Journal of Sustainable Development in Africa (Volume 10, No.4, 2009)

ISSN: 1520-5509

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Assessing the Effects of Fermentation Time on Tomato (*Lycopersicon lycopersicum Mill*) Seed Viability

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ABSTRACT

An experiment to determine the effect of fermentation time on tomato (Lycopersicon lycopersicum MILL) seed viability was done at the Seed Services Institute in Zimbabwe. Tomato fruits were cut and the seed and gelatinous material scooped and fermented for varying time periods. After drying the fermented seed to 5% moisture content, germination tests were done. The results showed that seeds can be fermented for up to three days without affecting their viability. Longer fermentation has negative effects on tomato seed viability as measured by the germination rate, number of dead seeds, and the development of abnormal seedlings.

Key Words: Tomato, Seed, Germination, Fermentation, Viability

INTRODUCTION

The tomato plant (*Lycopersicon lycopersicum* MILL) is one of the most important vegetables, both nutritionally and economically (Ruben, 1980; Osata, 2003). Despite the crop's importance, Zimbabwe is facing a critical shortage of tomato seed due to the fact that most seed producing companies having left the country at the turn of the century. Most of the seed available on the market is imported; hence, expensive to small-scale, resource-poor farmers. The farmers, therefore, resort to retaining seed from the

previous crop or exchanging with other farmers under informal seed markets (Chiramwiwa, 1999). Tomato seed can be retained for up to ten years (Ruponga, 2001). Extraction and seed storage conditions have a direct bearing on seed viability and growth of the successive planted crop (Mafa, 2000). There are three methods commonly used in extracting tomato seed: juice and seed extraction, acid extraction, and extraction by fermentation. The fermentative extraction method is simple and commonly used to produce high quality, non-dormant and disease-free seeds (Shinohara, 1989; McCormack, 2004).

The objective of this study was to determine the ideal fermentation time period of tomato seeds. This would help resource-poor farmers produce their own high quality seed at cheaper costs and so improve on tomato production.

MATERIALS AND METHODS

Study Sites

Tomato (Rhodade cultivar) fruits were collected from a communal farmer who has been growing tomatoes for the last ten years and retaining seed in Chinamhora, Goromonzi District, Zimbabwe. The laboratory experiment was conducted at the Seed Services Institute of the Department of Agricultural Research and Extension, Harare.

Fermentation Process

Ten kilograms of big (±250 grams average fruit weight), ripe, regularly-shaped, and healthy-looking tomato fruits were selected and transported to the laboratory. They were then cut across and a spoon used to scoop out the seed together with the gelatinous material into a plastic bucket. The contents were then equally distributed into twelve two-litre plastic containers and allowed to ferment at room temperature ($\pm 25^0$C) over different time periods.

There were four fermentation times: one, two, three, and four days. During the fermentation process, the pulp was stirred after every three hours during the day in order to maintain a uniform rate of fermentation and to also avoid seed discoloration. The experiment was laid out as a complete randomized design with three replications.

At the expiry of the set fermentation period, one litre of water was added to the pulp. Heavy seeds sank to the bottom of the container while fruit debris and small, underweight seeds floated in the water and were decanted. The remaining mixture was poured onto a 1.5 mm sieve to get rid of the remaining water and small seeds.

Seeds collected on the sieve were spread on table cloth and turned every thirty minutes to ensure uniform drying. They were dried for five days and then placed in labeled envelopes. The envelopes were placed in a laboratory drier for four months at 25^0C to bring seed moisture content to 5%.

Seed Germination Tests

The tests were carried out based on the recommendations of the International Seed Testing Association (ISTA, 2005). Seeds that received the same fermentation treatment were pooled and 200 seeds were randomly sampled and divided into four equal parts of fifty seeds each. The seeds were placed between two filter papers and then moistened every eight hours. They were then incubated at 25^0C. Five days later, germination counts were done and continued until the 14^{th} day.

