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Assessment of electrical conductivity and germinability of groundnut genotype seeds

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SUMMARY

Seed quality affects crop establishment and productivity. In addition, the use of good-quality seed is an essential prerequisite for sustainable crop production including groundnuts. Assessing germinability and electrical conductivity provides early evidence of the production potential of a given crop variety or genotype. Therefore, this study assessed the germinability and electrical conductivity of seeds of three groundnut genotypes. A laboratory experiment arranged in a Completely Randomized Design (CRD), replicated three times, was conducted at the Faculty of Agriculture, Kyambogo University, in 2020. Seeds of Igola, Serenut 1, and Serenut 2 groundnut varieties were tested, and data was collected on germination percentage and electrical conductivity. Analysis of variance (ANOVA) was performed using GenStat and means were separated using the least significant difference test at a 5% probability level. Germination percentage and electrical conductivity significantly (p<0.05) differed among the groundnut varieties, with Igola recording the highest germination percentage, followed by Serenut 1, and the lowest was in Serenut 2. The highest electrical conductivity was recorded in Serenut 1 and the lowest in Igola. Since Igola had one of the lowest electrical conductivity and the highest germination percentage, it was concluded that Igola genotype retained higher quality attributes.

Keywords: *Arachis hypogaea; genotype; seed quality*

INTRODUCTION

Groundnut (*Arachis hypogaea*), also known as peanut, is ranked the sixth most important oilseed crop cultivated globally for its edible seeds. The seeds contain protein, oil and are a rich source of fiber, dietary minerals, and vitamins. Globally, approximately 26.4 million ha are dedicated to groundnut cultivation, with about 38.2 million metric tons produced (FAOSTAT, 2003). More than 100 countries globally grow groundnuts, with developing countries accounting for 97% of the global cultivated area and 94% of the total production. Asia and Africa account for majority of the groundnut production (FAOSTAT, 2011). Groundnut is an annual herbaceous plant that can grow between 30 to 50 cm tall. The leaves are pinnate with four leaflets, and opposite. Each leaflet measures around 1–7 cm long and 1–3 cm in width. Groundnut is an important legume widely utilized for food, oil production and animal feed globally (Upadhyaya et al., 2016). Groundnut serves as a valuable source of food in various forms and plays a big role in crop rotation systems in various countries (Zhao-Hai et al., 2016). Many people in developing countries utilize groundnuts as their primary source of cooking oil, digestible protein, and vitamins like thiamine, riboflavin, and niacin (Syed, 2021). Groundnut cake and haulms (straw stems) are also used in various countries as livestock feed. Groundnut plays a big role in the household food security of the rural economies due to its ability to thrive in marginal soil conditions and its tolerance to drought conditions. Groundnut has served as famine reserve and food security crop for so long, mainly cultivated through smallholder subsistence farming systems. Furthermore, the increased demand for groundnut as an industrial raw material and source of household income for over 600 million people globally has magnified the existing gap in production and demand of the crop (Konate et al., 2020).

In Uganda, it is popular in the northern and eastern regions of the country where it has been adopted as part of peoples' culture (Mugisha et al., 2014). It is generally cultivated in all parts of the country in various conditions including both dry land and rainy conditions (Ronner and Giller, 2012). Groundnut is cultivated by small holder farmers, often with minimal or no agricultural inputs (Mugisha et al., 2011). Groundnut growing in the semi-arid zones of Uganda is by far one of the best farming activities in these places. According to UBOS (2007), Lira district is one of the leading growers of groundnut in Uganda. Most groundnut varieties grown in Uganda are still local, and they include Igola, Erudu, Etesot and Red beauty. Although superior genotypes, like the Serenut series, have been developed at research Centres like the National Semi-Arid Resources Research Institute –

