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Assessment of the Effect of Soaking Duration on Germination and Seedling Growth of Tomato-82-B Variety (*Solanum lycopersicum* l.)

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Abstract
The research was carried out to evaluate the effect of soaking duration on the germination and seedling growth of the tomato (*Solanum lycopersicum L.*) Tomato-82-B variety. The treatment had four soaking durations of 6 hours, 12 hours, and 18 hours. 24 hours, and the control (zero hour) replicated three times. The results indicated a significant increase in germination percentage. The 24-hour treatment was observed to record the highest germination percentage (98%) while the control had the lowest germination percentage (78%). There was a significant increase in the plant height between the various treatments and the control. The 24-hour treatment had the highest plant height (115 cm), while the control (72 cm) was the least. The result obtained from the number of leaves showed that 24 hours of soaking duration (139) had the highest, while the control (107) had the lowest. The results from stem girth and plant canopy showed a similar result, 24 hours gave the highest result, while the control was the lowest. The seed soaked for 24 hours recorded the highest stem girth (1.17 cm) when compared to other treatments, while the control (0.99 cm) had the least value. Data collected on plant canopy showed that the seed soaked for 24 hours had the highest plant canopy (63 cm), while the control (29 cm) had the lowest value. Results from plant height, stem girth, number of leaves and plant canopy showed significant differences ($p \leq 0.05$). We recommend that farmers soak their tomato seeds for 24 hour duration before planting for optimum vegetative growth.
Keywords: Soaking, duration, germination, growth

Introduction

Saeed-Awan *et al*. (2012) reported that tomato (*Solanum lycopersicum* L.) is one of the most economically important vegetables grown all over the world. Because of its wide adaptability and versatility, it is cultivated all over the world. It is regarded in many parts of the world as an important cash and industrial crop over the last century (Ajagbe *et al*., 2014).Babarinsa and Ige (2014) noted that tomato is a tender and compression-sensitive fruit. It belongs to the Solanaceae family known botanically as berry (Abdullah *et al*., 2010). Although, some cultivars of tomatoes are cultivated as annual crops in some parts of the world, it is a perennial crop. After potatoes, it is the second most useful vegetable (Abdullah *et al*., 2010). Olayemi *et al*. (2010) reported that tomato as an essential vegetable plays a key part in supplying minerals and vitamins for humans. It is seen as vital ingredients in the preparation of many local dishes in both rural and urban regions in Nigeria.

Tomato has high content of sugars, essential amino acids, water-soluble vitamins and minerals, dietary fiber, low in fat and calories; the main source of vitamins A, B, and C, phosphorous, iron, protein, edible oil and lycopene (Ayandiji and Adeniyi, 2011; Achoja and Okoh, 2014). They are also consumed fresh in salads, soup, and meat/fish dishes, cooked in sauces, or as raw materials for food industries by processing into value-added products like paste, purée, juices, ketchup, and canned products (Ajagbe *et al*., 2014). Onifade *et al*. (2013) reported that daily intake of tomatoes supplies the body with vitamin, carotene, and lycopene which reduces the risk of cancer and cardiovascular diseases. The antioxidant components are medically beneficiary for bone metabolism, cataracts, asthma, and aids to reduce the risk of prostate and breast cancer (Shankara *et al*., 2005). Ebimieowei and Ebideseghabofa (2013) noted that tomato is used as condiments for stew, a regular feature of African meals and accounts for about 18% of the average daily consumption of vegetables in

Nigeria. (Saeed-Awan *et al*., 2012).

Esan *et al*. (2021)suggested different approaches of breaking dormancy in seeds to aid the rate of germination. These include leaching, heating, potassium nitrate, soaking, and gibberellic acid treatment (Esan *et al*., 2021). The use of cold water soaking can also be used to overcome physical dormancy in seeds (Sabongari, 2003).Under drought-prone conditions, seed priming is known as a secure approach to improve germination and increase crop yield (Soleimanzadeh, 2013; Yanrong *et al*., 2003).Although, drought germination is triggered before actual sowing, priming is done to initiate the metabolic activities that prepare seeds for radical protrusion. It has been over-emphasized that seed priming accelerates and improves germination and early seedling growth, which under the typical drought stress conditions is appropriate at the onset of the season in the Sahelian zone of West Africa (Souza *et al.,* 2016). Gupta *et al.* (2013) reported the successful development of various priming procedures, all geared towards increasing the speed of seed germination, and secures emergence through improved water absorption capacity. Hydro-priming, a well-known efficient priming technique, involves soaking seeds in a fluid such as water. The beneficial effect of hydro-priming has been demonstrated for various field crops such as maize, (Mohammadi *et al*., 2014), sunflower (Kaya *et al.,* 2006), and others (soybean, wheat, cowpea, etc.) (Pazhanisamy *et al*., 2020). Hossain *et al*. (2014) reported that seeds with hard, solid, impermeable seed coats were noted to establish germination after pre-sowing treatments.

