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Impact of Maize Seed Moisture Content Reduction on Germination Parameters as Influenced by Sun Drying

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***Abstract*— *When growing seedlings for commercial purposes, excellent seed quality is crucial. Seed quality influences germination rate because seeds that sprout slower typically produce lower-quality seedlings. In numerous plants, seed moisture content has a significant impact on seed germinating speed. This study investigates the impact of various moisture content (MC) reductions on maize germination parameters and determines the moisture content level essential for maize germination. A comprehensive laboratory experiment was laid out in a completely randomized design (CRD) consisting of five treatments and three replicates. The treatment levels were maize seeds not sun-dried after collection (control), maize seed sun-dried for 3 days, maize seed sun-dried for 6 days, maize seed sun-dried for 9 days, and maize seed sun-dried for 12 days. Data were obtained on shoot length, root length, seedling length, germination percentage (GP), germination energy (GE), mean germination time (MGT), and seedling vigour index (SVI). All germination parameters were taken and calculated and the experiment was terminated two weeks after planting (WAP). Results indicated that the control significantly (p<0.05) performed better than other treatments for all the germination parameters. It was determined that maize with moisture content of 9.4% and below had low germination ability. This study concludes that the impacts of reduced moisture content on maize's physical properties (quality, texture, shape), chemical composition (fat and starch content), and biological characteristics (seed viability) resulted in the low germination ability of maize seeds.*

***Keywords*— Germination parameters, maize seed, moisture content reduction, sun drying.**

I. INTRODUCTION

Maize, commonly referred to as corn is widely grown around the world (Awopegba *et al.*, 2017; Suleiman *et al.*, 2013). Maize is a member of the grass family (family: Poaceae, previously Gramineae) (Badu-Apraku and Fakorede, 2017). Globally, maize grain is an important source of food, feed, and raw materials for industrial processes. Starch, protein, oil, and fiber, which make up around 95% of the biomass of harvested grains, are the main nutritious components (Bheemanahalli *et al.*, 2022; Venkatesh *et al*, 2016). Maize is a staple grain crop grown in temperate and tropical locations across the globe in a variety of soil types and climates (Khaeim *et al.*, 2022).

For operations including the production, selling, and processing of maize (*Zea mays* L.), as well as serving as the basis for research, grain moisture content (GMC) measurement precision is crucial (Gao *et al.*, 2021). A key element in maintaining resistant seeds quality is moisture content. The odd association of subcellular water with macromolecular surfaces in seeds ensures membrane and macromolecule preservation (Patil and Krishna, 2016). The loss of water during the drying process results in several metabolic changes that affect the control of growth regulators, the quantity and type of proteins and carbohydrates, the presence of free radicals, and the physical water status, among other things, and causes the deterioration process to begin. When the germination percentage was significantly reduced, this moisture was called critical moisture content. When there was no germination, it was called fatal moisture content (Patil and Krishna, 2016).

Maize deformation results from high moisture content in storage. Maize is dried for planting in a variety of traditional ways, including sun, hot air, and other methods. In addition, maize seeds are damaged when dried at high temperatures (Nair *et al.*, 2011). Drying seeds artificially requires removing extra moisture. Seed drying lowers respiration while also preventing seed quality from deteriorating in storage due to microbial development and insect and mite activity (El-Abady, 2014). Maize seeds lose moisture during drying, causing physical changes. Changes in mass, volume, density, colour, and porosity are typically used to characterize physical changes in cereal grains during growth or a decrease in moisture content (Cârlescu *et al.*, 2023). However, moisture-rich maize should not be stored.

Germination is the process through which a seed or spore grows into a plant following a period of inactivity (Wade *et al.*, 2016). Seed germination is a protrusion of the radicle from the tissue(s) enclosing it (Soltani *et al.*, 2015). A seedling grows and develops during germination, a physiological process that sets off a chain reaction of biological and biochemical events (Khaeim *et al.*, 2022; Poudel *et al.*, 2019). Rapid water absorption by seeds during the imbibition phase of germination causes the seed coat to stretch and soften at the right temperature (Fu *et al.*, 2021). The seed's internal physiological processes are then triggered, and respiration begins (Itroutwar *et al.*, 2020; Koornneef *et al.*, 2002). Last but not least, the cracked seed coatings enable the development of radicles and plumules. This means that, as a result, it begins with the dry, dormant seed absorbing water and ends with the radicle emerging as a result of the lengthening of the embryo axis (Fu *et al.*, 2021). Several coordinated physiological and morphogenetic processes, such as seed energy transfer, endospermic nutrition absorption, and physiological and metabolic changes are all involved in this process (Nciizah *et al.*, 2020).