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Serere, since the 1990's, their distribution to resource constrained farmers in rural areas has been ineffective. This is largely because the improved varieties are expensive and unaffordable for the resource constrained subsistence farmers. Utilizing high-quality seeds is of great importance for proper establishment of a crop in any agricultural setting. Seed quality encompasses a range of factors, including the physiological, physical, pathological, genetic, and entomological attributes, all of which affect seed lot performance. Physiological seed quality is typically evaluated through germination and vigor tests. These tests not only determine the seed's maximum potential but can also provide insights about its performance under stress conditions (McDonald Jr. and Miller, 1975). While standard germination tests may predict field emergence under favorable soil conditions, they often fail to predict field performance in less optimal conditions (Tekrony and Egli, 1991) as cited by Smayli and Biradarpatil (2019), making vigor tests crucial. According to Vieira and Krzyzanowski (1999), several vigor tests have shown potential for application across different cultivated species. Among these tests, the electrical conductivity test stands out because it is simple to carryout, gives quick results, and affordability. Studies have confirmed its efficiency in evaluating seed vigor of crops such as soybean, peanut, sesame, corn, and other horticultural fruit and forest species (Vieira and Krzyzanowski, 1999). The primary goal of seed quality evaluation is to allow reasonable predictions about the field performance and determine the seeds' value for planting. At planting, information about the seed vigor is important for making informed management decisions, especially under unfavorable conditions.

Testing seed quality is very important before carrying out cultivation, breeding, or even before doing research activities. Previous works show that seed germinability may decrease during storage (Sundareswaran, 2023) due to primary or secondary dormancy. Studies conducted by Lazar et al. (2014) showed linear increase in electrical conductivity with storage time, corresponding to a decline in seed viability. Most farmers often keep seeds under uncontrolled storage conditions from harvest to sale and planting which may affect their germinability and electrolyte conductivity. It's upon this background that the present study was conducted to assess the germinability and electrical conductivity of groundnut seed genotypes commonly grown in Eastern Uganda.

MATERIALS AND METHODS

Study area

This experiment was conducted in the Agricultural Laboratory of Kyambogo University in Uganda. The University is located on Kyambogo hill, Nakawa Division, Kampala District. It's approximately eight kilometers by road, east of the central business district of Kampala. The altitude of the area rises to 1,240 meters (4,070 ft.), above sea level. The coordinates of Kyambogo are: $0^0$20'54.0" N $32^0$37'49.0"E (Latitude: 0.348334; Longitude: 32.630275).

Collection of samples

Three different samples of groundnut genotypes were collected from different farmers in Amuria sub-county, Amuria district. The genotypes collected were Serenut 1, Serenut 2 and Igola as the control.

Experimental design and treatments

The experiment was laid out in a Completely Randomized Design (CRD), with three groundnut genotypes (Serenut 1, Serenut 2 and Igola), each constituting a treatment. Each treatment was replicated three times giving rise to 9 seed lots.

Data collection

Germinability

Some seeds were tested for viability to ascertain their suitability for planting. 20 seeds were taken at random from the seed lot of each genotype and evenly spaced on a petri dish on a layer of moistened cotton, then left for a prescribed amount of time to imbibe moisture and germinate. Distinctions were made between normally and abnormally germinated and dead seed. Only the germination of non-dormant seed was assessed. The radical protrusion was measured in centimeter. Detailed assessments of damage were not included in the test. Germinability was determined using the formula (Gairola, 2011):

$$\text{Germination \%} = \text{Number of germinated seeds} / \text{Total number of seeds} \times 100$$

Electrical conductivity vigor test

The electrical conductivity was based on the assumption that cell membranes disintegrate during seed deterioration (ISTA, 2006). The test was conducted with three replicates of 25 seeds per groundnut genotype. The seeds were weighed using an electronic balance and placed in a glass jar. 125mls of distilled water were added in to each jar, sealed with aluminum foil and kept at room temperature. The electrical conductivity of the substances leaking from the seeds was measured in a solution above the submerged seeds using electrical conductivity meter (HANNA instruments, HI 8733) after gently stirring the seed-water mixture for 10–15 seconds (ISTA, 2006).

Data analysis

The data collected was subjected to one way analysis of variance (ANOVA) using GenStat computer package (15th Edition). The means were separated using the Least Significant Difference (LSD) test at 5% probability level.

