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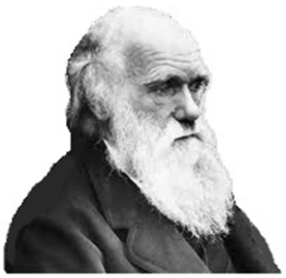

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Effect of Pre-chilling and Storage Temperature on Seed Germination of *Solanum macrocarpon* L. (African Eggplant)

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ABSTRACT

This study examined the effects of storage temperature and pre-chilling on the germination of the seeds of *Solanum macrocarpon* – which according to literature has a seed viability of 63.33%. In our study, the seeds were sown in dry Petri dishes and placed in the refrigerator set at 4 °C for 1, 3, 5, 7 and 10 days. Another set of seeds was placed in incubators set at 25, 35 and 45 °C for 40 days before the germination experiment was carried out on a laboratory workbench. Results from the study revealed that while storage temperature had a significant effect on that the germination of seeds of this plant, pre-chilling of seeds and incubator treatments generally reduced seed germination. Thus seed germination in this plant is temperature dependent.

***Keywords*:** Germination, Pre-chilling, Seeds, *Solanum macrocarpon*, Temperature

1. INTRODUCTION

Solanum macrocarpon L. commonly known as African eggplant or Gboma and "Igbagba" among the Yoruba ethnic group of Southwestern Nigeria is an erect herbaceous perennial herb. It grows up to about 1-1.5m tall. It is thought to be a native of Africa although it is now widely distributed in different ecological zones. The leaves are broad with pointed apex and arranged in an alternate pattern. The shape of the leaves can be said to be oval and lobed with a wavy margin, both sides of the leaves are hairy with simple hairs.

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Prickles are usually found along the mid-rib. The flowers are usually of about 2-3.5cm and of purple colour, fruits are fleshy, round and flattened at the bottom and contain numerous seeds of reniform shape which are used for propagation (Oboh *et al*., 2005). The leaves are eaten as a separate dish or sauce together with other ingredients including pepper, tomato, onions, locust beans and fish or meat. It contains vitamins and minerals including vitamins A, C, E, folic acid, niacin, potassium, thiamin and riboflavin which contribute to growth and the maintenance of good health (Sanstead *et al.*, 1998; Roberts *et al.*, 2000). Appreciable amounts of antioxidants such as flavonoids, phenolics, ascorbic acid and tocopherols which are also found in *S. macrocarpon* have been shown to be scavengers of harmful radicals that are known to cause cellular damage, heart diseases, cancer, Parkinson's and Alzheimer's diseases (Sodipo *et al.*, 2012). Its leaves are also rich in dietary fiber, an important nutrient found only in plant food.

Seed germination is one of the critical phases in plant life cycle (Shoab *et al.*, 2012) which is affected by dormancy and environmental factors. Adequate temperature, water, light and moisture content are important environmental factors that are important for seed germination and seedling development. A proper investigation of germination requirements show how a species germination process is adapted to habitat conditions and regulated by environmental factors (Van Assche *et al.*, 2002). It is common for seed lots to have moisture contents considered inadequate for safe and effective storage, such as contents higher than 12%. Reduction in moisture content is important to preserve the physiological quality of seeds for at least eight months; this will slow down possible chemical and physical changes that may come about during storage (Barrozo *et al.*, 2014; Carvalho *et al.*, 2016).

Temperature is considered one of the crucial factors for the process of germination (Forcella, 1998). Before domestication of a plant species can be achieved, proper information about the best environmental condition for its germination must be available. Vegetable crops with orthodox seeds may present differences in germination due to possible dormancy, loss of viability due to preservation conditions, genetic differences among the materials, or aging (Gisbert *et al.*, 2011). Poor seed germination rate limits the use of different species for culture or plant breeding, and different treatments such us scarification, stratification and addition of different chemical substances are commonly used to promote germination in several species (Bone, 2003; Brady and McCourt, 2003). Ecological studies of important plant species such as vegetables provide prerequisite information that will promote their cultivation. Dormancy and low germination rates have been observed in the genus *Solanum* (Adebola and Afolayan, 2006). Recent initiative revealed that very little research has been carried out on seed germination of *Solanum macrocarpon*.

