

Full Length Research Paper

Effect of seed priming on seedling emergence and growth of bitter kola (*Garcinia kola*) in Owerri, Nigeria

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The potted experiment was conducted in the early planting season of 2018, at the Teaching and Research Farm of Imo State University, Owerri, Nigeria to ascertain the effects of seed priming using water, coconut water and *moringa* leaf extract on the seedling emergence and growth of bitter kola. Completely Randomized Design was used with four treatments and three replicates. The treatments were thus; soaking of bitter kola seeds in water for 36 h, soaking of bitter kola seeds in coconut water mixed with ordinary water for 36 h, soaking of bitter kola seeds in *moringa* leaf extract for 36 h and non-soaked seeds (control). Bitter kola seeds were purchased from a farmer that has a bitter kola tree in his compound at Owerri, Imo State. Data were collected on number of seedlings emergence, percentage emergence, plant height, number of leaves per plant, root dry weight, shoot dry weight, leaf dry weight and total dry weight. The result revealed that priming treatments had significant effect ($P \leq 0.05$) on number of seedlings that emerged when compared with the non-primed seeds. The least seedling emergence (0) was recorded from non-soaked seeds. Seeds soaked in water for 36 h gave the highest seedlings emergence of 10.67. Priming had effect on plant height and number of leaves. Priming also significantly affected total dry weight, shoot dry weight, leaf dry weight and root dry weight compared to the control which had no seedling that emerged. The values obtained from primed seeds were statistically similar ($P \leq 0.05$), although water treatment gave the best result. Therefore, priming of bitter kola before planting is very necessary to enhance seedling emergence and growth.

Key words: Bitter kola, priming, seedling emergence and growth, nigeria, west Africa

INTRODUCTION

Bitter kola botanically known as *Garcinia kola* is a member of the Clusiaceae family believed to have originated in tropical or subtropical low land forest is a very important economic tree. Its fruits, nuts, seeds and bark have been used from the time immemorial in folk medicine (Hooker, 2008). However, it has been reported

that germination is slow in bitter kola seed especially with the wild form, it last for as long as 365 days (Ogunade et al., 2013). Seed germination is negatively affected by drought (Damirkaya et al., 2006). Seedling vigour and seedling establishment have in several species of plant been related to the time of seedling emergence (Matthew

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and Powell, 2011).

Bitter kola is cultivated from sea level to 1200 m and between latitude 6°10' and 6°45'N (Hooker, 2008). Bitter kola is also reported to be cultivated between 22 and 33°C and susceptible to abrupt change and sensitive to cold temperatures. Additionally, it does not tolerate dry cold winds, and it needs high light intensity to grow (Villachita 1998) although, the wide population studied by Saunder (1999) in India are apparently shade tolerant. The contrast suggests that it is completely domesticated species as proposed by Gordon and Roew (2003). Soil characteristics for the crop are very vital in its production. It is absolutely sensitive to water logging. Bitter kola does not thrive in soils with drainage problem. High water content in soil causes root diseases. Bitter kola prefers moderate deep soils with good water infiltration and aeration and can grow in different soil types (Ogunade et al., 2013). Ogunade et al. (2013) reported that the best soil pH is between 6 and 6.5, while Sheat (1998) emphasized that it is between 5.5 and 6.5 which shows that bitter kola thrives well in acidic soils. The plant parts such as bark fruits, seeds and nuts have been used in traditional medicine for the treatment of various ailments such as cough, fever, gonorrhoea, chronic urethral discharge, stomach pains, pulmonary and gastrointestinal condition and general body pains (Odebunmi et al., 2009).

Poor seedling emergence is one of the major biotic constraints encountered by the people who are interested in the domestication of the crop (Hartman et al., 2002). Improvement in seed germination is an active area of research and efforts are being made to improve seed germination in this very economically important crop (Ufaz and Gald, 2008). Seed priming is a pre-germination treatment in which seeds are held at low water potential (Nouman et al., 2012). The priming process gives the seed a "head start" at germination and emergence when planted in the soil (Hussain et al., 2015). Accelerating and homogenizing the germination process is a prerequisite for a good crop establishment, the efficient use of resources and eventually to increase yields (Harris, 1976). A robust seedlings establishment has high tolerance to environmental stresses and maximizes biological and grain yields (Hussain et al., 2015). Seed priming techniques were successfully being used for cereals, vegetables and range grasses (Ashraf et al., 2008).

