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Influence of Different Priming Agents on Germination and Field Performance of Soybean (*Glycine max* (L) Merrill) in Guinea Savanna of Nigeria

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Abstract: ***Poor seed germination and poor crop establishment are major challenges for farmers. A field study was carried out at the University of Abuja Research Farm to evaluate the influence of different priming agents on the germination/establishment and field performance of soybean in the Guinea Savanna region of Nigeria. Five (5) treatments were used in the study, four (4) priming agents (gibberrelic acid, sodium chloride (NaCl), coconut water and warm water) and the control. The study was arranged in randomized complete block design (RCBD) with three replicates. Seed priming improved germination percentage of soybean. Soybean seeds primed with gibberrelic acid performed best in respect to flowering percentage by 92.03% followed by those primed with coconut water which had 87.07%.Gibberrelic acid stimulated the highest germination percentage (97.20%) in seeds of soybean while the control (no-priming) had the lowest soybean 64.83%. The significant difference recoded among the priming agents used in the study in respect to germination percentage, number of leaves, plant height and flowering percentage may be attributed to the differences in their ability to improve seed vigour. Gibberrelic acid and coconut water have high capacity to improve seed vigour which results in high germination percentage and field establishment of soybean. Coconut water is effective, more accessible, natural and cheap for seed priming for smallholder farmers in Nigeria. Coconut water is thereby recommended as seed priming agent for smallholder farmers in Nigeria.***

Keywords: Priming, Gibberrelic acid, coconut water, soybean, NaCl, priming agent

1. Introduction

In spite of planting high quality seed, soybean, rarely attain appropriate density of plants per unit area probably due to poor seed viability (Dashield et al., 1983). Seed priming technique is used to increase viability of deteriorated seed or to increase their ability to grow under wide range of environmental conditions or to get high, fast and homogeneous percentages of germination and field emergence, strong seedling and good field establishment (JCEA, 2017).

Soybean seeds have high content of oil (22-25%) and high amount of crude protein (35-40%) (Purseglove, 1984). The very high nutrient content makes the seeds prone to attack by a variety of pests and saprophytic organisms thereby lowering the viability of the seeds (Mladen Tatic et al, 2012).

Seed priming technique means controlled process of seed ibibition during soaking or moisturizing and allows the commencement of metabolic events before planting without allowing emergence of radicle or plumule (Murungu et al., 2004; Nawaz, 2013). Seed priming technique have developed to include many methods. It has advantages or disadvantages depending on plant type, growth stage, priming factor concentration and priming duration (Ashraf and Foolad, 2005). That technique may lead to improve and initiate germination, homogeneous growth of seedlings, field establishment and high yield even under conditions of environmental stress compared with non-primed seed. Moradi and Younesi (2009) found that osmo-priming or hydro priming seeds led to reduced rate of emergence time and improved percentage of germination, but it gave negative results during test of accelerated ageing compared to non-primed seed.

Richards et al. (2001) mentioned that secretion of gibberellins at early stages of germination led to decode curbed genes that have control on synthesis of seed enzymes such as amylase, beta amylase, protease and hydrolyases. Gibberellins lead to accelerating growth of embryo maybe through decreasing physical hindrances of seed coat, which help emergence of radicle and plumule (Olszewski et al., 2002).

Potassium chloride (KCl) is a source of K and Cl, needed at crops planting (Fixen, 1993). Percentage of normal seedling at final count, speed of germination, length of radicle, dry weight of seedling, speed of field emergence and yield of grain per plant during spring and fall seasons were increased when seed of soyabean soaked in 40 mgL^{-1} of KCl (Dawood, 2014). Sodium chloride (Nacl) used in this experiment also supply chlorine (Cl) and is expected to achieve similar result to priming of seeds with KCl.

Farhoudi and Sharifzadeh (2006) suggested that seed priming with NaCl improves salinity tolerance in canola plants by limiting the destruction of cell membranes due to salinity and increasing proline concentration in seedlings. Moosavi et al. (2009) added that seed priming with an osmotic solution increase germination and the activity of antioxidant enzymes compared to non-priming seeds.

This technique helped seedlings to grow in stressed conditions (Welbaum, et al., 1998; Ashraf and Foolad, 2005). Seed priming, especially with NaCl, have improved germination and growth of many crops under stressed conditions (Sivritepe et al., 2003; Omami, 2005; Basra et al., 2005). Seed priming with NaCl improved growth and yield of tomato plants (Cano et al., 1991), asparagus plants (Pill et al., 1991) and cucumber plants (Passam and Kakouriotis, 1994).

There is paucity of literature on the use of coconut water (CW) as a seed primer but the coconut water has several enzymes that can aid seed germination Coconut water is an essential growth supplement for plant tissue culture/ micro propagation (Neumann, Kumar, & Imani, 2009).A few studies have been carried out to reduce the period between seed sowing to emergence of seedlings as this play a key role in crop production. One of the important developments in this area has been in the seed priming techniques where Bassey (2012) obtained a promising outcome when cotton seeds were primed with coconut water under laboratory conditions.