Breaking dormancy in seed varies from species to species.Soaking *Garcinia kola* (Herkel) for 72 hours in water allows light to influence the germination rate, primary growth, and development (Oboho, 2011). Seeds of Kola have both seed coat dormancy and physiological dormancy, probably imposed by the chemicals in the seeds (Oboho and Urughu, 2010). Soaking for the duration of 72 hours was enough to leach out the inhibitory chemicals. According to the study of Ibrahima and Otegbe(2004), soaking *Adansonia digitate* seeds for 1hr,12hr, and 24hr resulted in an increased rate of seed germination. Amoaka *et al.* (2017) showed that soaking the seed of *Pouteria campachiana* for about 24 to 48 hours led to earlier germination of the seed than the untreated seeds (control) and the condition is suitable for each plant species.

Tomato is faced with the problem of seizure or shortage within some period of the year, especially in Guinea savannah zones of Nigeria. Since tomatoes are one of the most important crops, more effort is needed to ensure that their availability is not constrained by either the cultivation stage, or the harvest period. The purpose of this research work is to evaluate the effect of soaking treatments on the germination and growth of tomato (*Solanum lycopersicum*). Hydro-priming initiates physicochemical alterations in seeds before germination (Basra *et al*., 2003). Also, protoplast in hydro-primed seeds has greater permeability to nutrients and water, lesser viscosity, and greater resistance to dehydration (Jisha *et al.,* 2013).

Tomato as an important cash and industrial crop in many parts of the world is rich in vitamins and minerals, hence, necessary in the preparation of many local dishes and very important in the diet of both rural and urban dwellers in Nigeria (Olayemi *et al*., 2010). Soaking treatment can be explored to overcome drought and ensure cultivation all-round the year. The aim of the study is to study the effects of soaking treatment (hydro priming) on the germination, growth, and yield of tomato (*Solanum lycopersicum*) variety tomato- 82-B. The objectives of this research are to: access the germination percentage of tomatoes treated with water at different soaking durations, examine the growth parameters of tomato plants treated with water at different soaking durations and determine the most effective treatment period that enhances the germination and growth of tomato (*Solanum lycopersicum*) variety tomato-82-B.

Materials and Metho*d*

Source of materials

Seeds of tomato variety Tomato-82-B were obtained from the National Seed Council of Nigeria within the premises of the National Root Crop Research Institute (NRCRI), Umudike, Abia State.

Study area

The experiment was conducted within the premises of Michael Okpara University of Agriculture, Umudike. Umudike is in the rainforest belt of Nigeria and lies on latitude 05° 28°N and longitude 07° 32°E 245mm (N.R.C.R.I., 2016).

It has an average rainfall of 2,200 mm and is 123m above sea level. The minimum and maximum temperatures are 22.41 °C and 30 °C respectively, with the total annual mean rainfall of 1,245 mm (N.R.C.R.I., 2016).

Experimental design

The experiment was conducted in a completely randomized design (CRD) with three replications at a screen house of National Root Crop Research Institute (NRCRI) Umudike, Abia State.

Seed Preparation

Two hundred seeds of the tomato variety were placed in five different 100ml beaker. The first group served as the control whereas the other groups represented various soaking durations (6h,12h,18h, and 24h), each of them clearly labeled. After preparation, the seeds were soaked and decanted at different treatment periods. The seeds were air dried for about 30 minutes. After; the germination test was done using a Petri dish. The Petri dishes were labeled accordingly (0h(control),6h, 12h,18h, and 24h). After which, 10 seeds of the tomato variety 82- B were placed on the surface of the Petri dishes to determine the germination percentage using tissue paper moist with water as a substrate. 10 more

seeds of the treated tomato82-B variety were planted in the screen house using a plastic pot. The pots were clearly labelled according to the treatment durations.

