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BREAKING SEED DORMANCY IN GROUNDNUT (*Arachis hypogaea* L.)

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ABSTRACT

Groundnut (*Arachis hypogaea* L.) is cultivated in the Dry and Intermediate Zones of Sri Lanka and the national yield average is around 0.84 t ha^{-1}. Low productivity is the main constraint in this crop, which is mainly due to the low use of quality seed. The seed dormancy of Spanish type groundnut varieties (e.g. *Tissa*, *Tikiri* and *Indi*) varies from 5-50 days whereas that of the Virginia type (e.g. *Walawa*) ranges from 100-120 days. A considerable number of seed lots are rejected due to poor germination in the laboratory test conducted by the Department of Agriculture (DOA), though the same seeds lots have shown higher germination at the field level. Therefore, the objective of this study was to find out an appropriate treatment to break seed dormancy of locally cultivated groundnut varieties to harmonize the laboratory and field germination test results. Ten seed treatments were arranged in a Complete Randomized Design (CRD) with four replicates. The germination % varied significantly ($p<0.05$) among the treatments irrespective of the groundnut variety. Pre-heating method was found to be the most suitable for breaking fresh-seed dormancy of groundnut. However, further investigations on pre-heating duration are required prior to making recommendations.

KEYWORDS: Groundnut, *Arachis hypogaea*, Seed dormancy, Seed treatment

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is one of the most important legume crops cultivated in Sri Lanka. The crop is mainly cultivated in the highlands during the *maha* season under rainfed conditions and in the well-drained paddy fields with supplementary irrigation during the *yala* season in the Dry and Intermediate zones of Sri Lanka. Groundnut is grown mainly in Monaragala, Hambantota, Kurunegala, Anuradhapura, Badulla, Rathnapura and Puttalum Districts. The current average annual groundnut cultivation area is approximately 10,297 ha and the national production is about 8600 t with an average yield of 0.84 t ha^{-1} (Department of Census and Statistics, 2009).

Low yield is one of the main constraints and the use of high quality seed is identified as major requirement to increase production and productivity of groundnut in Sri Lanka. The majority of groundnut farmers are reported to use seeds produced from an informal system, such as farm-saved seed from their previous crop, or seeds received from a neighbouring farmer to cultivate the crop, where seed quality is not assured. The Department of Agriculture (DOA) in Sri Lanka solely handles the formal groundnut seed production and supply system as there is little involvement of private seed producers, which may be due to the erratic demand and low profitability. At present, the total groundnut seed requirement is around 1029.7t (Ministry of Agriculture, 2010) and only 5 % was delivered through the formal groundnut seed production system in 2010.

The species *A. hypogaea* L. is divided into two subspecies namely, *A. hypogaea subsp. hypogaea* (Virginia and Runner market types) and *A. hypogaea* subsp. *fastigiata* (Valencia Spanish market type). The Spanish and Valencia varieties are currently the most commonly cultivated in dry areas, particularly in Africa and Asia (Faye *et al.*, 2010). Pre–harvest sprouting is a common problem in most of the Spanish type varieties leading to a 10-20 % reduction in pod yield and also may result in low seed quality. Therefore, the fresh-seed dormancy is a highly desirable trait in Spanish types of groundnuts.

The periods of dormancy depends on the variety and storage conditions. Spanish types have virtually no dormancy or are naturally broken in several days (5-50 days), while Virginia types can be dormant up to 100-120 days (Department of Primary Industries and Fisheries, 2007). The environmental factors may also help in breaking seed dormancy. Currently, four groundnut varieties are used in the national seed production programme in Sri Lanka, and of these the variety *Walawa* belongs to the Virginia types and *Tissa*, *Tikiri* and *Indi* belong to the Spanish type. Though the documented information on the fresh-seed dormancy periods of above varieties are scarce, all of them have shown a seed dormancy period of about 8 weeks.