Reducing the gap between percentages of germination under laboratory conditions and field emergence has become one of important goals in crop production as it leads to increase in yield. This study was therefore conducted to improve field emergence and grain yield of soybean under wide range of environmental conditions by using technique of seed priming.

2. Materials and Method

Study Location: The research was carried out at the Teaching and Research Farm and the Crop Science Laboratory of the University of Abuja, Nigeria during the 2017cropping season. The location which lies on Latitude 8^0 45' and Longitude 6^0 45' and is characterized by a bimodal rainfall pattern. The mean annual rainfall is about 1500 mm, the soils are sandy loams and classified as Ferric Acrisol (FAO, 2017).

Experimental Materials: The materials used include the seeds of soybean, sourced from the International Institute of Tropical Agriculture (IITA) and Institute of Agriculture (IAR) Samaru, Zaria, Giberrelic Acid (a growth Hormone), Coconut water, NaCl, Distilled Water and Warm water.

Soil Sampling and Analysis: Prior to land preparation and sowing, soil samples were taken across the fields with an auger at the depth of 0-30 cm and bulked in a polythene bag to form a composite Soil Sample. The samples were later taken to the laboratory for physico-chemical analysis using standard laboratory procedures.

Seed Priming Treatments includes;

1. The seeds of soybeans were soaked with coconut water CW) for 12 hours, after which the seeds was removed and placed on top of a clean filter paper to air dry to its normal moisture content.
2. The seeds were soaked in warm water (WW) at 25 ^{0}C for one minute after which the seeds were removed and placed on top of a clean filter paper to air dry to its normal moisture content.
3. The seed were soaked with 3g/ litre solution of Giberrelic Acid (GA) for four hours after which the seeds were later removed and placed on top of a clean filter paper to air dry to its normal moisture content.
4. The seeds were planted without any treatment application (Control).
5. The seeds were soaked with 12g/litre solution of Sodium chloride (NC) for 24 hours after which the seeds were removed and placed on top of a clean filter paper to air dry to its normal moisture content.

Experimental Design and Field Lay Out: The experimental design adopted had treatments arranged in a Randomized Complete Blocks Design (RCBD) with two (2) varieties of soybeans and Five (5) Priming Agents (No Primers, Giberrelic Acid, Coconut water, Warm water, and NaCl) making up 10 treatments replicated three (3) times.The plot size measured 2.5 m by 4 m with inter – row spacing of 0.75 and intra - row spacing 0.1m. Plots measured 0.5m apart while blocks were1m apart.

Crop Husbandry: The field was disc-ploughed and harrowed twice, to a fine seed-bed, before the layout was done to produce plots measuring 3M wide and 4M long spaced 0.5M within the rows that were 0.75M apart. Two seeds were sown along the rows at 10cm to produce 40 stands along the rows and 160 stands within a plot and 320plants per plot. All agronomic appropriate practices (weeding, disease and pest control etc) were carried out as and when due.

Data Collection/Observations: Germination count, seedling emergence, plant height, number of leaves and days taking to attain 50% flowering by all the plants in the plot were carried out as described below-

i. **Percentage emergence** $= \frac{\text{Number of emerged seedlings}}{\text{Expected number of plants (no of seed sown)}} \times 100$

ii. **Plant height (cm)** will be measured at 2, 4and 6 WAS using a measuring tape from randomly selected and marked plants from which an average was calculated per plant.

iii. **Number of leaves:** was counted at2, 4 and 6 WAS from randomly selected and marked plants from which an average was calculated per plant.

iv. **Number of soybean flowers:** was determined by carefully counting the numbers of flowers.

Data analysis: Data collected were subjected to analysis of variance (ANOVA) using GENSTAT 11th edition (Gen Stat, 2009). Fischer's least significant difference (LSD) was used to separate means.

3. Results

Germination % of soybean as affected by priming: From the result presented on Table1, priming significantly affected germination of soybean seeds. Soybean seeds

treated with Gibberellic acid and coconut water during the priming had 88% and 66% germination respectively. The germination due to Gibberellic acid was significantly better than due to other priming agents but it was statistically similar to that of coconut water which also similar to other agents and the control 5DAS. The trend was maintained 10 and 15 DAS

Table 1: Effect of seed priming on the Germination % of Soybeanat 5, 10 and 15 Days after sowing (DAS)

Priming Agent	5 DAS	10 DAS	15 DAS
No priming (Control)	48.93b	57.43b	64.83b
NaCl	61.87b	69.20ab	71.50b
Giberrelic Acid	88.13a	91.73a	97.20a
Coconut Water	66.37ab	72.73ab	78.17ab
Warm Water	51.17b	61.30b	68.67b
S.E	**10.34**	**10.42**	**9.09**

Means with the same letter in a column are not significantly different ($P \leq 0.05$). S.E.= standard error

Table 2: Effect of seed priming on number of Soybean leaves at 2, 4 and 6 weeks after sowing (WAS)