The present study therefore seeks to provide information on the effect of pre-chilling and storage temperature on germination of *Solanum macrocarpon*.

2. MATERIALS AND METHODS

Seed collection, weight and moisture content determination

Mature fruits of *Solanum macrocarpon* were harvested during field surveys from different areas in Ekiti State, Nigeria. The freshly harvested seeds were removed from their capsules, air-dried and later used for germination studies in this experiment. Seed weight was determined by weighing 100 seeds using an analytical balance and the mean weight of one

seed was calculated. Moisture content of seed was determined by oven drying method and calculated using the formula:

$$\%\ Moisture\ content = \frac{FW - DW}{FW} \times 100$$

where: FW = Fresh weight of seeds
DW = Dry weight of seeds

Viability testing

Seeds of *S. macrocarpon* to be tested for viability were surface sterilized using 1.0% sodium hypochlorite solution for 5 min and thoroughly rinsed with distilled water. 9 cm sterile Petri-dishes were overlaid with cotton wool and moistened with 7ml of distilled water. 50 randomly selected seeds were counted, put in the Petri dish and then covered. Treatments were arranged in a complete randomized design and replicated three times. Emergence of radicle was taken as a criterion of seed germination and the germinated seeds were recorded on the 14th day. Mean values obtained were separated using the Duncan Multiple Range Test (DMRT) at a probability level of 0.05.

Another batch of seeds, were be subjected to floatation method of viability test. This involved steeping of seeds into water in a beaker; seeds that sank to the bottom were identified to be viable.

Germination experiment

Prior to germination test, seeds were also subjected to refrigerator set at 4 °C for 1, 3, 5, 7 and 10 days. Another set of seeds was placed in incubators set at 25, 35 and 45 °C for 40 days before the germination experiment was conducted on a laboratory work bench at ambient temperatures (AOSA, 1998). Germination tests were conducted in 9-cm sterile Petri dishes lined with cotton wool, moistened with distilled water. Each treatment had three replicates of 20 seeds each. The Petri dishes were examined daily and seeds were considered germinated when their radicles were visible. Germination counts were taken on the 14th day after planting. Germination percentage for each treatment was calculated using the formula cited by Czabator (1962).

$$Germination\ (\%) = \frac{\text{Total number of seeds germinated}}{\text{Total number of seeds per replicate}} \times 100$$

All experiments were conducted in a complete randomized design with three replicates. Data collected were subjected to analysis of variance with storage temperature and pre-chilling as treatments using SPSS Version 20.

3. RESULTS AND DISCUSSION

Seeds of *S. macrocrapon* subjected to viability test yielded 63.33% (Table 1). Previous study by Finkeltein *et al.* (2008) revealed the presence of gibbrellic acid in freshly extracted

seeds of this species which has been has been found to enhance germination. Thus the moderately high germination obtained in this study can be attributed to the presence of this acid.

The average seed weight and moisture content of *S. macrocrapon* was 4.15 ± 0.09 mg and 8.27 ± 2.70% respectively (Table 1). Several authors have stated that seed attributes are greatly influenced by climatic and edaphic factors in addition to density and of plant and genetic variation among species population (Pathak *et al.*, 1975, Rutger and Crowder, 1967). A slight change in seed moisture content greatly affects its storage life (Mane and Puri, 2013). Studies have revealed that a number of orthodox seeds require moisture content of between 6 and 10% for them to retain viability after a long storage (Luna and Wilkinson, 2009). In the present study the moisture content of *Solanum macrocarpon* seeds allows for long term storage without reducing their viability (Table 1)

The effect of pre-chilling and storage temperature on seed germination produced is presented in Table 2. The result from the present study shows some variability in germination percentage in both treatments, however, while significant differences were observed in germination of seeds subjected to temperature treatments, no significant statistical differences were obtained in seeds pre-chilled in the refrigerator.