Seed testing of groundnut in Sri Lanka is carried out by the DOA prior to purchasing the seed lots from the contract growers. The present germination testing procedure for grounnut used in the country involves two methods for breaking dormancy at the laboratory level namely, (a) soaking seeds in 0.2 % ethral for 10 min followed by rinsing the seeds in water and (b) wrapping the seeds using blotting paper soaked in $HNO_3$and storing them in an oven at 40±2 °C for 48 hr. However, seed lots of most of the contract growers are rejected due to poor germination rate after the above treatments, although the same seed lots have shown higher germination % during field testing. Therefore, the present study was designed to find out an appropriate dormancy breaking treatment for locally cultivated

groundnut varieties to ensure harmonization between the laboratory and field germination results. The study aimed at enhancing the multiplication and use of formally produced groundnut seeds in Sri Lanka.

MATERIALS AND METHODS

The study was carried out at the Seed Testing Laboratory of Department of Agriculture at Aluttarama, Sri Lanka in the *yala* season 2011, in a Complete Randomized Design (CRD) with four replicates. Mature seed samples of groundnut were collected from four varieties *viz. Tissa*, *Indi*, *Tikiri*, and *Walawa*, grown by contract growers in the Aluttarama, Bataata and Nikavaratiya regions of the country. Seed samples were drawn according to the rules of the International Seed Testing Association (ISTA, 2011) and composite samples were brought to the laboratory, together with a separate sample for moisture determination. The ISTA prescribes germination test of *A. hypogaea* using sand or blotting papers as substrates, at 20-30 °C alternative temperature regimes (20 °C for 6 hrs and 30 °C for 8 hrs) and remove shells before pre-heating at 40±2 °C (ISTA 2011). The Association of Official Seed Analysts (AOSA) recommends the removal of shells and expose to ethephon or ethylene as seed dormancy breaking methods of groundnut (http://www.seedtechnology.net/AOSA_rules_for_testing_seed).

All seed samples were collected 3-5 weeks after harvesting and was desiccated to around 9 % moisture on a dry weight basis. The collected seed samples were subjected to two commonly used treatments and seven new treatments and an untreated control (Table 1). The germination test was performed using 25 seeds for each treatment with four replicates. De-shelling was done before treatments and immediately after treatments, the treated seeds were germinated in a sterilized germination box (26 cm × 20 cm) in sterilized sand (500 g) moistened with 15 ml of distilled water. All germination boxes were sealed to reduce evaporation and water loss and no additional water was required during the test. Germination was carried out at room temperature (30±2 °C) under normal day/light conditions. Seeds were considered germinated when the top of the radicle had grown free of the seed coat.

Analysis of variance was performed for the data collected using the SAS computer software package and the mean comparison was done using the Duncan's Multiple Range Test (DMRT) at p=0.05.

Table 1. Seed treatments carried out to break the dormancy

Code	*Description*
T_1	Control
T_2	Soaking 10 min in 0.2 % HNO_3
T_3	Soaking 10 min in 0.2 % Ethral (commonly used)
T_4	Wrapped with blotting paper soaked n HNO_3 and pre-heat at 40±2 °C for 2 days (commonly used)
T_5	Pre-heat 40±2 °C for 1 day
T_6	Pre-heat 40±2 °C for 2 days
T_7	Pre-heat 40±2 °C for 3 days
T_8	Pre-heat 40±2 °C for 4 days
T_9	Pre-heat 40±2 °C for 5 days
T_{10}	Soaking for 20 min in 50 °C hot water

RESULTS AND DISCUSSION

The mean germination percentages for different seed dormancy breaking treatments are shown in Table 1. There were significant differences ($p<0.05$) among the treatments imposed on the four cultivated varieties of groundnut.

