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The Effect of Traditional Shade-drying Method on Seed Germination and Vigour of Two Varieties of Tomato

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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Short Research Article

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ABSTRACT

The effect of traditional shade-drying method on the seed germination and vigour of two varieties of tomato was investigated. The experiment was conducted at the seed testing laboratory of The National Centre for Genetic Resources and Biotechnology (NACGRAB), Ibadan, Nigeria in July 2015. The seed samples were dried for one week in the drying chambers and thereafter evaluated for germination and vigour tests. The experiment was carried out in a completely randomized design with three replications, in 2 x 2 factorial scheme. Two varieties of tomato (Ibadan local and Alausa) and two drying methods: traditional (shade-drying with an electric fan at a temperature between 23.5 to 32.3°C) and mechanical (seed dryer at 35°C) were evaluated. The germination

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percentage of Ibadan local variety was significantly higher (87.2%) when compared to that of Alausa (79.0%). Mechanical drying at 35°C gave the higher germination percentage (94.16%), while seeds dried traditionally gave the germination of 72.0%. Moreover, the effect of drying method was not significant on germination index of tomato seeds, suggesting that seeds dried using both methods may not exhibit differential performance when subjected to unfavourable environmental conditions either on the field or during storage. The study indicates that drying using seed dryer at controlled drying temperature would enhance germination of tomato seeds better than traditional shade drying method.

Keywords: Tomato; drying; germination percentage; germination index.

1. INTRODUCTION

Tomato (*Lycopersicon lycopersicum* Mill.) is one of the most important vegetables worldwide belonging to the Solanaceae family. It is cultivated for its fruits which contribute to a healthy, well-balanced diet in human nutrition. Tomato fruits are rich in minerals, vitamins, essential amino acids, sugars and dietary fibres. The fruits can be consumed fresh in salads or cooked in sauces, soup and meat or fish dishes. They can be processed into purées, juices and ketchup. Canning and drying are also economically important means of processing tomato fruits.

Tomato is propagated by seed and the use of high quality seeds is very important for the successful production of this crop as the establishment of an adequate plant population in the field is necessary to achieve high productivity [1]. Drying operation is a critical step in the post-harvest processing of tomato seeds however, seed quality can be reduced during drying due to injury caused by unfavourable drying conditions, although the causes and impairment mechanisms are poorly understood [2]. The air temperature and relative humidity of the environments during drying process are the two major factors that influence the germination characteristics of seeds hence methods of drying must be carefully selected in order to avoid injury caused by unfavourable drying conditions. There are several factors to be considered when choosing seed drying method to be used which include seed volume effectively harvested, harvest speed, drying time, energy consumption and end purpose of seeds. There are different methods of seed drying, such as shade and sun drying, vacuum drying, freeze drying and refrigeration drying with low relative humidity [3]. Other recommended methods for safe drying of seeds include seed drying chambers, seed dryers and controlled conditions [4] however, in many developing countries, such drying facilities are limited due to the high cost of establishing, running and maintaining such facilities.

The fundamental objective of seed testing is to establish the quality level of seed. Seed vigour and germination tests aimed at differentiating low and high quality seeds from each other. The Association of Official Seed Analysts [5] defined seed germination as ‘the emergence and development from the seed embryo of those essential structures which, for the kind of seed in question, are indicative of the ability to produce a normal plant under favourable conditions’. Germination capacity, therefore, forms a crucial aspect of seed quality hence the germination tests are used worldwide to determine the maximum germination potential of a seed batch under optimum conditions. The International Seed Testing Association (ISTA) [6] defined seed vigour as “the sum total of those properties of the seed that determine the level of activity and performance during germination and seedling emergence”. The aspect of performance associated with seed vigour include (i) rate and uniformity of seed germination and seedling growth, (ii) field performance, including the extent, rate and uniformity of seedling emergence, and (iii) performance after storage and transport particularly the retention of germination capacity. The concept of seed vigour implies that two seed lots having similar germination level may perform differently due to differences in vigour potential when subjected to poor field conditions. Speed of emergence of seedlings is one of the oldest seed vigour concepts and vigorous seeds have been shown to germinate rapidly. Speed of germination has been measured by various techniques and given many different names such as: emergence rate index, germination rate, germination index and speed of germination. The tests have important advantages. They are inexpensive, rapid, require no specialised equipment, and most importantly do not necessitate additional technical training.