	2 WAS	4 WAS	6 WAS
Control	4.93c	20.87c	70.27b
NaCl	5.20c	21.20c	76.07b
Giberrelic Acid	11.80a	35.10a	92.60a
Coconut Water	11.13a	30.80ab	85.57a
Warm Water	9.07b	24.87bc	74.33b
S.E.	**0.549**	**2.974**	**3.26**

Means with the same letter in a column are not significantly different ($P \leq 0.05$). S.E.= standard error

The effect of seed priming on the number of leaves counted from soybean plants: In Table 2 is the result of the number of leaves counted from soybean plants after 2, 4 and 6WAS. Significantly higher numbers of leaves were counted from soybean plants which had there seeds primed with Gibberellic acid and coconut water than the other plants that had their seeds primed by other agents throughout the period of observation. The leaves counted from plants that had their seeds treated with NaCl and warm water were significantly higher than the control 2 and 4 WAS but after 6WAS there was no difference.

The effect of seed priming on the plant height of soybean: The height of soybean plants as influenced by deed priming is presented on Table 3. Plants treated with gibberellic acid grew significantly taller than all the plants treated with Nacl and the control. However they (GA treated plants) were at par with plants that had CW and WW treatment at 4WAS. The difference observed in plant height due to the different priming agents was not statistically significant at 4 WAS and 6 WAS.

Effect of seed priming on the flowering of soybean plants: Table 4 shows the influence of seed priming on the flowering of soybean. At 50 DAS seed priming had no influence on flowering but at 60 and 70DAS plants emerging from seeds treated with GA produced superior number of flowers. However, the number of flowers counted from plants treated with GA did not differ statistically from those primed with CW, NC and the control after 60days but not the control at70DAS.

Table 3: Effect of priming agent on soybean plant height (cm) at 2, 4 and 6 weeks after sowing (WAS)

Priming Agent	2 WAS	4 WAS	6 WAS
Control	2.15	52.51b	77.77
NaCl	2.24	56.23b	88.88
Giberrelic Acid	2.72	74.49a	91.91
Coconut Water	2.35	61.60ab	85.33
Warm Water	2.61	60.35ab	81.77
SE	**0.244**	**6.29**	**5.95**

Means with the same letter in a column are not significantly different ($P \leq 0.05$). S.E.= standard error.

Table 4: Effect of seed primingon the number of flowers of soybean plants

Priming Agent	50 DAS	60 DAS	70 DAS
Control	73.97	77.10ab	78.17b
NaCl	78.13	82.20ab	86.63ab
Giberrelic Acid	84.93	86.90a	92.03a
Coconut Water	81.27	82.83ab	87.07ab
Warm Water	73.67	75.83b	77.83b
S.E.	**4.56**	**4.21**	**5.00**

Means with the same letter in a column are not significantly different ($P \leq 0.05$). S.E = standard error.

4. Discussion

Germination and establishment of crops on the field are two very important factors that determine plant population which in turn determines crop yield as there are some studies to prove this assertion with particular reference to soybean (Shafshak, S.E,. Seif, S.A and Sharaf, A.E (1988; Chiezey, et al, 1991). The significant difference recoded among the priming agents used in the study in respect to germination percentage may be attributed to the differences in their ability to improve seed vigour. Different priming agents influence the seeds differently enhancing seedling vigour, capacity and rate of growth (Cokkizgin and Bolek, 2015).

Seed priming is effective in improving traits studied in this trial (number of leaves, plant height and flowering) when compared with non-primed seed. This is consistent with what is mentioned by Ashraf and Foolad (2005) and Moradi and Younesi (2009). Gibberellins and play an important role inmetabolic activities that occurs during the process of germination and this may lead to improve growth and grain yield later. Coconut water possess some growth enhancing properties, hence, it is being used as supplement for plant tissue culture/ micro propagation (Neumann, Kumar, and Imani, 2009). Maybe, that was the reason behind the superiority of GA and CW in influencing percentages of germination, plant height,

number of leaves and flower count. These traits will invariably be translated into yield attributes such as weight of grain, number of grain per plant and yield of grain per plant in comparison with other treatments.

The control (non-primed) had the lowest germination %. This is in agreement with findings of Dezfuli et al. (2008) who reported that primed seeds completed their germination processes early as compared to non-primed seeds. There are reports that seed priming with giberrelic acid enhances emergence, germination rate and development of the soybean (Assefa et al., 2010).

5. Conclusion

In order to attain uniform germination and adequate plant population for better yield seed priming has become necessary, most especially, when we consider environmental changes as a result of climate changes and other factors that hinder the smooth germination of seeds. Gibberrelic acid recorded the highest germination percentage, number of leaves and plant height while control (no-priming) had the lowest. Gibberrelic acid and coconut water have high capacity to improve seed vigour which results in high germination percentage and growth of soybean. Coconut water is effective, more accessible, natural and cheap for seed priming for smallholder farmers in Nigeria. Exploring the potential of natural products like coconut water as alternative seed priming agents is more sustainable.

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