Measurement of growth parameters

The following growth parameters were measured at 21-days intervals after planting was done.

Germination percentage (%): this was checked at 14 days after planting. Germination percentage (%) was calculated as follows:

Plant height (cm): this was measured from the soil level to the meristematic tip using a meter rule.

Number of leaves: this was by visual counting of the leaves as the plant grows.

Number of branches: this was done by visual counting of the leaves as the plant grows.

Stem girth (cm): This was done using the vernier caliper.

Leaf area: this was done by calculating the leaf length and width of the tomato variety using the formula of Carmassi *et al*. (2007) below:

Leaf area of tomato = $0.5 \times L \times W$

Statistical Analysis

The data obtained from our analysis were subjected to Analysis of variance (ANOVA) using IBM SPSS Statistics v23 Software. Mean variability amongst the cultivars were determined. Their treatment means were separated using Duncan Multiply Range test (DMRT) and the Least Significant Difference (LSD) at statistical significance of 95% confidence interval.

Results and Discussion

Results

Effect of soaking duration on the germination percentage

The result in Table I showed the effect of soaking treatment on germination. The result obtained showed that the germination percentage was increased with an increase in the soaking duration. The 24 hours treatment was observed to record the highest germination (98%). The control had 78%, and the other treatments had values ranging from 71-83%. The seeds soaked for 6 hours had 71%, whereas the ones soaked for 12 hours and 18 hours recorded 73 and 83% respectively (Table I).

Effect of soaking duration on the plant height

The result in Table II showed that the soaking duration had observable effects on the plant height of tomatoes at various soaking durations. Data collected on the 11th week after planting showed that the effect was dependent on the number of hours the seeds were soaked. There was a significant increase in the plant height between the various treatments and the control. The 24 hours treatment had the highest plant height (115 cm), followed by 18 hours (101.56 cm), while the control had the least plant height (72 cm).

Effect of soaking duration on the number of the leaves

The result in Table III showed the effects of soaking treatments on the number of leaves. Using the data collected after 11 weeks, it was observed that the soaking treatments affected the number of leaves. From the result obtained, the soaking duration of 24 hours gave the highest number of leaves (139). The control had had the least number of leaves (107). The other treatments 6 hours, 12 hours, and 18 hours had 110, 119, and 130 numbers of leaves respectively. The result showed that the soaking duration significantly (<0.05) affected the number of leaves.

Effect of soaking duration on stem girth of 82-B tomato

The table IV showed the result of soaking duration on the stem girth. The result showed that an increase in the soaking duration resulted to an increase in the stem girth. The seed soaked for 24 hours recorded the highest stem girth (1.17 cm) when compared to other treatment. The control had the least stem girth (0.99 cm). This showed a significant increase ($p \leq 0.05$) at 18hrs and 24hrs compared to the control.

Effect of soaking duration on plant canopy of 82-B tomato

The result in table V showed a duration dependent effect. The data collected after 11 weeks of planting showed that the seed soaked for 24 hours had the highest plant canopy (63 cm). The control had the least plant canopy (29 cm). This showed a significant increase ($p \leq 0.05$) in plant canopy with regard to soaking duration.

Discussion

The effect of water soaking on the germination of seeds showed that the duration of soaking significantly improved the germination percentage of tomato seeds. Esan *et al*. (2021) suggested different approaches to breaking seed dormancy to enhance the germination rate and increase the germination process. These include heating, soaking, leaching, potassium nitrate and gibberellic acid treatment (Esan *et al*., 2021). Seed priming is known as one of the conventional methods of breaking dormancy in seeds. It helps initiate the metabolic activities that prepare seeds for radical protrusion. Work done by so many researchers has shown that seed priming accelerates and improves germination and early seedling growth. This is particularly appropriate under the typical drought stress conditions occurring at the onset of the season in the Sahelian zone of West Africa (Souza *et al.,* 2016).Gupta *et al.*(2013) reported that various priming procedures have been developed successfully, all targeted at increasing the speed of seed germination, and securing emergence through improved water absorption capacity. A well-known efficient priming technique is hydro-priming, where seeds are soaked in a fluid such as water. The beneficial effect of hydro-priming has been

