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Effects of acidified clay on radicle and plumule emergence in protected seeds of maize varieties (*Zea mays* L)

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ABSTRACT: Maize is the third most important cereal in the world next to rice and wheat and with high production potential among the cereals. It is a staple crop of many nations and reputed as crop for food security. A laboratory study was conducted at the Department of Crop, Soil and Pest Management, the Federal University of Technology Akure, Ondo State, Nigeria to determine the effects of acidified clay on the radicle and plumule emergence in protected seeds of maize varieties. The experiment was laid out in 2 by 4 factorial in Completely Randomized Design with each of the treatment in three replications. Concentrated hydrochloric acid (HCl) was diluted with 200 ml of distilled water at 5, 8 and 10% concentrations. Hundred (100 g) of finely powdered clay soil was weighed and mixed with 25 ml of 5, 8 and 10% diluted HCl. One hundred and fifty (150 g) of maize seeds were mixed with 30 g of acidified clay at various rates and were kept in air tight containers for 7 days. Maize seeds were sterilized in the diluted hypochlorite solution for 30 seconds. The sterilized seeds were plated at the standard plating pattern (9 round and 1 in the middle). Emergence was observed at 24, 48, and 72 hours for the radicle emergence and after 96 hours for the plumule emergence. After each day of the plating, number of seeds that germinated were recorded. The results showed that the germination of white and yellow maize responded similarly to the treatments even at different rates. Both radicle and plumule emergence were better when seeds were treated with 10% acidified clay at 48, 72 and 96 hours of plating. White maize showed better response to the treatment compared with the yellow maize. Treated maize seeds had better germination compared with the control.

Keyword: Acidified, clay, effect, radicle, plumule, *Zea mays.*

INTRODUCTION

Maize (also known as corn in some countries) is *Zea mays*, a member of the grass (*Poaceae*) family. It is a cereal grain which was first grown by people in ancient Central America. It is now the third most important cereal crop in the world (Geiger, 2009). It is next to rice and wheat and with high production potential among the cereals (Prathyusha et et al., 2013). A Central American cereal plant that yields large grains (corn or sweetcorn) set in rows on a cob. Maize is widely grown throughout the world and has the highest production of all cereals with 817 million tons produced (IITA, 2009). Maize production in Africa was around 75 million tons in 2018, representing 7.5% of world maize production. According to IITA report on maize, the largest African producer is Nigeria with over 33 million tons followed by South Africa, Egypt, and Ethiopia. The total harvest in Africa was estimated at 40 million hectare, with Nigeria being the top producer (16%) followed by Tanzania. In Canada and the United States, maize is commonly referred to as "corn".

In recent years corn has become an important part in a majority of American foods through the use of corn starch. People have long eaten sweet corn and popcorn with little processing, and other kinds after processing into flour for making cornbread and other artificial foods. Millions of people around the world depend on agriculture for their subsistence and the challenge is to feed 9 billion people by the year 2050 (Godfray et al., 2010). Globally, maize is known as the queen of cereals because it has the highest genetic yield potential among the cereals. It is cultivated on nearly 150 m/ha in about 160 countries having wider diversity of soil, climate, biodiversity and management practices that contribute 36% (782MT) of the global green production (IITA, 2001).

Maize constitutes one of the major diets of millions of people. In Africa, maize is mainly grown by small-scale farmers for utilization as both human food and animal feed (Edelduok et al., 2015). Maize is a socio-economically important crop used in human diets, animal feed and as an industrial resource.

Many species of plants have strictly specified physiological requirements concerning the soil pH. There are many plant species utilized by man, where acid pH is necessary to grow, but there are also species intolerant of soil acidity. In some cases, this results from toxic properties of aluminium ions responsible for soil hydrolytic acidity (de Lima and Copeland ,1990; Samuels et al., 1997; Deska and Jankowski, 2001; Alamgir and Sufia, 2009). However, sometimes the presence of H+ ions only has a negative effect on plant development (Slootmaker, 1974; Budagovskaya, 1995; Chohura et al., 2004). This refers mainly to early phases of plant development, i.e. seed germination and development of seedlings (Mayer and Poljakoff-Mayber, 1989; Carver and Ownby, 1995).