Hydropriming encounters available soil moisture dryness to endow plants with greater tolerance to subsequent stress exposure (Patanea et al., 2009). *Moringa oleifera* leaf extract has the potential to promote plant growth hence it is used as a natural plant growth enhancer (Barsa et al., 2005). *M. oleifera* extract as a plant growth promoter influences plant growth in several ways and also promotes defense mechanism against abiotic stresses by harmonizing the plant regulates endogenous concentration (Wasif et al., 2012).

Various plant growth regulators have been used in seed

priming to improve the seed emergence, plant growth and the crop yield (Farooq et al., 2006). But the poor resource farmers could not afford them due to their high cost. Therefore, this present study is designed to introduce organic and inexpensive seed priming tools using cheap and available moringa leaf and coconut extract and water as natural and adaptable priming agents to improve germination, seedling establishment of bitter kola seed.

MATERIALS AND METHODS

Study location

The experiment was conducted during the early planting season of 2018 at Imo State University Teaching and Research Farm in Owerri. Owerri lies between latitude 5° 0'N and 6° 0'N and longitudes 6° 5'E and 7° 0'E, with altitude 92 m above sea level in rainforest belt of South Eastern Nigeria. The annual average rainfall is 250 mm and falls between March and October, and the relative humidity is 75% (NIMET, 2016).

Experimental materials

Dried bitter kola seeds, top soil, coconut water, *moringa* leaf polybags plastic bowls were used. The dried bitter kola seeds were purchased from a farmer who has bitter kola tree in his compound at Owerri. He informed me that he stored the seeds for seven months in a basket covered with dried banana leaves and kept in his house (that is room temperature). The coconut water was gotten from freshly harvested ten medium size coconut heads by breaking them and the water collected was up to one litre.

Preparation of *Moringa* leaf extract / coconut mixture

The moringa leaves that were collected at Teaching and Research Farm of Imo State University, Owerri were grinded manually with mortar and pestle. 500 g of fresh grinded leaves was added in 5 L of water and left undisturbed for 24 h after which the mixture was sieved to obtain moringa leaves extract. Also 1 L of coconut water was mixed 5 L of water.

Preparation of the nursery medium / experimental treatments

The nursery medium was sterilized by heating it in a drum for one hour in Teaching and Research Farm of Imo State University, to avoid soil born disease. A day before planting, 2 kg of the sterilized soil was weighed with a weighing balance and bagged in black perforated polyethylene bags. Some of the bitter kola seeds were soaked using plastic containers in water without soil for 36 h (Treatment 1), some were soaked in coconut water mixed with water (Treatment 2), some were also soaked in *moringa* leaf extract for the same duration (Treatment 3) and non-soaked seeds which served as control (Treatment 4). The treatments were replicated three times using Completely Randomized Design. After 36 h of soaking, the seeds were removed, air dried and planted separately inside black perforated bags based on treatments. The non-soaked seeds were also planted in perforated bags and all the bags were placed in the nursery. The bitter kola seeds used for the experiment were so dried, so soaking them up to 36 h in different priming agents was to enable them imbibe enough water for quick enzymes activation which will hasten the physiological processes involved in

seed germination.

Mulching

The polybags were mulched using dried grass in order to reduce the rate of transpiration.

Watering

Equal amount of water were applied once in two days until when the rainfall stabilized. This was because the experiment was set up in first week of March by then the rainfall was not enough to sustain the crop.

Weeding

This was done by hand picking anytime the weeds emerged.

Data collection

The experiment was monitored and data collected on the following parameters:

1. Percentage Seedlings Emergence: The number of emerged seedlings from each plot was counted and data obtained from each used to estimate the percentage emergence using the formula:

$$\text{Percentage emergence} = \frac{\text{No. of seedlings emerged}}{\text{No. of seeds planted}} \times \frac{100}{1}$$

2. Number of leaves per seedling: The number of leaves from each bitter kola plant were counted and recorded at 22 weeks after planting.

3. Seedling root dry weight: The seedling root dry weight was obtained by drying the root after uprooting the seedlings at 22 weeks after planting until a constant weight was gotten.

4. Seedling shoot dry weight: This was obtained by drying the shoot after uprooting the seedlings at 22 weeks after planting until a constant weight was gotten.

5. Number of the seedlings emerged: The number of bitter kola seedlings that emerged were counted and recorded at 22 weeks after planting.

6. Seedling height: The height of bitter kola seedlings that emerged at 16 weeks after planting, 18 weeks after planting, 20 weeks after planting and 22 weeks after planting were measured and recorded.