shown for various field crops such as maize, (Mohammadi *et al*., 2014), sunflower (Kaya *et al.,* 2006), and others (soybean, wheat, cowpea, etc.) (Pazhanisamy *et al*., 2020).Hossain *et al*. (2014) reported that seeds with hard, solid, impermeable seed coats were noted to establish germination after pre-sowing treatments. Sambogari (2003) reported that water soaking treatment has been used in various crops to improve their germination and overall growth of the crop, as well as breaking seed to kick-start the germination process. Cold water soaking of seeds has proved to be a handy tool towards enhancing the germination and growth of many seed plants, and hence leading to crop improvement. The result from this study showed that the soaking duration significantly improved the growth parameters of tomato (*Solanum lycopersicum*) such as plant heights, stem girth, number of leaves, and plant canopy. This research work has revealed that a 24hours soaking duration had a huge impact on the growth components of the tomato variety under study than any other treatment, including the control for all the growth variables investigated. This showed that the soaking duration improved the growth rate and overall development of the tomato seed. Result was supported by the results of Yamaguchi *et al*. (1983) and Schmidt (2000) who worked on vegetables and forest seeds respectively. This research work has shown that soaking treatment can serve as a tool to enhance seedling growth potential. In this present study, the effects of soaking duration were shown on plant height, number of leaves, stem girth, number of branches and the plant canopy. The result obtained in the present work showed an increase in most vegetative criteria of the tomato variety (*Solanum lycopersicum*) across all the soaking intervals. This research work has revealed that a 24hours soaking duration had a huge impact on the growth components of the tomato variety in this study than any other treatment, including the control. However, this work contradicts the work from Ibrahima (2004) who reported a reduction in the growth parameter of Garcinia kola (herkel) seeds treated with different soaking durations. The plant height reduction caused by a decrease in the soaking duration is inconsistent with this report.

Conclusion

The soaking treatment on tomatoes helped us to understand the effect of moisture on tomato seeds. This research showed soaking duration of 24 hours had the best impact on both germination percentage and growth parameters of the tomato variety understudy. There was significant increase in the parameters studied with increase in soaking duration. Farmers should be encouraged to soak their tomato seeds for 24 hours prior to planting. I therefore recommend that further research should be done on soaking duration above 24 hours. Other tomato varieties should also be investigated to ascertain whether they will conform to our findings.

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Table I: Effect of soaking duration on the germination percentage

Treatment	Germination Percentage
0hrs	78%
6hrs	71%
12hrs	78%
18hrs	83%
24hrs	98%

Table II: Effect of soaking duration on plant height

Treatment	Plant height (cm)
0 hr	72.56^{e}±1.42
6 hrs	82.78^{d}±1.66
1 2 hrs	94.67^{c}±0.88
18 hrs	101.56^{b}±1.30
24 hrs	115.56^{a}±1.63

Mean ± Standard error; ($p \leq 0.05$)

Table III: Effect of soaking duration on number of leaves

Treatment	Number of leaves
0 hr	107.11^{e}±2.78
6 hrs	110.44^{d}±1.12
1 2 hrs	119.78^{c}±2.31
18 hrs	130.44^{b}±2.29
24 hrs	139.00^{a}±2.79

Mean ± Standard error; ($p \leq 0.05$)

Table IV: Effects of soaking duration on the stem girth

Treatment	Stem girth (cm)
0 hr	$0.99^{c}\pm0.02$
6 hrs	$1.03^{bc}\pm0.02$
1 2 hrs	$1.06^{bc}\pm0.02$
18 hrs	$1.10^{b}\pm0.02$
24 hrs	$1.17^{a}\pm0.03$

Mean $\pm$ Standard error; ($p\leq0.05$)

Table V: Effect of soaking duration on plant canopy

Treatment	Plant canopy (cm)
0 hr	$29.67^{b}\pm2.96$
6 hrs	$34.67^{b}\pm4.09$
12 hrs	$39.00^{b}\pm5.29$
18 hrs	$56.33^{a}\pm2.73$
24 hrs	$63.67^{a}\pm6.74$

Mean $\pm$ Standard error; ($p\leq0.05$)