The study by Marschner (1991) proves that in the case of some plants their growth in acid soil is possible, but seed germination must take place in less acidified environment. This phenomenon is caused by the need for maintaining the appropriate pH of the soil solution for amylolityc enzymes initiating germination. Acid soil pH also determines the availability of macro- and microelements necessary for plant development. Acid soil pH stimulates initial development phases of some species. These include plants with thick seed coats (Turner et al., 1988; Vleeshouwers et al., 1995; Yost, 2000). The effect of acid pH may be direct, manifesting itself in dissolving of the seed coat or indirect, which involves stimulating conditions for development of some species of fungi whose action causes perforation of the seed coat (Vleeshouwers et al., 1995). Thus, what will happen when seeds of maize are treated with acidified clay? Therefore, the aim of this study was to evaluate the effects of acidified clay on the radicle and plumule emergence in protected seeds of maize varieties.

MATERIALS AND METHODS

Study site

The experiment was conducted at the entomology section of the analytical laboratory of the Department of Crop, Soil and Pest Management, the Federal University of Technology Akure (FUTA), Ondo State, Nigeria. FUTA lies within the tropical rainforest belt, between latitude 7°15’N and longitude 5°15’E (Adekayode and Olojugba, 2010). The experiments were conducted under prevailing laboratory conditions of 28±2^{0}C temperature and 60±5% relative humidity.

Collection of materials

Fresh clean seeds of yellow and white maize were obtained from Oja-oba, Akure, Ondo State, HCl acid was obtained from laboratory of the department, distilled water was obtained from the Department of Food Science and Technology, Hypo (Sodium hypochlorite), tissue paper and paper tape were also obtained from Oja-oba, Akure while the clay was sourced from Ipinsha, in Akure South Local Government Area of Ondo State.

Preparation of materials and experimental procedures

Concentrated hydrochloric acid (HCl) was diluted with 200 ml of distilled water at 5, 8and 10% concentrations then 100 g of powdered clay soil was weighed and mixed with 25 ml of 5, 8 and 10% concentrations of HCl. One hundred and fifty (150 g) of maize seeds were mixed with 30 g of acidified clay soil at various concentrations and were placed in air tight containers for 7 days. Twenty five (25 ml) of Sodium hypo-chlorite was diluted with 975 ml of distilled water to make 1 litre hypochlorite solution. Thirty (30) maize seeds from the different seed lots treated with acidified clay were sterilized for 30 seconds in a prepared hypo solution (Adebayo and Salako, 2017). The sterilized seeds were plated using the standard plating pattern (9 round and 1 in the middle) (Adebayo et al., 2018) and replicated three times. Percentage emergence was observed at 24, 48, and 72 hours for the radicle and after 96 hours for the plumule which was on the 6th day. After 24 hours of the plating, number of seeds that germinated was recorded. The experimental design used was 2 by 4 factorial in Completely Randomized Design (CRD).

Data analysis

Data obtained from the experiment were subjected to analysis of variance (ANOVA) using Minitab software version 17 after transformed using square root transformation. Means were separated with Tukey’s test at 5% level of significance.

RESULTS

The percentage germination due to the effects of concentrations of acidified clay at 24, 48, 72 and 96 hours of yellow and white maize varieties was presented in Table 1. There was no significant difference (p>0.05) in the percentage germination across the treatment at different concentrations. Ten percent (10%) concentration of treatment had the highest values at 48 hours (56.7%), 72 hours (86.7%) and 96 hours (71.7%) but were not significantly different at p>0.05.

Table 1. Effect of rates of acidified clay on percentage germination of maize varieties.

Treatments	Hours after plating			
	24	48	72	96
5%	11.70a	45.00[a]	80.00[a]	70.00[a]
8%	20.00a	50.00[a]	83.30[a]	68.30[a]
10%	11.70a	56.70[a]	86.70[a]	71.70[a]
Control	11.70a	40.00[a]	70.00[a]	68.30[a]

Means followed by the same letter are not significantly different at 5% probability.

Table 2. Varietal effect of rates of acidified clay on germination of the two maize varieties.

Variety	Hours after plating			
	24	48	72	96
White	14.20[a]	50.00[a]	79.20[a]	73.30[a]
Yellow	13.30[a]	45.80[a]	80.80[a]	65.80[a]

Means followed by the same letter are not significantly different at 5% probability.