Germination impacts maize yield and quality (Xue *et al.*, 2021). Plants develop fundamentally from a single seed into a plant (Lara-Núñez *et al.*, 2021). The interaction of environmental variables and seed physiological conditions regulates germination (McCormick *et al.*, 2016). Germination is influenced by temperature, light, and water availability (McCormick *et al.*, 2016). Seed germination reflects population size, distribution, and abundance (Khaeim *et al.*, 2022). Seed physiological response to overlapping extrinsic and abiotic stimuli impacts propagation success (Norgrove, 2021).

Maize is traditionally dried outside in the sun. To dry maize, lay the grains out on a mat and expose them to the sun (Ntwali *et al.*, 2021). Sun drying is an alternative and affordable method for smallholder farmers of reducing maize moisture content (Kaminski and Christiaensen, 2014). Uneven moisture removal, exposure to insects, rodents, birds, and dust, and failure to obtain an acceptable moisture level due to a significant dependence on weather conditions are the method's drawbacks for sun-drying (Fudholi *et al.*, 2010). However, this study investigates the impact of various moisture content (MC) reductions on maize germination parameters and determines the level of moisture content essential for maize germination.

II. MATERIALS AND METHODS

Experimental Site

A comprehensive laboratory experiment was conducted in the Agricultural Technology Department of Ekiti State Polytechnic, Isan Ekiti. It is located in the rainforest agroecological zone in southwest Nigeria. The laboratory has a constant 22^0C temperature. The experiment was carried out between January 12th and February 7th, 2023.

Source of Material

Improved maize variety **(**Mastrop 143) was collected from Sunbeth Global Concepts, Ondo State, Nigeria.

Experimental Design

This study consists of five (5) treatments. Ten (10) seeds were planted per replicate which makes it thirty (30) seeds per treatment as each treatment was replicated three times. In this study, the experimental design was completely randomized (CRD). The treatment levels were:

T_1 = Maize seed not sun-dried after collection (Control)

T_2 = Maize seed sun-dried for 3 days

T_3 = Maize seed sun-dried for 6 days

T_4 = Maize seed sun-dried for 9 days

T_5 = Maize seed sun-dried for 12 days

For all the sun-dried maize, it was sun-dried for 7 hours between 9:00 am and 4:00 pm daily.

Planting and Cultural Practices

Desiccators were used to store maize seeds not to absorb moisture after sun drying. Maize seed was uniformly planted at 3 cm depth. Maize seeds were planted directly in moisture containers containing sterilized loam soil and arranged on the slab in the Agricultural Technology Laboratory. A maize seed was planted inside each moisture container and water was applied every day. All germination parameters were taken and calculated and the experiment was terminated two weeks after planting (WAP).

Data Collections

Immediately after the collection of maize seeds, the moisture content was determined with a moisture meter before planting. The moisture content at every stage of planting was also determined with a moisture meter. Germination parameters were taken every 24 hours up to two weeks after planting. Data were obtained on plant shoot length (plumule), plant root length (radicle), seedling length, germination percentage (GP), germination energy (GE), mean germination time (MGT), and seedling vigour index (SVI).

- Plant shoot length was determined using measuring tape in centimetres. Plant root length was determined with a measuring tape after uprooting the plant. The seedling length was obtained by combining plant shoot length and plant root length.

- $GP = \frac{\text{Number of seeds germinated}}{\text{Total number of seeds planted}} \times 100$ (Anupama *et al.*, 2014) (1)
- $GE = \frac{\text{Number of seeds germinated at 144 hours}}{\text{Total number of seeds planted}} \times 100$ (2)
- $MGT = \frac{\Sigma (n \times d)}{N}$ (Kulkarni *et al.*, 2007) (3)

where n = Number of seeds germinated on each day, d = Number of days from the beginning of the test, and N = Total number of seeds germinated at the termination of the experiment.

- SVI = Seedling Length × Germination Percentage (Anupama *et al.*, 2014) (4)

Data Analysis

The data obtained on the germination parameters were analyzed statistically using Analysis of Variance. Data were examined with SPSS version 21 and Duncan's Multiple Range Test (DMRT) was used to compare treatment means.

III. RESULTS AND DISCUSSION

Table 1 shows the moisture content of maize seeds influenced by sun drying. The moisture content of maize sun-dried for 3 days (T_2), maize sun-dried for 6 days (T_3), maize sun-dried for 9 days (T_4), and maize sun-dried for 12 days (T_5) were 12.0%, 9.4%, 6.9%, and 5.2% respectively while the moisture content of the control was 14.6%. Patil and Krishna (2016) discovered that a reduction in the moisture content of seeds occurs during drying under shade and that the longer the time of drying the more the reduction of moisture content. In other words, the longer the sun-drying duration, the lower the moisture content of maize seeds.