Table 1. Effects of different dormancy breaking treatment on germination percentages of four cultivated groundnut varieties in Sri Lanka

Code	*Treatment*	*Mean Germination %*			
		Tissa	*Tikiri*	*Indi*	*Walawa*
T_1	Control	73 cd	74 b	81 c	24 c
T_2	Soaking 10 min in 0.2% HNO_3	68 d	84 ab	85 bc	28 bc
T_3	Soaking 10 min in 0.2% Ethral	82 abc	80 ab	90 ab	51 a
T_4	Wrapped with blotting paper soaked n $HNO_3$and pre-heat at 40±2°Cfor 2 days	92 a	88 a	92 ab	30 bc
T_5	Pre-heat 40±2 °Cfor 1 day	93 a	87 a	95 a	25 bc
T_6	Pre-heat 40±2 °Cfor 2 days	87 ab	80 ab	95 a	33 bc
T_7	Pre-heat 40±2 °Cfor 3 days	77 bcd	82 ab	92 ab	24 c
T_8	Pre-heat 40±2 °C for 4 days	82 abc	73 b	95 a	37 b
T_9	Pre-heat 40±2 °C for 5 days	86 ab	88 a	93 a	60 a
T_{10}	Soaking 20 min in 50 °C hot water	90 a	87 a	87abc	61 a
	CV %	9.48	9.21	6.17	20.7

Within a column, the means followed by the same letter are not significantly different at p=0.05.

The germination percentage of the groundnut variety *Tissa* was significantly different ($p<0.05$) among the treatments (Figure 1). The highest germination percentage was shown by T_5 (Pre-heat 40±2 °C for one day). There was no significant difference ($p>0.05$) betweenT_5, T_4 and T_{10}. The T_2 recorded the lowest

germination percentage. In general all other treatments showed more than 75 % germination percentage (Figure 1). The mean germination percentages significantly differed among the tested treatments ($p<0.05$) and ranged from 73-88 % (Figure 2). The highest germination percentages were shown by the treatments T_4, T_9, T_5 and T_{10}. The germination % of the variety *Indi* also showed significantly different germination % ($p<0.05$) among the tested treatments (Figure 3). The highest germination percentages were observed in the treatments T_5, T_6, and T_8. The mean germination percentages significantly ranged between 24 – 61 % (Figure 4). The highest germination percentages were shown by T_3, T_9, and T_{10}.

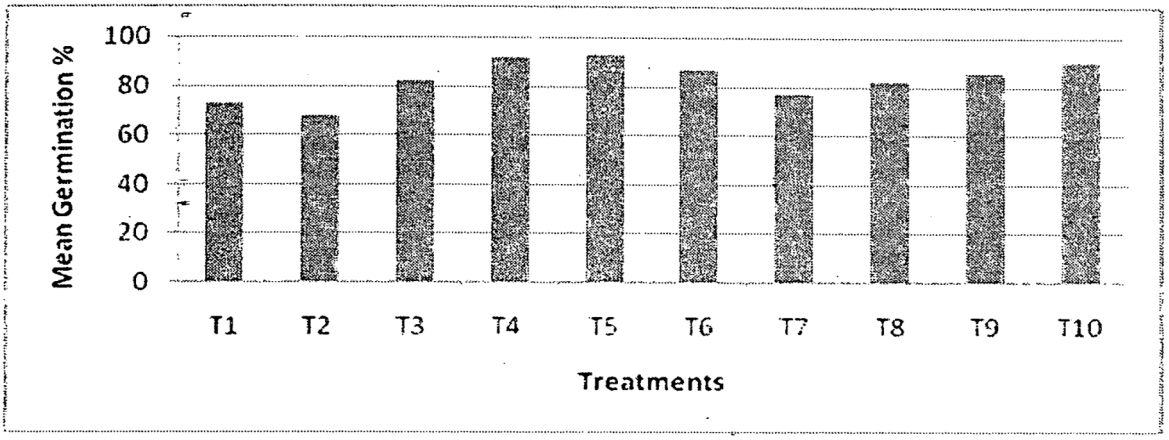

Figure 1. Comparison of mean germination percentage of variety *Tissa* due to different treatments (refer to Table 1 for the description on treatments)

