Original Research Article

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 drying methods on germination and vigour of tomato seeds. Freshly extracted seeds of two varieties of tomato (Ibadan local and Alausa), were subjected to 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.) The laboratory experiments were conducted at the seed testing laboratory of The National Centre for Genetic Resources and Biotechnology (NACGRAB), Ibadan, Nigeria. The seed samples were drawn at weekly intervals from the drying chambers and evaluated for germination and vigour tests. The experiments were conducted weekly for five weeks between July and August 2015. The experiment was arranged in 2 x 2 x 5 factorial using completely randomized design (CRD) in three replications. The three factors were two varieties of tomato, two drying methods and five experiments. The results of Analysis of variance (ANOVA) revealed that effects of variety of tomato, drying methods, experiments, variety by experiment interaction as well as drying method by experiment interaction were highly significant (P<0.01) on germination of tomato seeds. However, only the effect variety by drying method interaction were highly significant (P<0.01) on emergence index. Ibadan local variety was significantly higher (90.6%) in germination percentage compared with Alausa with germination percentage of 82.7%. Mechanical drying at 35^{o}C gave the higher germination percentage (92.7%), while seeds *dried traditionally gave the germination of 80.7%. In addition, mean germination percentages due to the influence of the period of conduct of experiments from first week were 87.2, 92.7, 87.3, 83.5 and 82.6% respectively suggesting that tomato seed drying should be done as soon as possible after harvesting and extraction to avoid rapid ageing. Also, mean germination index due to the influence of the period of conduct of experiments from first week were 4.9, 5.0, 5.1, 5.1 and 5.1 days respectively indicating that slight deterioration in the course of drying would probably reduce the vigour hence increase in time taken to germinate. Therefore from the study mechanical drying would give better germination and enhance vigour.*

Keywords: Tomato, drying, germination, germination index.

1. INTRODUCTION

Tomato (*Lycopersicon lycopersicum* Mill.) is one of the most important vegetables worldwide. It belongs to the Solanaceae family. Tomato fruits contribute to a healthy, well-balanced diet. They are rich in minerals, vitamins, essential amino acids, sugars and dietary fibres. They also contain much vitamin B and C, iron, phosphorus and Lycopene. Lycopene is a very powerful antioxidant in tomato which helps prevent the development of many forms of cancer. Tomato fruits are consumed fresh in salads or cooked in sauces, soup and meat or fish dishes. They can be processed into purées, juices and ketchup. Canned and dried tomatoes are economically important processed products.

Tomato is propagated by seed and the use of high quality seeds is one of the most important factors for successful crop production as the establishment of an adequate plant population in the field is necessary to achieve high productivity [1]. Seed quality is often reduced because of drying injury, although the causes and impairment mechanisms are poorly understood. However, the impairment of lip body alignment along the plasma membrane during artificial drying of seed has been associated with decrease in germination and vigor [2].

The fundamental objective of seed testing therefore 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. 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.

Drying is an expensive and energy demanding operation. Several factors have to be considered when choosing between seed drying methods. These aspects include seed volumes effectively harvested, harvest speed, drying time, energy consumption, end purpose of seeds, apart from human-related aspects like technological knowledge and purchase power of the producer. Nevertheless, the specific characteristics of each product harvested as seen in the light of the heat transfer technique adopted may determine the best drying method to be used, with minimal damage to physical and physiological seed quality [3]. Early harvest and rapid drying have been advocated as a means of reducing the incidence of seed-borne pathogen and consequently reducing the level of toxic metabolites production. Diverse methods of seed drying, such as shade and sun drying, vacuum drying, freeze drying and refrigeration drying with low relative humidity are available [4] along with recommended methods for safe drying of seeds such as seed drying chambers, seed dryers and controlled conditions [3]. In developing countries, such drying facilities for germplasm storage are limited or not available. In a study determining the optimum conditions for drying tomato seeds of cultivar on a commercial scale, 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° with percentage germination maintained at 89-91% using seed dryer. With an objective of developing efficient, alternative and energy efficient drying methods to reduce seed moisture content 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 small seeded crops like tomato. Therefore, the aim of this study was to compare two drying methods with a view to identify the best suited for a successful and cost effective production of biologically viable tomato seeds.

2. MATERIAL AND METHODS

2.1 Plant materials and seed production

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 centre during the growing seasons of 2015.

2.2 Seed processing

Fruits of the two accessions 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^{o}C) and Mechanical (seed dryer at 35 ^{o}C).