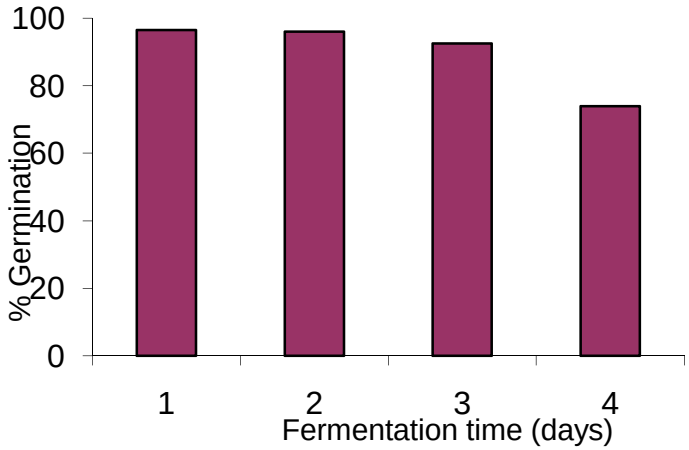
Data Collection

Data on germination, abnormal seedlings, dead and fresh seeds were collected, and analyzed using analysis of variance (ANOVA).

RESULTS

Germination Tests

Figure 1: Effect of Fermentation Time on Germination Rate



n =12

LSD = 6.13

CV (%) = 8.23

Seeds fermented for one day had the highest germination percentage (96.5%), while those fermented for four days had the lowest germination percentage (74.0%). There were no significant differences (p=0.05) in fermenting seeds for up to three days. However, a significant difference was observed when seed were fermented for four days.

Effect of Fermentation Time on Tomato Seed

Table1: Effect of Fermentation Time on Tomato Seed Condition

Fermentation Time (days)	Abnormal seedlings (%)	Dead seed (%)	Fresh seed (%)
1	3.0a	1.0c	1.5e
2	2.0a	1.0c	1.0ef
3	4.5ab	1.5cd	1.5e
4	11.0b	5.5d	4.0f
n	12	12	12
Mean	5.13	2.25	2.00
LSD	3.93	4.36	2.28
CV (%)	15.25	20.03	10.36

Means followed by the same letter do not differ significantly.

The highest proportions of abnormal (11%), fresh (4%), and dead (5.5%) seeds were obtained where seeds were fermented for four days. Fermenting seed for three days had no effect on seed condition. Significant effects were only observed where seeds were fermented for four days.

DISCUSSION

The results showed that tomato seeds can be fermented for up to three days without affecting germination rate. Where seeds were fermented for more than three days, they started germinating. When such seeds were dried afterwards, they died. This helps to explain the high proportion of dead seeds where fermentation was done for four days.

Fresh seed are those assumed to be viable but dormant. This assumption may be wrong since the seed may be empty although the seed covering structure may be intact. It is common for empty seeds to be classified as fresh seeds and mistaken for dormant seeds at the end of germination tests. One way to avoid this mistake is to use the cutting test. The cutting test will only determine accurately the proportions of empty, moldy, insect- or severely discolored seeds. The proportion of viable but dormant or dead seeds remains difficult to detect (Ellis *et al*., 1985). This situation was observed in this experiment whereby fermenting seeds for four days had the highest percentage of what appeared like fresh seed.

Abnormal seedlings were those that did not show potential to develop into a normal plant even if they were to be grown under favorable conditions. They had stunted primary roots and constricted mesocotyls. Fermenting seed for four days increased the proportion of abnormal seedlings. This could have been due to hormonal imbalance and the disruption of the biochemical sequence of the germination process. Also, the effects of inbreeding depression could have been more pronounced where seeds were fermented for four days.

Dead seeds were those which, at the end of the test period, were soft, but neither fresh nor had produced any part of a seedling (ISTA, 2005). These started germinating during fermentation, and died during drying. Other seeds could have been attacked by pathogens which produced enzymes that catabolyzed the embryo (Ellis *et al*., 1985). Lengthening the fermentation period increased the proportion of dead seed.

CONCLUSION

The study showed that tomato seeds can be fermented for up to three days without affecting seed viability. Seeds fermented for one day had the highest germination percentage, while those fermented for four days had the lowest germination percentage. Farmers can use this technology as a way of improving their retained seed quality since fermentation is known to break dormancy and kill seed-borne pathogens.

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