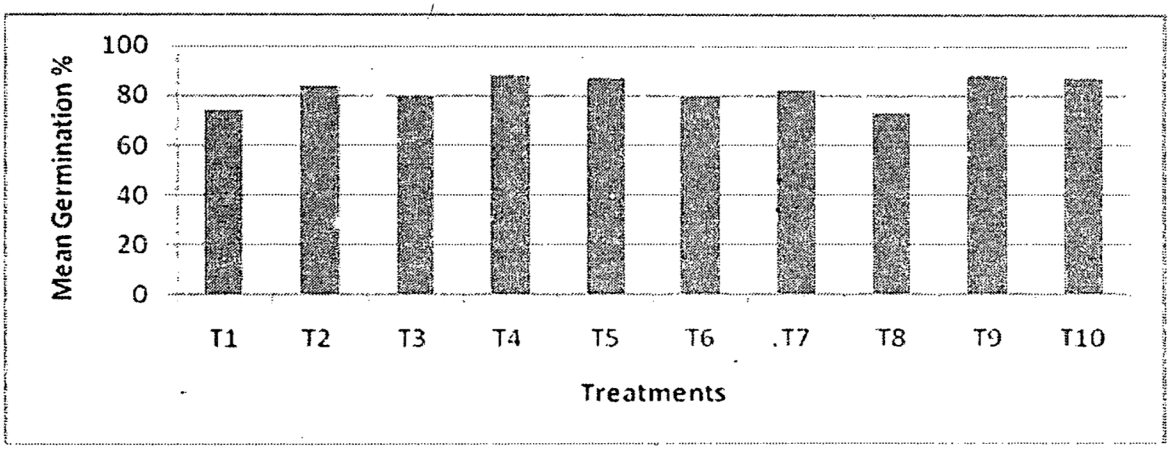

Figure 2. Comparison of mean germination percentage of the variety *Tikiri* due to different treatments (refer to Table 1 for the description on treatments)

The groundnut variety *Walawe* (ICGV 86564) belongs to the Virginia types and other three varieties tested were Spanish type. The results revealed that the varieties *Tissa*, *Tikiri* and *Indi* showed a low fresh-seed dormancy as the control treatment recorded a higher germination percentage (above 73 %). The variety *Walawe* showed a significantly higher fresh-seed dormancy ($p<0.05$).

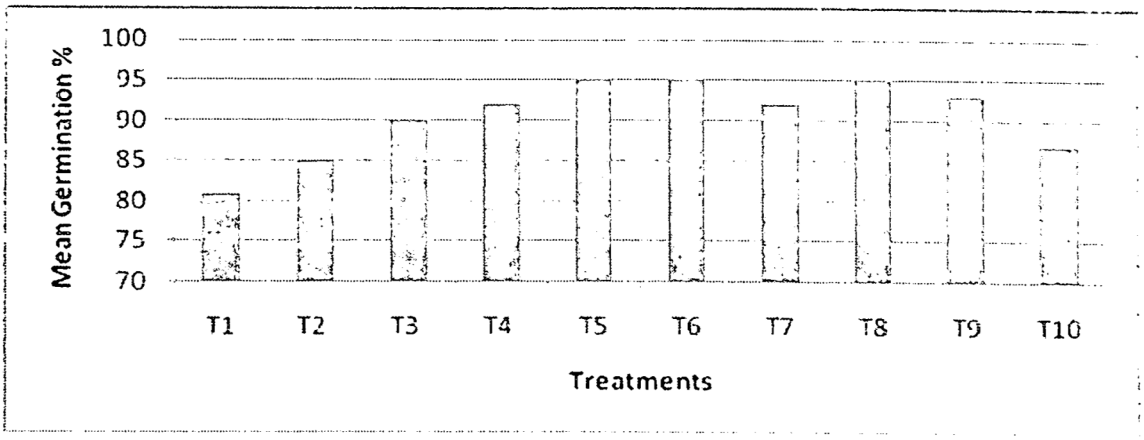

Figure 3. Comparison of mean germination percentage of the variety Indi due to different treatments (refer to Table 1 for the description on treatments)

