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Research Article

Differential Impact of Hydro-Priming Regimes on Seed Germination and Early Seedling Growth of Contrasting Bambara Groundnut (*Vigna Subterranea* L.) Landraces

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Abstract
The study was aimed to determine the impact of priming on the germination of Bambara groundnut seed and to study the optimum hydro-priming duration for increased germination rate and fast seedling emergence of two Bambara groundnut landraces. Two Bambara Ground nut (Vigna subterranea) seeds (plain cream with white eyes and Black stripes with black eye) were used for the experiment with four different hydro-priming treatments; soaking for 24 hours in cold water, soaking for 1 minute in boiled water, soaking for 2 minute in boiled water and control (without any soaking) which were rinsed in cold water before sowing. They treatments were laid out in a Completely Randomized Design with four repetitions. Results showed that there were significant (p<0.05) differences in the treatments applied. Results obtained shows that 24 hours soaking in cold water on black stripes produced the tallest seedling stand, whereas 24 hours soaking in cold water on plain cream inhibit germination (0% germination). 1-minute hot water treatment on plain cream significantly produced longer seedling length, weight and less percentage of dead seeds. It was therefore concluded that different Bambara groundnut landraces response variably and sensitively to the same durations of water treatments. Application of 24 hours cold water treatment on black stripes white eye landrace gave the highest seedling length and canopy cover whereas 1-minute hot water treatment on plain cream white eye landrace gave the highest seedling length, weight and less percentage of dead seeds.

Keywords: *Bambara, Groundnut, Seed, Hydro-priming, Soaking and Sowing.*

INTRODUCTION
Bambara groundnut (*Vigna subterranea* [L.] Verdc.) is a lesser-known African crop belonging to the family Fabaceae. It ranks as the third most important food legume in Africa, following groundnut (*Arachis hypogea* L.) and cowpea (*Vigna unguiculata* [L.] Walp.) (Bamshaiye *et al*., 2011). This crop is highly valued for its adaptability to diverse environmental conditions and its ability to produce yields even in poor soils, making it a preferred choice among African farmers (Bamshaiye *et al*., 2011).

Efficient seed germination plays a pivotal role in successful crop establishment. Rapid and uniform seedling emergence, coupled with effective root development, is essential for early establishment. Germination in orthodox seeds is characterized by three distinct phases: Phase I involves hydration of dry tissues through passive imbibition and initial water movement in apoplastic spaces; Phase II encompasses metabolic reactivation and cellular repair processes; and Phase III initiates cell elongation, leading to radicle protrusion. Notably, Phase II represents a critical stage where hydration stabilizes and germination can still be reversed without affecting seed viability. This reversibility allows seeds to dry again and remain viable for future germination under favorable conditions (Stanley Lutts *et al*., 2016). Seed priming, particularly water-based priming, refers to a pre-sowing process where seeds are partially hydrated but do not progress to emergence (Chen and Arora, 2011). Priming treatments vary in terms of osmotic potential, duration, temperature, and the inclusion of chemical compounds (Santini and Martorell, 2013). These treatments activate metabolic processes during Phase II of germination, which are then temporarily halted to prevent desiccation, thereby enhancing seed performance (Lutts *et al*., 2016).

Achieving optimal seed germination is crucial for establishing a healthy crop stand, as seeds are a fundamental input in agriculture. However, various environmental factors and crop-specific challenges have negatively impacted seed germination, emergence, and seedling vigor. This, in turn, leads to reduced crop yields. Seeds subjected to priming often demonstrate faster growth compared to unprimed seeds (Stanley Lutts *et al*., 2016). It remains unclear whether this growth advantage arises from accelerated seedling establishment or from long-term physiological changes induced by priming (Lutts *et al*., 2016). In many instances, the benefits of priming are more pronounced under suboptimal conditions, leading to improved stress resistance, faster germination, uniform seedling growth, early flowering, and increased yield from primed seeds (Zhang *et al*., 2015; Santini and Martorell, 2013). Delayed seedling emergence and poor establishment hinder efficient resource utilization, including light, nutrients, and weed suppression, ultimately affecting the final seed yield at harvest (Ogbuehi *et al*., 2013). These challenges are particularly significant in Bambara groundnut production. Consequently, this study seeks to address these challenges on the effect of priming on the germination of Bambara groundnut seeds and the optimal hydro-priming duration for improved germination rates and accelerated seedling emergence in Bambara groundnut.