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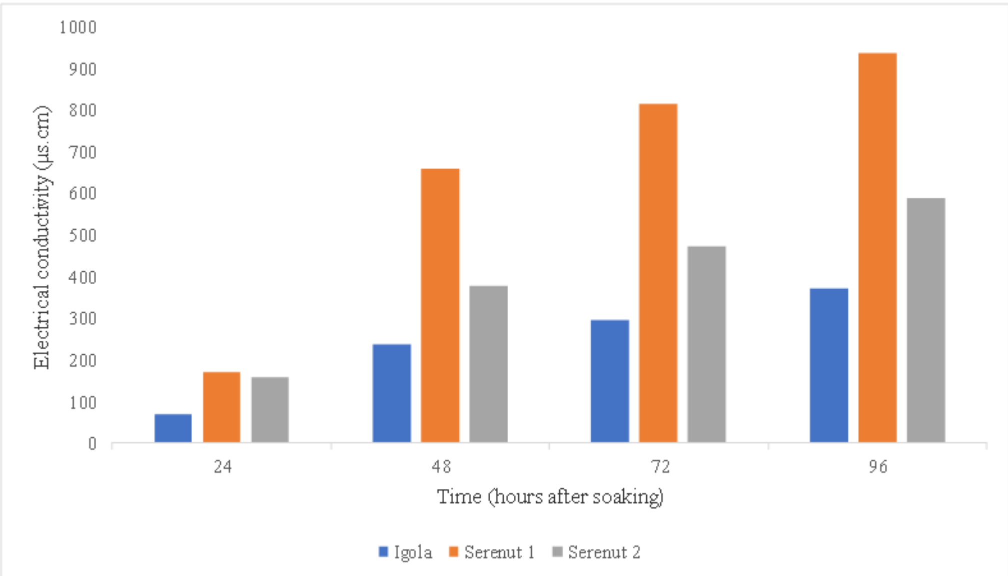
RESULTS AND DISCUSSION

Electrical conductivity of seeds of groundnut genotypes

There was no significant difference (P>0.05) in electrical conductivity of the different groundnut genotypes after 24 hours and 96 hours after soaking. However, 48 and 72 hours after soaking (*Figure 1*), there was a significant difference (P<0.05). Serenut 1 genotype had higher mean electrical conductivity value of 170 µS·cm (0.17 dsm) in 24 hours whereas Igola genotype had the least. The results in the second week also revealed that Serenut 1 had a mean electrical conductivity value of 659 µS·cm (0.659 dsm) after a period of 48 hours which was the largest compared to the Igola and Serenut 2 genotypes. These significant differences in the electrical conductivity could be attributed to differences in seed size and the genetic makeup of the groundnut genotypes. This is in line with the findings of Gharineh and Moshatati (2012) who equally observed significant differences in electrical conductivity of different seed sizes. Also, the difference in electrical conductivity was attributed to the permeability of the different groundnut seed genotypes. Studies by Panobianco et al. (1999) expounded that electrical conductivity is significantly influenced by genotype. Basing on reports relayed by Prohens et al. (2017), it is possible that some seeds usually have superior genes as a result of gene introgression by breeders. As a result, it is possible that after the interaction between the genotypes and the environment, the cell membranes of the seeds retain their integrity, leading to little electrolyte leakage during the electrical conductivity test. Different groundnut genotypes can be stored for varying length of time within which they can start to deteriorate. Studies by Lazar et al. (2014) explained that there are always an increase in electrolyte leakage from seeds with increasing deterioration time (Demir et al., 2008) where small changes recorded by measuring conductivity after germination.

Figure 1. **Electrical conductivity of seeds of groundnut genotypes**



The germinability of the groundnut seeds of different genotypes

The germinability parameters measured included root length, and germination percentage (*Figure 2*). The results showed significant difference in the different groundnut genotypes (*Table 1*), with Igola having the highest germination percentage and highest root length followed by Serenut 1 and least in Serenut 2 (*Table 2*). This was probably attributed to the difference in genetic constitution of genotype seeds, and critical moisture content of the seeds, seed size and also storage conditions which caused the seeds to germinate at different rates and times. In terms of seed size, as the small seeded genotype (Igola) had the highest germination compared to the other large sized genotypes. This aligns with findings of Kaya et al. (2008) who also reported that germination was greater with small and medium seeds than with large seeds in all genotypes. According to Shitting (2002), small sized seeds can germinate easily and produce normal plants even if the grain size is only one-tenth that of the larger seeds. In fact, plants grown from small seeds exhibited a higher growth than those from normal-sized seeds, although all seed sizes attained the same size eventually. Similarly, studies have shown that germinability is affected by genotype and environment during seed development (Penfield and MacGregor, 2017). Generally, large, heavy seeds have greater nutritional reserves and usually produce strong seedlings with robust development. Westoby et al. (1996) in his research noted that larger seeds contain higher levels of essential nutrients and carbon-based

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reserves compared to small seeds, thus an advantage to large seeds growing in nutrient-deficient soils. Interestingly however, this study found out that Igola genotype had the highest germination percentages yet it had a comparably smaller seed size. This contrasts with the findings of Afshin et al. (2002) which showed a relatively high establishment rate in larger seeds, as they are larger and heavier, utilize cotyledonary reserve (UCR) more effectively making them have a higher rate of stem elongation and accumulation of root and shoot dry weight compared to the smaller seeds. Earlier studies by Baalbaki et al. (2009), assessed deterioration using accelerated ageing related seed deterioration to genetic differences. Tests conducted by Mavi et al. (2010) showed that the physiologically aged and more deteriorated seed lots exhibited slower germination to the radicle emergence stage.