Analysis of variance also shows that pre-chilling has no significant effect on the seed germination of *Solanum macrocarpon* (Table 3). A study of the effect of pre-chilling on seed germination of *Solanum nigrum* by Bvenura (2014) revealed a lower germination percentage (28%) in seeds subjected to pre-chilling for 3 days. In the pre-chilling treatment, germination was highest in control seeds followed by seeds pre-chilled for 7 days. Some studies have shown that pre-chilling breaks seed dormancy and enhances germination in plant species (Baskin *et al.*, 2001) while others posit that it has harmful effects on viable seeds (Ren and Tao, 2004). The cold pre-chilling may change the hormonal balance of seeds and increase germination through enhancement of gibberellic acid and cytokinin activity and/or the decline of abscisic acid (Copeland and McDonald, 2001). Amini *et al.* (2015) also stated that pre-chilling provides enough moisture to activate the hydrolytic enzymes which make seeds ready to germinate once they were moved to the warm temperature. The results from this study however shows that germination reduces with increase in length of days seeds are subjected to pre-chilling, but dropped in seeds that were pre-chilled for 10 days.

In the present study, analysis of variance shows that seed germination is significantly affected by temperature (Table 4). The importance of temperature on seed germinaton has been articulated by some authors such as Nkomo and Kambizi (2009), Sowunmi and Afolayan (2015). A variety of high temperature treatments has been employed successfully to overcome dormancy in seeds (Suthar *et al.*, 2009). In the present study, *Solanum macrocarpon* had 10% germination when subjected to a temperature of 25 °C however Nkomo and Kambizi (2009) observed no germination in *Corchorus olitorius* seeds subjected to a temperature of 25 °C.

Percentage seed germination increased with temperature up to 45 °C, although germination was higher in the control. This is similar to the report of Bvenura (2014) who observed 56% germination in freshly extracted *Solanum nigrum* seeds. Germination was significantly higher in seeds placed in the incubator set at 45 °C. The increase in seed germination percentage which was directly proportional to temperature increase is expected, this agrees with Hegarty (1977) who asserted that the rate of germination increases linearly with temperature within a well defined range.

Table 1. Weight, moisture content and viability of *Solanum macocarpon* seeds

Parameters	Values
Seed weight	4.15 ± 0.09 mg
Seed moisture content	8.27 ± 2.70 %
Seed viability	63.33 ± 0.04 %

Table 2. Effect of pre-chilling and temperature on seed germination of *Solanum macrocarpon*

Treatment		Percentage (%) germination
Pre-chilling	1 day	48.33 ± 25.22[a]
	3 days	33.33 ± 18.78[a]
	5 days	26.67 ± 6.67[a]
	7 days	50.00 ± 7.64[a]
	10 days	25.00 ± 10.00[a]
	Control	61.67 ± 8.82[a]
Temperature	25 °C	10.00 ± 5.77[a]
	35 °C	18.33 ± 3.33[a]
	45 °C	50.00 ± 5.77[b]
	Control	61.67 ± 8.82[b]

Mean with different letters along the same column represent significant difference at $p < 0.05$
Values shown are mean ± standard error.

Table 3. Analysis of variance of seed germination for pre-chilling treatment in *S. macrocarpon*

Source of variation	**SS**	**Df**	**MS**	**F-value**	**Sig.**
Between Group	3245.83	5	649.17	1.02	0.447

Within Group	7616.67	12	634.72		
Total	10862.50	17			

*Significant at 0.05

Table 4. Analysis of variance of seed germination for pre-chilling treatment in *S. macrocarpon*

Source of variation	**SS**	**Df**	**MS**	**F-value**	**Sig.**
Between Group	5516.67	3	1838.89	15.76	0.001
Within Group	933.33	8	116.67		
Total	6450.00	11			

*Significant at 0.05

The degree of enzymatic actions is usually altered by temperature, in addition, Mader (1993) found out that an increase in temperature of 10 °C doubled the rate of enzymatic activity in a living cell. This suggests that *Solanum macrocarpon* seeds will only germinate at optimum temperature suitable for its growth.

4. CONCLUSION

This study suggests that *Solanum macrocarpon* is well able to thrive under varied temperatures however, cold stratification by pre-chilling is not necessary as the seed does not possess any form of dormancy.

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