2.3 Laboratory experiments and experimental design

The laboratory experiments were conducted at the seed testing laboratory of NACGRAB. The seed samples were drawn at weekly intervals from the drying chambers and evaluated for germination and vigour tests. The experiments were conducted weekly for five weeks between July and August 2015. The experiment was arranged in 2 x 2 x 5 factorial using completely randomized design (CRD) in three replications. The three factors were two varieties of tomato, two drying methods and five experiments.

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 15ml 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 the following formulae:

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

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 thereafter 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 to drying methods

Analysis of variance (ANOVA) revealed that effects of variety of tomato (VAR), drying methods (DRY), experiments (EXP), variety by experiment (VAR × EXP) interaction as well as drying method by experiment (DRY × EXP) interaction were highly significant (P<0.01) on germination of tomato seeds (Table 1). However, only the effect variety by drying method (VAR × DRY) interaction were highly significant (P<0.01) on emergence index (Table 1).

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

Source of variation	df	Germination (%)	Emergence index (days)
Rep	2	64.87ns	0.02ns
Varieties (VAR)	1	928.27**	0.06ns
Drying Methods (DRY)	1	2160.00**	0.07ns
Experiment (EXP)	4	188.17**	0.14ns
VAR x DRY	1	640.27**	0.55**
DRY x EXP	4	391.50**	0.08ns
VAR x EXP	4	93.76ns	0.08ns
VAR x DRY x EXP	4	65.76ns	0.04ns
Error	38	70.90	0.06
Total	59	161.18	0.07
R^2 (%)		0.72	0.49
CV		9.72	4.76
Mean		86.67	5.03

*, **, Significant at probability level of 0.05 and 0.01, respectively; ns = not significant

3.2 Germination Performance of tomato seeds as influenced by Variety, Drying Methods and Experiments

A significant difference between varieties of tomato was observed for germination percentage obtained. Ibadan local variety was significantly higher (90.6%) in germination percentage compared with Alausa with germination percentage of 82.7% (Table 2). This finding also agrees with that of Tame and Elam [8] who reported significant difference in germination of soybean varieties. Similarly effect of storage drying methods was significant on germination of tomato seeds. Mechanical drying at 35^{o}C gave the higher germination percentage (92.7%), while seeds dried traditionally with electric fan at room temperature gave the germination percentage of 80.7%. In addition, mean germination percentages due to the influence of the period of conduct of experiments from first week were 87.2, 92.7, 87.3, 83.5 and 82.6% respectively (Table 2). This downward trend especially from the second week might be due to slight deterioration in the course of drying. This suggests that tomato seed drying should be done as soon as possible after harvesting and extraction to avoid rapid ageing of these materials. Also, mean germination index due to the influence of the period of conduct of experiments from first week were 4.9, 5.0, 5.1, 5.1 and 5.1 days respectively (Table 2). This upward trend in time taken to germinate clearly showed that the slight deterioration in the course of drying would probably reduce the vigour hence increase in time taken to germinate.

Table 2: Effect of varieties, drying methods and experiment in storage on seed germination of seed at NACGRAB, Ibadan.

Factors	**Seed germination (%)**	**Emergence Index (days)**
A. Varieties		
Ibadan Local	90.6a	5.06a
Alausa	82.7b	5.00a
LSD	**4.40**	**0.13**
B. Drying Methods		
Traditional	80.67b	5.06a
Mechanical	92.67a	5.00a
LSD	**4.40**	**0.13**
C. Experiments		

Experiment 1	87.2ab	4.86b
Experiment 2	92.7a	4.97ab
Experiment 3	87.3ab	5.11a
Experiment 4	83.5b	5.08a
Experiment5	82.7b	5.11a
LSD	**6.96**	**0.20**

In addition, germination response in a drying chamber varied between varieties. Ibadan local variety (VAR1) had germination percentage (87.9%) which was significantly higher than Alausa (VAR2) with germination of 73.5% under traditional drying (Table 3).

Table 3. Germination of tomato seeds as influenced by interaction of varieties and drying method at NACGRAB, Ibadan.

Varieties (VAR)	Drying Method (DRY)	Germination (%)	Emergence index (days)
VAR1	DRY1	87.87a	5.19a
VAR2	DRY2	92.00a	5.06ab
VAR2	DRY1	73.47b	4.94b
VAR1	DRY2	93.33a	4.93b
LSD		**7.49**	**0.19**

VAR1=Ibadan local, VAR2=Alausa; DRY1= Traditional, DRY2=Mechanical

CONCLUSION

This study led to the conclusion that the drying method highly affects the seed germination percentage as well as speed of germination (vigour) of tomato seeds. From this study mechanical drying at 35^{o}C would give better germination and enhance vigour. Moreover, the significant variety by drying method interaction suggests that in a drying method variety should be given consideration.

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