RESULTS

Soil physico-chemical properties of experimental soil

The result of the soil analysis used for the potted experiment is shown in Table 1. The textural class of the soil was sandy loam with pH of 5.78 which implies that the soil was moderately acidic. The chemical characteristics of the soil indicated low potassium, nitrogen, calcium and phosphorus. The soil was also low in organic matter, cation exchange capacity which means that the soil was low in nutrients contents.

Number of seedlings emerged at 22 weeks after planting

The result of the study revealed that priming had effect on seedling emergence (Table 2). At 22 weeks after planting, non-primed seeds did not emerge at all, but 10.67 seedlings, 10.33 seedling and 9.67 seedlings emerged from water, coconut water mixed with water and *moringa* leaf extract respectively. The values were statistically similar ($P \leq 0.05$) (Table 2).

Percentage seedling emergence at 22 weeks after planting

The summary of the effect of seed priming on percentage seedling emergence of bitter kola is shown in Table 2. The seeds soaked in water gave the highest percentage emergence of 71.13% which was statistically similar ($P \leq 0.05$) to the values obtained from coconut water and *moringa* leaf extract. But the non-primed seeds had percentage emergence of 0 at twenty two weeks after planting of the seeds when the experiment was terminated (Table 2).

Plant height (cm)

The effect of seed priming on plant height of bitter kola is shown in Table 3. All the plant height values obtained from primed seeds irrespective of the priming material were statistically similar ($P \leq 0.05$). But the seeds that were primed with ordinary water gave the highest values. The seeds that were not primed had no plant height because none of the seeds was able to germinate at 22 weeks after planting when the experiment was terminated (Table 3).

Number of leaves per plant

Table 4 shows the summary of number of leaves per plant as affected by different priming treatments. Number of leaves obtained from the primed seeds was statistically similar ($P \leq 0.05$). The non-soaked seeds did not have leaves because no seedling emerged (Table 5). The highest mean value of 6.00 was recorded from seeds primed for 36 hours in *moringa* leaf extract at 20 and 22 WAP. The same trend was applicable for the number of leaves obtained at 16 and 18 WAp (Table 4). The result revealed that all the priming agents used had almost the same effect on number of leaves.

Dry matter partition of bitter kola seedlings

The effect of seed priming on dry matter of bitter kola is

Table 1. Physico-chemical properties of the soil before planting.

| Soil properties | Status |
|---|------------|
| pH (H ₂ O) | 5.78 |
| Sand (%) | 86.80 |
| Clay (%) | 9.20 |
| Silt (%) | 4.00 |
| Textural class | Sandy loam |
| Organic carbon (%) | 1.47 |
| Organic matter (%) | 2.56 |
| Total exchangeable acid (cmol/100gsoil) | 0.60 |
| Aluminium (cmol/100gsoil) | 0.20 |
| Calcium (cmol/100gsoil) | 2.50 |
| Hydrogen (cmol/100gsoil) | 1.30 |
| Total nitrogen (%) | 0.40 |
| Potassium (cmol/100g soil) | 0.12 |
| Cation exchange capacity (cmol/100g soil) | 0.32 |
| Base saturation (%) | 85.2 |
| Sodium (cmol/100g soil) | 0.28 |
| Available phosphorus (ppm) | 4.75 |

Table 2. Effect of seed priming on seedling emergence and percentage of bitter kola at 22 weeks after planting.

| Priming treatments | Mean number of seedling that emerged | Mean percentage emergence (%) |
|---|--------------------------------------|-------------------------------|
| Non-soaked seeds (control) | 0.00 ^b | 0.00 ^b |
| Seeds soaked in water for 36hours | 10.67 ^a | 71.13 ^a |
| Seeds soaked in coconut water mixture for 36hours | 10.33 ^a | 68.87 ^a |
| Seeds soaked in <i>moringa</i> leaf extract for 36hours | 9.67 ^a | 64.47 ^a |

Means in the same column with the same letter are not significantly different ($P < 0.05$) according to Duncan Multiple Range Test.