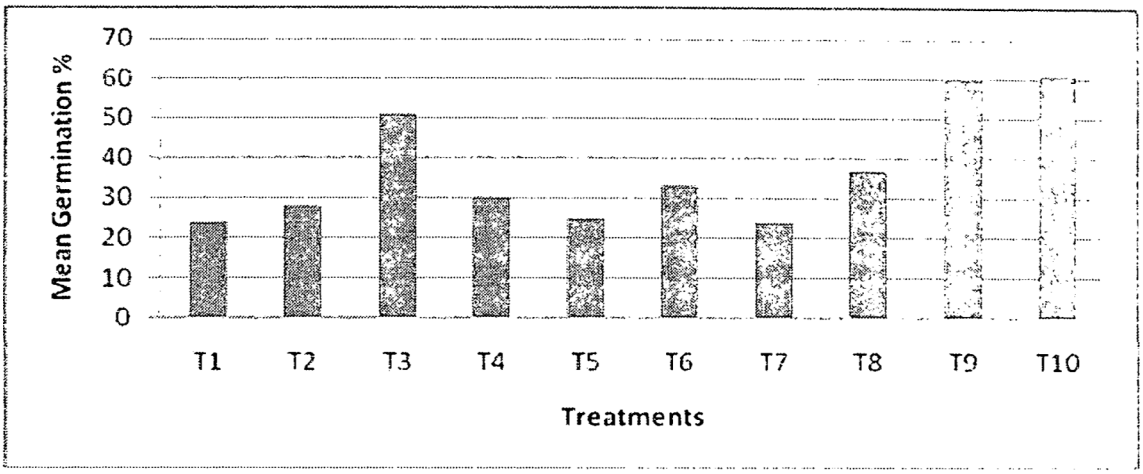

Figure 4. Comparison of mean germination percentage of the variety *Walawa* due to different treatments (refer to Table 1 for the description on treatments)

In the formal seed production programmes in Sri Lanka, testing the quality of groundnut seeds by applying prescribed standards is a requirement. Both varieties *Tissa* and *Tikiri* recorded higher germination percentages with treatment T_4,T_5 and T_{10}, with no significant differences between the three treatments ($p>0.05$). The results of the hot-water treatment agree with those of Ketshajwang *et al.* (1998) who reported of enhanced seed germination by elevating water and O_2 permeability of the seed testa during hot water treatments. For the *Indi* variety (Figure 3) higher germination percentage was recorded with pre-heating treatments of T_5, T6 and T_8. The highest germination % for the variety *Walawa* (Figure 4) was observed for the treatment T_{10}, which is a hot water treatment. However, there was no significant difference of treatment of T_{10}, T_3 and T_9 ($p>0.05$).

ThepPre-heating treatment showed the highest seed germination percentages regardless of the variety. The exposure to higher temperature (40-45 °C for 15 days) can break dormancy of groundnut (Ntare *et al.*, 2006). The ISTA methods of

germination testing of groundnut also recommended the pre-heating at 40±2 °C for breaking dormancy (ISTA 2011). However, the present study was done at room temperature (30±2 °C) under normal day light condition however, in the ISTA methods, it is a requirement to maintain alternative temperatures at 20 °C for 16 hrs 30 °C for 8 hrs. The environmental conditions such as temperature and moisture, and other non-genetic factors could influence the seed germination in groundnut (Toole *et al.,* 1964). Faye *et al.* (2009) also reported that seed germination tests should be performed under correct humidity, light and appropriated temperatures. The results of the present study suggested that the seed germination tests should be carried out according to the ISTA procedures for the four cultivated varieties of groundnut in Sri Lanka.

CONCLUSIONS

Pre-heating is the best method to break fresh-seed dormancy of the four cultivated groundnut varieties in Sri Lanka. However further investigations on pre-heating time periods is required under control temperature regimes before making any firm conclusion. Facilities should be developed at the Seed Testing Laboratory to follow the ISTA procedures for germination tests of groundnut in Sri Lanka.

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