Table 1: Moisture Content of Maize Influenced by Sun Drying

Treatments	**Moisture Content (%)**
T_1= Control (Maize not sun-dried after collection)	14.6
T_2= Maize sun-dried for 3 days	12.0
T_3= Maize sun-dried for 6 days	9.4
T_4= Maize sun-dried for 9 days	6.9
T_5= Maize sun-dried for 12 days	5.2

Table 2 shows the impact of moisture content reduction on maize shoot and seedling length as influenced by sun drying. There were significant differences among the treatments in root length. T_1 had the longest root length while T_5 had the least. Significant differences in shoot and seedling length occurred among the treatments. T_1 had the longest shoot and seedling length and the shortest was T_5.

Table 2: Impact of Moisture Content Reduction on Maize Shoot and Seedling Length as Influenced by Sun Drying

Treatments	Root length (cm)	Shoot length (cm)	Seedling length (cm)
T_1	8.28^a	7.22^a	15.50^a
T_2	7.70^b	6.70^b	14.40^b
T_3	7.25^c	6.16^c	13.41^c
T_4	7.00^{cd}	5.50^d	12.50^d
T_5	6.00^e	4.45^e	10.45^e

* Means followed by the same letter in the same column are not significantly ($p > 0.05$) different as indicated by Duncan Multiple Range Test.

Table 3 shows the impact of moisture content reduction on germination parameters as influenced by sun drying. Germination parameters under consideration were germination percentage, germination energy, and seedling vigour index. Significantly, higher seed germination (93.33 percent) was observed in seeds planted immediately after collection (T_1). In addition, the maize seeds sun-dried for 3 days (T_2) performed relatively well compared with the control in terms of germination percentage. The lowest seed germination (13.33 percent) was observed in seeds sun-dried for 12 days (T_5). In general, seeds' moisture content dropped as drying time increased, inhibiting seed germination. Broschat and Donselman's (1986) findings in the tropical species corroborated this study. As for the germination energy, the data were taken 6 days after planting. There were significant differences among the treatments**.** Significantly, T_1 germinated faster than every other treatment while the least was recorded for T_5. The highest seedling vigour was observed for T_1, while it declined as maize moisture content reduced across other treatments.

Table 3: Impact of Moisture Content Reduction on Germination Parameters as Influenced by ***Sun Drying***

Treatments	GP (%)	GE (%)	SVI
T_1	93.33^a	90.00^a	1446.62^a
T_2	83.33^{ab}	53.33^b	1199.95^b
T_3	46.67^c	40.00^c	625.84^c
T_4	26.67^d	23.33^d	333.38^d
T_5	13.33^e	6.6^e	139.30^e

*****Means followed by the same letter in the same column are not significantly (p> 0.05) different as indicated by Duncan Multiple Range Test.

Figure 1 shows the mean germination time influenced by sun-drying maize seeds. Reduction in maize seeds' moisture content caused an increase in germination time. There was an increase in the mean germination time as the moisture content decreased. T_1 with the highest moisture content has the lowest mean germination time compared to other treatments, which makes it better than the rest of the treatments. The fastest germination has the lowest mean germination time. Fetouh and Hassan (2014) established that faster germination leads to lower values of the speed index known as mean germination time (MGT). Reduction in moisture content seriously affected T_4 and T_5.

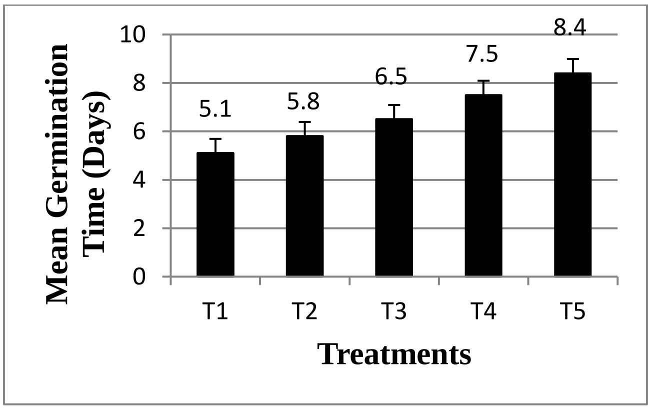

Fig. 1: Mean Germination Time Influenced by Sun Drying Maize Seeds

IV. CONCLUSION

This study demonstrated that reducing maize moisture content below 12% affects germination of maize. Germination percentage varied between 93.33% and 83.33% when the moisture content was 14.6% and 12%. Below that, 46.67% was obtained as a germination percentage for maize at 9.4% moisture content. Other germination parameters such; as germination energy, seedling vigour index, and mean germination time were also considered. It was determined that maize with 9.4% moisture content had low germination ability. This study concludes that the impacts of reduced moisture content on maize's physical properties (quality, texture, shape), chemical composition (fat and starch content), and biological characteristics (seed viability) resulted in maize seeds' low germination ability.

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