Figure 2. **Germination percentages of seeds of groundnut genotypes**

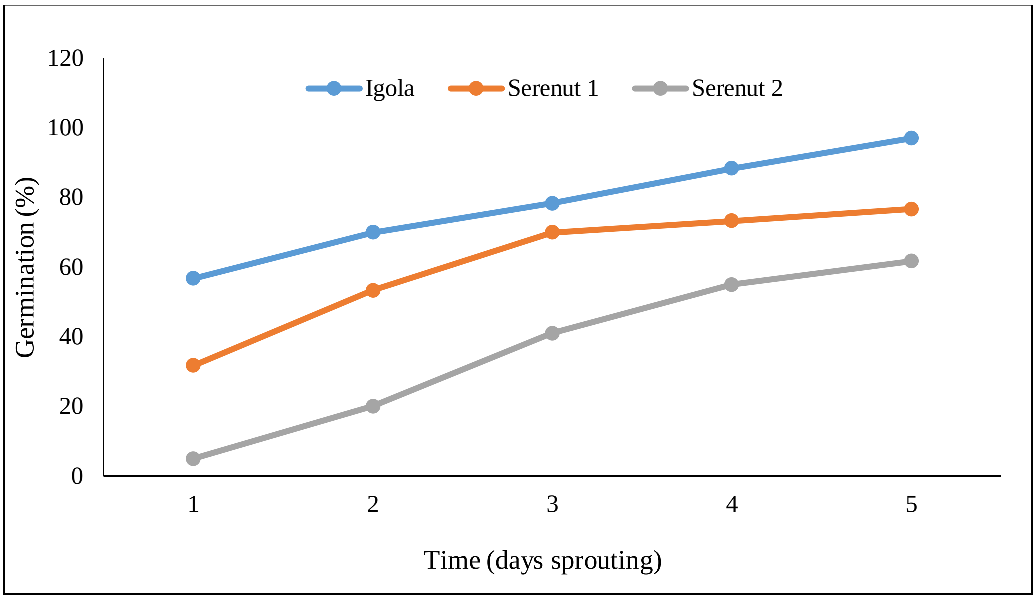

Table 1. **Summary of ANOVA mean squares for average root length of seeds of groundnut genotypes**

		Days after sprouting				
Source of variation	d.f	1DAS	2DAS	3DAS	4DAS	5DAS
Genotype	2	0.0411	1.084	0.908	1.080	1.270
F.pr		0.003	0.004	0.004	0.002	0.068

DAS means days after sprouting

Table 2. **Average root length of seeds of groundnut genotypes**

	Average root length (cm)				
Genotype	1DAS	2DAS	3DAS	4DAS	5DAS
Igola	0.30	1.73	2.13	2.87	3.47
Serenut 1	0.20	1.20	1.57	2.27	2.77
Serenut2	0.07	0.53	1.03	1.66	2.17
LSD*(0.05)*	0.076	0.44	0.39	0.34	1.07

DAS means days after sprouting

The relationship between electrical conductivity and germinability

Generally, in this study, a great relationship between electrical conductivity and germinability was observed. Seeds with low electrical conductivity had higher germination and vice versa. Previous studies have shown a linear relationship between electrolyte loss, seed germination and vigor. As seeds aged and germination percentage declined, electrolyte leakage increased linearly (Lazar et al., 2014). Delazeri et al. (2016) explained that the physiological quality of the seeds is good if they have low electrical conductivity and high germination results.

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CONCLUSIONS

The study evaluated the quality of groundnut genotype seeds in terms of electrical conductivity and germinability. The highest electrical conductivity was recorded in Serenut 1 and the lowest in Igola. Since Igola had one of the lowest electrical conductivity and the highest germination percentage, it was concluded that Igola genotype retained higher quality attributes.

CONFICT OF INTEREST

Authors declare no conflict of interest.

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