Tomato fruits harvested at physiological maturity usually contain high moisture of 60 to 70% hence sooner the seed is extracted, cleaned and dried better will be the quality. In addition, the rate at which moisture evaporates from the seed surface also determines the quality of tomato seeds. If moisture evaporates too rapidly, the resulting moisture stress can damage the embryo. If the moisture evaporates too slowly, it may favour invasion of pathogen, therefore, seeds should be dried carefully to arrest stress damage.

Investigations have been conducted on effective methods of drying seeds of some solanaceous crops such as chilli [7,8] and tomato [9]. However, most of the studies laid much emphasis on traditional methods of drying probably due to the high cost of establishing, running and maintaining mechanical methods of drying such as drying chambers or seed dryers. In order to develop an efficient drying method without compromising seed health and quality, the National Centre for Genetic Resources and Biotechnology (NACGRAB) located in Ibadan, Nigeria who has institutional mandate for genetic resources conservation and utilisation in Nigeria recently procured seed dryer for drying of seeds especially for small seeded crops like tomato, however, information on comparative performance between traditional method (shade-drying with electric fan at temperature between 23.5 to 32.3°C) which was in practice at NACGRAB and mechanical method (seed dryer at 35°C) on seed quality of tomato is not available. The aim of this study, therefore, was to compare these two drying methods with a view to identify the best method suitable for a successful and cost effective production of biologically viable tomato seeds.

2. MATERIALS AND METHODS

2.1 Plant Materials and Seed Production

The seeds of two varieties of tomato: Ibadan local and Alausa, which are popularly cultivated by farmers in the South West Nigeria were sourced from the seed gene bank of the National Centre for Genetic Resources and Biotechnology (NACGRAB), Ibadan. Seed production was carried out at the experimental field of NACGRAB during the growing seasons of 2015.

2.2 Seed Processing

Fruits of the two varieties of tomato were harvested at physiological maturity stage and seeds were extracted directly after harvesting. The extraction was done by hand to minimise mechanical damage. The seeds of each variety were partitioned into two equal parts and samples from each variety were subjected to two drying methods: traditional (shade-drying with electric fan at temperature between 23.5 to 32.3°C) and Mechanical (seed dryer at 35°C). The seed samples were dried for one week in the drying chambers and thereafter evaluated for germination and vigour tests.

2.3 Experimental Design

The experiment was conducted at the seed testing laboratory of NACGRAB in July 2015. The experiment was carried out in a completely randomized design with three replications, in 2 x 2 factorial scheme. Two varieties of tomato and two drying methods: traditional (shade-drying with an electric fan at temperature between 23.5 to 32.3°C) and mechanical (seed dryer at 35°C) were evaluated.

2.4 Standard Germination and Vigour Tests

One hundred seeds of each variety were drawn and evaluated for standard germination test in three replications. The test was assayed by placing the seeds in germination plastic containers lined with four layers of tissue paper moistened with 15 ml of distilled water. The containers were covered and placed in a germinating chamber at 25 ± 2°C. The seeds were kept moist every day for seven days. Germination percentages were calculated by expressing the number of seedlings in a replicate that emerged 7 days after planting as a percentage of the number of seeds planted according to ISTA rules [10]. Germination Index (GI) was calculated by taking the germination counts at 5, 7 and 9 days after planting using the following formula:

$$GI = \frac{\text{No of germinated seed}}{\text{Days of first count}} + \ldots\ldots\ldots + \frac{\text{No of germinated seed}}{\text{Days of final count}}$$

2.5 Data Analysis

Data on germination percentage were subjected to analysis of variance (ANOVA) using Statistical Analysis Software, SAS Version 9.1 [11]. Data on percentages do not conform to normal distribution, the germination data were therefore log transformed before subjecting them to the ANOVA. However, since ANOVA did not detect any significant difference between transformed and untransformed values, untransformed values are hereby presented. Pertinent means were separated by the use of the least significant difference (LSD) at 0.05 level of probability.