Table 3. Effect of seed priming on plant height of bitter kola.

| Priming treatments | 16 WAP (cm) | 18 WAP (cm) | 20 WAP (cm) | 22 WAP (cm) |
|--|-------------------|--------------------|--------------------|--------------------|
| Non-soaked seeds (control) | 0.00 ^b | 0.00 ^b | 0.00 ^b | 0.00 ^b |
| Seeds soaked in water for 36 h | 4.73 ^a | 11.53 ^a | 14.53 ^a | 16.83 ^a |
| Seeds soaked in coconut water mixture for 36 h | 3.80 ^a | 10.37 ^a | 13.43 ^a | 16.40 ^a |
| Seeds soaked in <i>moringa</i> leaf extract for 36 h | 4.87 ^a | 10.00 ^a | 12.47 ^a | 13.60 ^a |

Means in the same column with the same letter are not significantly different ($P < 0.05$) according to Duncan Multiple Range Test.

shown in Table 5. In total, dry weight, the highest mean value of (2.37 g/plant) was obtained in seeds primed in water for 36 h followed by seeds primed in coconut water for 36 h (2.13g/plant) and finally by seeds primed in *moringa* leaf extract for 36 h (1.43). There was no significant difference among the values ($P \leq 0.05$). However, non-primed seeds (control) did not produce any dry matter mean value.

In terms of leaf dry weight, root dry weight and shoot

dry weight, the seeds that were soaked in water had the highest values (Table 5).

DISCUSSION

The results obtained from the study showed that seed priming had effect on number of seedling emergence compare to non-primed seeds. The number of seedlings

Table 4. Effect of seed priming on number of leaves of bitter kola.

| Priming treatments | 16 WAP leaves | 18 WAP leaves | 20 WAP leaves | 22 WAP leaves |
|--|-------------------|-------------------|-------------------|-------------------|
| Non-soaked seeds (control) | 0.00 ^b | 0.00 ^c | 0.00 ^c | 0.00 ^c |
| Seeds soaked in water for 36hours | 3.67 ^a | 4.00 ^b | 4.00 ^b | 4.00 ^b |
| Seeds soaked in coconut water mixture for 36 h | 4.00 ^a | 4.00 ^b | 4.00 ^b | 5.33 ^a |
| Seeds soaked in moringa leaf extract for 36 h | 4.50 ^a | 5.67 ^a | 6.00 ^a | 6.00 ^a |

Means in the same column with the same letter are not significantly different ($P < 0.05$) according to Duncan Multiple Range Test.

Table 5. Effect of seed priming on dry matter of bitter kola (g/plant).

| Priming treatments | Total dry weight (g/plant) | Leaf dry weight (g/plant) | Root dry weight (g/plant) | Shoot dry weight (g/plant) |
|---|----------------------------|---------------------------|---------------------------|----------------------------|
| Non-soaked seeds (control) | 0.00 ^c | 0.00 ^b | 0.00 ^b | 0.00 ^c |
| Seeds soaked in water for 36hours | 2.37 ^a | 0.87 ^a | 0.57 ^a | 1.03 ^a |
| Seeds soaked in coconut water mixture for 336 h | 2.13 ^a | 0.77 ^a | 0.40 ^a | 0.97 ^a |
| Seeds soaked in moringa leaf extract for 36 h | 1.43 ^b | 0.53 ^a | 0.53 ^a | 0.60 ^b |

Means in the same column with the same letter are not significantly different ($P < 0.05$) according to Duncan Multiple Range Test.

that emerged was significantly higher in primed seeds than in non-primed seeds. This is in conformity with the finding of Aziza et al. (2004) who stated that priming reduced the time from sowing to emergence. The early emergence of the primed seeds might be resulted from the fact that primed seeds imbibed water which broke dormancy and revived seed metabolism that are needed in seed germination quickly.

The results obtained showed that hydropriming had positive improvement on leaf formation. The results are in agreement with the findings of Farooq et al. (2005) who reported better stand establishment and seedling vigour in primed seeds. Priming had a positive effect on the plant height, as growth advanced plant height gradually increased in seeds soaked for 36 h in moringa leaf extract, seeds soaked for 36 h in coconut water, seeds soaked for 36 h in water, compared to the non-soaked seeds (control) which did not even emerge. The results support the findings of Al-Soqueer (2004) who stated that plant height was increased by priming. The number of leaves per plant increased across the primed seeds compared to the non-primed which did not emerge. Higher results were obtained from seeds that were primed. It is conformed to the report of Wasif et al. (2012) who reported rapid plant growth in primed seeds. At 22 WAP, seeds showed increase in total dry weight, leaf dry weight and root dry weight and shoot dry weight compared to the non-soaked seeds (control).

Conclusion

The result showed that seedling emergence, plant height, number of leaves per plant, leaf dry weight, shoot dry

weight and root dry weight were improved by priming. Priming of dried bitter kola seed with water is recommended for early seedling emergence and growth.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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