Table 3. Interaction effects of varieties and concentration of acidified clay on the germination of maize seeds.

Variety	Concentration	Hours after plating			
		24	48	72	96
White	5%	6.70[a]	43.30[a]	70.00[a]	63.30[a]
	8%	26.70[a]	56.70[a]	96.70[a]	76.70[a]
	10%	10.00[a]	53.30[a]	76.70[a]	70.70[a]
	Control (0%)	13.30[a]	46.70[a]	73.30[a]	83.30[a]
Yellow	5%	16.70[a]	44.70[a]	90.00[a]	77.60[a]
	8%	13.30[a]	43.30[a]	70.00[a]	60.00[a]
	10%	13.30[a]	60.00[a]	96.70[a]	73.30[a]
	Control (0%)	10.00[a]	33.30[a]	66.70[a]	53.30[a]

Means followed by the same letter are not significantly different at 5% probability.

The varietal effects of the acidified clay on germination of maize varieties were shown on Table 2. Percentage radicle emergence was highest in white maize variety at 24 (14.2%),48 hours (50.0%) after plating while the yellow maize had the highest value at 72 hours (80.8%) but were not significantly different from each other at $p>0.05$. Similarly, no significant difference was observed with regard to percentage plumule emergence where white maize had the highest percentage (73.3%).

The results in Table 3 showed the interaction effects of varieties and concentrations of acidified on the germination of maize seeds. There was no significant difference between the varieties across the rates of application of acidified clay. The percentage radicle emergence in both maize varieties was not significantly different ($p> 0.05$). The percentage plumule emergence at 96 hours after plating was also not statistically different though the control in white maize variety had the highest value (83.3%).

DISCUSSION

The results obtained from this study showed that germination of seeds of maize varieties tested was not negatively affected by the acidified clay at the rates at which it was applied. However, application of 10% acidified clay performed best most especially at 48 to 96 hours after plating.

Several researchers have investigated products such as ashes, rice husks ash and clay for the protection of crop seeds against stored products (Adebayo and Ibikunle, 2014) which did not negatively affect the germination of the seeds. Seed germination is important and crucial to successful crop establishment in maize (Begna et al., 2001) and the seed quality can be inferred from germination characteristics. In terms of varieties, the result showed that the final germination for white and yellow maize responded similarly to the treatments even at different rates application of the acidified clay.

In an experiment, it was reported that rice husk ash and powdered clay protected cowpea and maize seeds against *C. maculatus* and *Sitophilus zeamais* (Adebayo and Ibikunle, 2014). They also reported that germination of the seeds was not negatively affected by the treatments. Though, *Garcinia cola* and groundnut oil protected cowpea seeds against *C. maculatus,* the germination percentage of the seeds was not affected negatively (Adebayo, 2015).

In this study, the germination of seeds was not hindered rather there seems to be scarification effects of the acidified clay on the seed. The treated seeds had better germination percentage in terms of radicle and plumule emergence than the control seeds. A study conducted by Marschner (1991) proved that in the case of some plants, their growth in acid soil is possible, but seed germination must take place in less acidified environment. The current results from this study agreed with his finding due to less acidic rates used in the clay.

Adebule (2018) reported an enhanced performance in the treated seeds of cowpea which was suggested could be due to the broken coat of seeds as a result of the scarificative effects of the acid which was not possible in the control seeds. There had also been suggested that the effect of acid pH may be direct, manifesting itself in dissolving of the seed coat or indirect, which involves stimulating conditions for development of some species of fungi whose action causes perforation of the seed coat (Vleeshouwers et al., 1995). This might be probable for the results obtained in this study.

Conclusion and recommendation

The findings from this study showed that both seeds (white and yellow maize) germination were not negatively affected by the application of treatments (acidified clay). This was because percentage germination of white and yellow maize was not significantly negatively affected. Improved germination was observed in treated maize seeds which suggested possible scarification effects of the acidified clay on the seeds. Therefore, it is recommended that further studies should be carried out on effects of acidified clay as a seed protectant against maize weevil, *Sitophilus zeamais* Mots and also to experiment whether the seeds of maize are scarified by the acidified clay.

CONFLICT OF INTERESTS

The author declares no conflict of interest.

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