	NS	0.2638	0.1773	0.169	0.2209	0.2675

Means with atleast one letter common are not statistically significant using Fisher's Least Significant Difference



Figure. 3. Germination of acid treated seeds in petri plate

Effect of Acid Treatment on germination

Seed dormancy resulting from an impermeable seed coat may be overcome by peeling off the coat [20]. Treatment with conc. acid was effective in breaking the seed coat and acid scarification is known to be highly effective in improving germination of species with hard seed coats [4, 35]. Some researchers that have been done on Caspian locust, Honey locust [28] and other species of leguminous like as *Albizia julibrissin* [19] emphasis the effect of sulphuric acid. Under the acid treatment, germination percentage was enhanced with treatment time. Except for the 15 min acid treatment the commencement of germination when compared to control, water and GA₃ treatments, was not influenced by the treatment time or the concentration level. Seeds soaked in concentrated acid for 10 min gave the highest germination of 72% (T5) followed by 15 min (T6) treatment (60%). No germination was observed in control seeds for the same period of the experiment.

Sulphuric acid is thought to disrupt the seed coat and expose the lumens of the macrosclereids cells, permitting imbibition of water [20] which triggers germination. Seed treatment with conc. sulphuric acid upto 30 minutes increased germination percentage to some extent was reported by [29, 22, 26]. However, the soaking duration in sulphuric acid varied in different plant species. After scarification the seed coat get softened and the process of hydrolysis started to release simple sugars that could be readily utilized in protein synthesis, which enhanced the seed germination [8, 9].

Immersion of seeds in highest conc. sulphuric acid for longer time (more than 30 min) disrupts the seed coat [13]. The fact that seeds treated with Conc. acid for 10 minutes gave the highest percentage of germination and within the shortest period as compared to 5 and 15 minutes respectively, indicate that the more rapidly the seed coat is ruptured the faster the rate of germination, however, prolonged emersion may be injurious to the seeds as the acid may rapture vital parts of the embryo.



Figure. 4. Seedlings in the nursery

IV. CONCLUSION

Based on the results, it was concluded that scarification with conc. sulphuric acid have very much effect on seed germination but varies with time period taken for treatment. So optimization of acid treatment is important and was found seed treated with conc. sulphuric acid for 10 min (T3) has obtained maximum seed germination which was followed GA₃ treatment for 30 min (T8).

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