The effect of drying methods on seed germination and vigour of two varieties of tomato

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ABSTRACT

Seed drying is an energy demanding operation. The objective of this study was to compare the effect of two drying methods on germination and vigour of tomato seeds. ~~Freshly extracted seeds of two varieties of tomato (Ibadan local and Alausa), were subjected to drying using traditional (shade drying with electric fan at temperature between 23.5 to 32.3^{o}C) and Mechanical (seed dryer at 35^{o}C) methods.~~ The ~~laboratory~~ 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~~arranged in 2 x 2 factorial using~~ completely randomized design ~~(CRD)~~ with~~in~~ three replications, in 2 x 2 factorial scheme. ~~The two factors were t~~Two varieties of tomato (Ibadan local and Alausa) and two drying methods: traditional (shade drying with electric fan at temperature between 23.5 to 32.3^{o}C) and mechanical (seed dryer at 35^{o}C) were evaluated. ~~The results of analysis of variance (ANOVA) revealed that effects of variety of tomato was significant ($P=0.05$) while effect of drying method was highly significant ($P<0.01$) on germination of tomato seeds.~~ The germination percentage of Ibadan local variety was significantly higher (87.2%) ~~than the germination percentage of~~ in comparison to the Alausa ~~with value of~~ (79.0%). Mechanical drying at 35^{o}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 ~~tomato~~ seeds dried using both methods may not exhibit *differential performance when subjected to unfavorable environmental conditions either on the field or during storage.*

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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 successful crop production as the establishment of an adequate plant population in the field is necessary to achieve high productivity [1]. Drying is an energy demanding operation and is a critical step in the post-harvest process of tomato seeds. However, seed quality can be reduced during drying due to injury caused by unfavorable 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 unfavorable 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 developing countries, such drying facilities for germplasm storage are limited.

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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. Germination capacity is a crucial aspect of seed quality therefore germination tests are used worldwide to determine the maximum germination potential of a seed batch under optimum 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 specialized equipment, and most importantly do not necessitate additional technical training.

In a study to determine the optimum conditions for drying tomato seeds on a commercial scale [5], ~~Gowda, et al [5]~~ compared traditional (sun only, shade only and sun and shade) and mechanical (using a drier at air temperatures of 35, 40, 45, 50 or 55°C) methods of drying. They concluded that combined sun and shade drying resulted in the highest seed germination rate (94%) while tomato seeds could be safely dried at temperatures of 35 or 40°C with percentage germination maintained at 89-91% using seed dryer. 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 utilization in Nigeria recently procured seed dryer for drying of seeds especially for small seeded crops like tomato however, information on drying of tomato seeds using traditional (shade drying with electric fan at temperature between 23.5 to 32.3°C) which was in practice at NACGRAB compared with ~~M~~mechanical (seed dryer at 35°C) is not available. Therefore, the aim of this study 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. MATERIAL AND METHODS

2.1 Plant ~~m~~Materials and ~~s~~Seed P~~p~~roduction

The seeds of two varieties of tomato: Ibadan local and Alausa, which are popular among the 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 the NACGRAB~~centre~~ during the growing seasons of 2015.

2.2 Seed ~~p~~Processing

Fruits of the two varieties were harvested at physiological maturity stage and seeds were extracted directly after harvesting. The extraction was done by hand to minimize 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).

2.3 ~~Laboratory experiments and e~~Experimental ~~d~~Design

The ~~laboratory~~ experiments were conducted at the seed testing laboratory of NACGRAB 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 arranged in 2 x 2 factorial using completely randomized design (CRD) in three replications. The two factors were two varieties of tomato and two drying methods~~ *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 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

The seed samples were dried for one week in the drying chambers. 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 [6]. Germination Index (GI) was calculated by taking the germination counts at 5, 7 and 9 days after planting ~~and the data were substituted into~~using the following formula~~e~~:

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

2.5 Data Analysis

Data on germination percentage were subjected to analysis of variance (ANOVA) using Statistical Analysis Software, SAS Version 9.1 [7]. 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 ~~t~~Tomato ~~s~~Seeds as ~~i~~Influenced by ~~v~~Variety ~~of tomato~~ and ~~d~~Drying ~~m~~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 variety was ~~significantly~~ higher (87.17%) in comparison to the Alausa (79.0%)~~than Alausa with germination percentage of 79.00%~~ (Table 2). This implies that genetic constitution of any seedlot is a major determinant of its quality. This finding agrees with ~~that~~ results of ~~Tame and Elam~~ [8], who reported significant difference in germination of soybean varieties.

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~~df~~	Germination (%)	Germination index (days)
Rep	2	73.58ns	0.00ns
Variety~~ies~~ (VAR)	1	200.08*	0.01ns
Drying ~~M~~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
R^2 (%)		0.91	0.61
CV		6.36	1.56
Mean		83.08	4.1

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

Similarly, effect of drying methods was significant on germination of tomato seeds. Mechanical drying at 35°C gave the higher germination percentage (94.16%) while seeds dried traditionally with electric fan at room temperature gave the germination percentage of 72.0~~0~~% (Table 2). This significantly lower in seed germination for electric fan drying at room temperature might be as a result slow evaporation from the seed surface coupled with fluctuation in temperature of the room conditions which may favour invasion of pathogen. Although, ~~Gowda et al.~~ ~~(~~[5]~~)~~ concluded that combined sun and shade drying resulted in the

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highest seed germination rate (94%) however from this study, drying at room temperature with electric fan could not give the best germination percentage. In addition, 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 unfavorable environmental conditions either on the field or during storage.

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

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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**

CONCLUSION

This study led to the conclusion that the drying method highly affects the seed germination percentage. From this study, mechanical drying at 35^{o}C would give better germination compared with electric fan drying under room temperature. 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 unfavorable environmental conditions either on the field or during storage.

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