MATERIALS AND METHODS

The experiment was conducted in the Institute for Agricultural Research (IAR) Samaru, Zaria (11^0 11`N, 07. 38^0 E) in the northern Guinea Savannah ecological zone. Samaru has an altitude of 686m above sea level. The soil type is sandy loam. The long term mean annual rainfall is 1058mm within 160 days (from May to end of September). The dry season period starts at the middle of October and last till the end of April. The hottest months are those preceding rains (March and April) with temperature above 27^0c

Treatments consists of two Bambara Groundnut seeds were used for the experiment with four different hydro- priming treatments as; soaking for 24 hours in cold water, soaking for 1 minute in boiled water, soaking for 2 minutes in boiled water and control (without any soaking) which were rinsed in cold water before sowing. They treatments were laid out in a Completely Randomized Design with four repetitions.

The seed of Bambara ground nut for this experiment were sourced from the department of Plant Science, Ahmadu Bello University, Zaria. Seeds were sown in a soil medium inside a plastic container measuring 24cm × 14cm. they seeds were sown to a depth of 2cm with intra-row spacing of 2.4 cm.

Seeds were soaked at room temperature for four different pre-sowing hydration treatments; soaking for 24 hours in cold water, soaking for 1 minute in boiled water, soaking for 2 minutes in boiled water and control. The seeds were sown in sand medium using plastic containers measuring 24cm × 14cm. Water was added to moisten them when necessary. Seedlings were considered to have emerged when the first true leaf had broken from the soil and was visible. Emergence numbers were determined by counting emergence seeds. Emergence was recorded for 15 days from sowing the seeds in soil medium and total emergence percentagewas calculated.

Data were collected from five days after sowing to fifteen days after sowing for which the experiment was terminated from the following parameters Percentage germination of first count, Emergence index, Percentage of dead seeds, Average root length of ten seedlings, Average shoot length of ten seedlings, Seedling weight, Root weights, shoot weights, Root weights, Shoot weights, Dried weights of shoots. Data were collected on each plastic container by counting emerged seedlings. Seedlings were considered to have emerged when the first true leaf had broken from the soil and was visible. Based on the medium (soil) used for this research, germination was not visible beneath the soil, therefore the term emergence was technically used. Ten seedlings were tagged for the collection of data related to lengths and weights in centimetres and grams respectively. The samples were cleared free of soil and then oven dried at 70^0c to constant weight for dry matter determination using EC2000 electronic meter balance. The weights were recorded in grams for each treatment. The analysis of variance of all data collected was done to test the significant effect of the treatments using SAS software 2014. The Duncan multiple range test was applied to compare the means of different treatment.

DISCUSSION

The best landrace of Bambara groundnut that produced the highest germination, emergence and growth characters like emergence index, seedling weight, seedling length, root weight, dry matter determination with respect to cold water treatment was the black stripes white eye landrace. Control on plain cream landrace produced the highest percentage germination of first count (54.00) followed by 1 minute (42.00) and two minutes (40.00) hot water treatment on the same landrace. This was followed by soaking in cold water for 24 hours (32.00) on black stripes landrace, control (22.00), 2 minutes (20.00) and 1 minutes (14.00) hot water treatments. However, this was in contrary to the findings of Albert T. Modi (2013) which reported that 24 hours duration of cold-water treatment gave the highest percentage emergence (61.8%), leaf area (130.910cm^2), plant height (25.675cm), number of leaves (81.76). Control gave the highest leaf area index (0.126) while the 12hours produced the highest net assimilation rate (0.0088mgcm^2) and that 24hours hydro priming duration improved the performance of growth indices measured. The variation in germination between the two landraces might be due to the hardness of the seed coat as reported by Berchie *et al.* (2010) in their studies that landraces with hard seed coat inhibit moisture permeability and thus, affect germination rate. In another report by Aziza *et al.* (2004) they reported a significant decrease in emergence time and increase in final emergence count. This might be due to a range of biochemical changes such as hydrolysis, activation of enzymes and dormancy breaking in the seed which are required to start the germination process and it resulted in improvements in field emergence heading to better canopy development and Crop Growth Rate (CGR). However, effect of 24 hours soaking in cold water on plain cream inhibit germination with 0% gemination count and 100% dead seeds count and the same treatment was found to increase seedling height, canopy cover and dried mass on black stripes landrace. Percentage of dead seeds was least recorded for control in both the landraces. This inhibition could be as a result of longer period of priming that led to excess water in the seeds and also could be caused by greater reduction in the O_2 availability to the embryo. Similar findings was reported by Ogbuehi *et al,* (2013) that there was poor germination in 36 hours primed seeds but 48 hours primed seeds inhibited germination This could be due to uncontrollable imbibition of water prior to the commencement of germination as was reported by Ghassemi- Golezani *et al.* (2008) that the resultant effect of priming depends on duration of seed soaking.