3. RESULTS AND DISCUSSION

3.1 Germination Performance of Tomato Seeds as Influenced by Variety and Drying Methods

Analysis of variance (ANOVA) revealed that effect of tomato variety was significant ($P < 0.05$) while effect drying methods (DRY) was highly significant ($P < 0.01$) on germination of tomato seeds (Table 1). The germination percentage of Ibadan local was significantly higher (87.17%) when compared to the germination percentage of Alausa (79.0%) (Table 2). This result emphasises the fact that genetic constitution of any seedlot is a major determinant of its quality. The result agrees with findings of some authors who reported variations among genotypes of different species of crops. Tame and Elam [12] reported significant variation among three soybean varieties for germination after 360 days in storage. Similarly, Omar et al. [13] also reported significant variation among three cultivars of wheat for germination, viability (Electrical conductivity and Acidity %) and seedling vigour (radical length, plumule length and seedling dry weight) after storage at different periods.

Similarly, effect of drying methods was significant on germination of tomato seeds. Mechanical drying method using the seed dryer at 35°C gave the higher germination percentage (94.16%) while seeds dried traditionally under shade with electric fan gave the germination percentage of 72.0% (Table 2). This significantly lower in seed germination for traditional shade-drying using electric fan might be as a result of slow evaporation of moisture from the seed surface coupled with fluctuation in temperature of the room conditions which might favour invasion of pathogen. Although, Gowda et al. [9] concluded that combined sun and shade drying resulted in the highest seed germination of tomato (94%) however from this study, mechanical drying method using the seed dryer at 35°C gave better germination percentage compared to traditional shade-drying using electric fan. This result corroborated with the findings of Ali et al. [14] who concluded that sorghum seeds dried with seed dryer gave the highest germination percentage compared to those dried using silica gel, or under shade and sun. They further reported that drying with silica gel and shade are good alternative methods of drying. Nevertheless, our results show that traditional shade-drying using electric fan could also serve as an alternative or low cost method of drying tomato seeds. This is in line with the report of [8] who investigated the effect of seed drying methods namely, sun-drying, shade-drying and freeze drying on physiological quality of chilli seeds and concluded that shade-drying was significantly better than other methods of drying. Furthermore, our results show that the effect of drying method was not significant on germination index of tomato seeds suggesting that tomato seeds dried using both methods may not exhibit differential performance when subjected to unfavourable environmental conditions either on the field or during storage.

Table 1. Mean squares from the analysis of variance for the germination test and germination index on tomato seeds at NACGRAB, Ibadan

Source of variation	DF	Germination (%)	Germination index (days)
Rep	2	73.58ns	0.00ns
Variety (VAR)	1	200.08*	0.01ns
Drying methods (DRY)	1	1474.08**	0.00ns
VAR x DRY	1	102.08ns	0.02ns
Error	6	27.91	0.00
Total	11	190.08	0.01
CV		6.36	1.56
Mean		83.08	4.1

*DF - Degrees of freedom; CV - coefficient of variation; *, ** - significant at probability level of 0.05 and 0.01, respectively; ns - not significant*

Table 2. Effect of varieties and drying methods on seed germination of tomato at NACGRAB, Ibadan

Factors	Seed germination (%)	Germination index (days)
Variety		
Ibadan local	87.17a	4.13a
Alausa	79.00b	4.01a
LSD	**7.46**	**0.09**
Drying methods		
Traditional	72.00b	4.11a
Mechanical	94.16a	4.08a
LSD	**7.46**	**0.09**

4. CONCLUSION

This study led to the conclusion that the drying method highly affects the seed germination of tomato. From this study, mechanical drying at 35°C would give better germination compared to traditional shade-drying using electric fan. Moreover, the effect of drying method was not significant on germination index of tomato seeds suggesting that tomato seeds dried using both methods may not exhibit differential performance when subjected to unfavourable environmental conditions either on the field or during storage. Furthermore, the study indicated that traditional shade-drying using electric fan could serve as an alternative method of drying tomato seeds.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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