Failure of plain cream to response to 24 hours duration might be attributed to the fact that different landraces response variably to same and different durations of pre-hydration treatment. Accordingly, this research revealed that different landraces response variably and sensitively to same and different durations of water treatments. Highest value of root length was recorded in control (24.00cm) and 2 minutes (23.00cm) hot water treatment on plain cream white eye landrace; this was followed by 1minute hot water (22.75cm) on plain cream, 2 minutes hot water (22.50cm), 24 hours cold water (21.00cm), 1minutes hot water (21.00cm) on black stripes white eye landrace which were all statistically the same. Control on black stripes white eye recorded (16.25cm) while the least value was obtained from 24 hours cold water treatment on plain cream white eye (0.00cm).

All they treatments shown a significant response in terms of shoot weight, root weight, shoot dried weight, and root dried weight, and were found to be statistically the same except pre- soaking in cold water for 24 hours on plain cream white eye landrace which recorded 0% response to the treatment applied.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

From the results of this study, it can conclude that application of 24 hours cold water treatment on black stripes white eye landrace gave the highest seedling length and canopy cover whereas 1 minute hot water treatment on plain cream white eye landrace gave the highest seedling length, weight and less percentage of dead seeds.

Recommendations

Application of 24 hours cold water treatment is recommended on black stripes whiteeye landrace.

Application of 1minute hot water treatment is recommended on plain cream whiteeye landrace.

Further studies should be conducted on different durations of hydro-priming and on different landraces of Bambara groundnut.

The results suggest that hydro priming is a useful method of improving seedling emergence and stand establishment of Bambara groundnut hence should be recommended for poor farmers who are engaged in production of Bambara groundnut.

Effect of different water treatments on two landraces ofBambara groundnut in 2021

Treatment	Emergence Index Varieties (V)	Dead seeds	Root length	Shoot length	Shoots Weight	Root weight	Seedling weight	Shoot Dry Weight	Roots Dried Weight
Varieties (V)									
V1H1	18.20bc	18.00bc	21.00ab	36.50b	24.00a	12.50a	36.50ab	3.10a	1.80a
V2H1	22.70ab	14.00bc	22.75ab	32.00bc	26.00a	13.0a	39.0ab	2.70a	2.45a
V1H2	21.25abc	16.00bc	22.50ab	34.00bc	25.00	13.00a	38.0ab	3.0a	2.20a
V2H2	17.10bc	26.00bc	23.00a	30.50c	23.50a	11.50a	35.00ab	2.60a	1.80a
V1H24	16.35c	38.00b	21.00ab	41.50a	28.00a	13.0a	41.0a	3.0a	2.45a
V2H24	0.00d	100a	0.00c	0.00d	0.00b	0.00b	0.00c	0.00b	0.00b

V1H0	23.40ab	6.00c	16.25b	32.50bc	21.00a	11.50a	32.50b	2.90a	1.6a
V2H0	24.90a	8.00c	24.00a	31.00c	25.00a	12.50a	37.50ab	2.95a	2.05a
SE±	**1.89**	**2.45**	**1.99**	**1.41**	**2.14**	**0.74**	**2.43**	**0.39**	**0.44**
Interaction									
V × W	NS	NS	NS	NS	NS	NS	NS	NS	NS
Means followed by the same letter(s) within the same column and treatment group are not significantly differentat 5% level of probability using DMRT. NS = not significant									

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