Kasetsart J. (Nat. Sci.) 40 : 848 - 853 (2006)

Responses of Bambara Groundnut Seed to Accelerated Aging

Vichai Wongvarodom* and Suteera Naulkong

ABSTRACT

Bambara groundnut seeds of Songkhla 1 and landrace variety were subjected to accelerated aging at temperatures of 40, 43, 46, 49, 52, and 55°C for 48, 72, and 96 hours in order to determine the response of variety and seed quality to accelerated aging conditions. The non-aged and aged seeds were subjected to tests of their quality including moisture content, standard germination, speed of germination, and seedling growth rate. Results indicated that responses of bambara groundnut seeds to accelerated aging differed with varieties and seed quality characteristics. The Songkhla 1 seed was more sensitive to accelerated aging than landrace variety. High quality seeds of both varieties with germination of 86.50-88.00% had a reduction of viability and vigor after accelerated aging at 40°C for 96 hours and at 43°C for 48-72 hours with germination of 75.50-62.25%. These aging regimes provided seed vigor separation between varieties with germination differences of about 10% while a greater separation (around 20%) occurred after aging at 46°C for 48 hours. Germination and speed of germination index showed a greater response to accelerated aging. Seedling growth rate in terms of shoot length, root length, and seedling dry weight could not be used to evaluate the deterioration of the acceleratingly aged seed.

Key words: accelerated aging, bambara groundnut, seed vigor, germination, seedling growth rates

INTRODUCTION

Bambara groundnut (*Vigna subterranean* (L.) Verdc.) is an important food legume in many drought and poor soil areas in the tropics, especially in Africa (Swanevelder, 1998; Kocabas *et al*., 1999). Accelerated aging test was first developed to predict seed storability or their longevity (Delouche and Baskin, 1973) and has been used for seed vigor indicator in various crops (Hampton and TeKrony, 1995; Association of Official Seed Analysts, 2002). Different responses to accelerated aging were found in many crop seeds. Santipracha *et al*. (1997) recommended that appropriate accelerated aging conditions for evaluating hybrid corn seed quality in the humid tropics be close to 100% relative humidity at 44 °C for 96 hours. The accelerated aging at 45°C for 48-72, 72 and 120 hours showed potential as a seed vigor test in aubergine, cucumber and melon, respectively (Demir *et al*., 2004). However, accelerated aging studies for evaluating seed storability and vigor in bambara groundnut seed are scarce. The purpose of this study was to investigate the responses of bambara groundnut variety and seed quality to accelerated aging or to determine whether there are variety or quality characteristics differences in tolerance to aging conditions.

Division of Agricultural Technology, Department of Industry and Technology, Faculty of Science and Technology, Prince of Songkla University, Muang, Pattani 94000, Thailand.

* Corresponding author, e-mail: seedinter@yahoo.com

Received date : 06/02/06 Accepted date : 27/07/06

MATERIALS AND METHODS

Seeds of bambara groundnut cv Songkhla 1 and landrace variety were obtained from Songkhla Field Crop Research Center. Seeds were subjected to tests of moisture content, standard germination, speed of germination, and seedling growth rate following the AOSA rules for testing seeds (AOSA, 2001 and 2002). All tests were done with four replications.

Moisture content Twenty seeds per replication were weighed and dried at 105°C for 24 hours. The dried seeds were weighed, and moisture content was calculated on a percentage of wet weight basis.

Standard germination One hundred seeds per replication were germinated in between paper (BP) in a 25°C germinator. First and final counts were done at 5 and 10 days, respectively. Number of normal seedlings were averaged as the germination percentage.

Speed of germination The seeds were germinated as in standard germination test. Normal seedlings were counted at 5, 7, and 10 days after germinating. Speed of germination index (SGI) was calculated as described in the Association of Official Seed Analysts (2002) handbook on vigor as the following formula

$$SGI = \frac{\text{number of normal seedlings}}{\text{days of first count}} + \ldots\ldots + \frac{\text{number of normal seedlings}}{\text{days of first count}}$$

Seedling growth rate Twenty seeds per replication were lined up in a row and rolled as in the between paper germination test. They were placed upright in a germinator at 25°C for seven days. Normal seedlings were counted, and their shoot and root lengths were measured. Seedling shoot and root length were calculated in cm per seedling. The remaining seed cotyledons were cut from the seedling axis and the axes from each replication were separately dried at 80°C for 24 hours. The dried seedlings were weighed and calculated as mg/seedling.

Accelerated aging The test was conducted according to the procedure described by Hampton and TeKrony (1995). Seeds were placed on a wire mesh tray inside a plastic box over water. The tightly closed plastic boxes were incubated in an oven at 40, 43, 46, 49, 52, and 55° C. After 48, 72, and 96 hours of accelerated aging, the seed quality were tested for the non-aged seeds

Quality of non-aged seeds and that after accelerated aging were compared using a completely randomized design and analyzed using analysis of variance. The statistical significance of means was tested by Duncan's multiple range test (DMRT).

RESULTS

Bambara groundnut seeds of Songkhla 1 and landrace variety with 10.66-10.16% initial moisture content had germination of 88.00-86.50%. Statistically the same seed vigor in terms of speed of germination index, shoot length, root length, and seedling shoot dry weight were also found in the two varieties (Table 1). Moisture content of the seeds after accelerated aging increased from 10.16-10.66 to 22.23-25.61% and varied depending on aging temperature and duration (Tables 2 and 3). Germination and vigor declined as the degree of stress increased. The germination of Songkhla 1 seeds was significantly reduced at accelerated aging temperature of 40°C for 72 hours while at the same accelerated aging temperature, it took 96 hours before germination of landrace variety was significantly reduced. The dramatic decrease in germination of both varieties was initially occurred at 46°C accelerated aging temperature for 72 hours with mostly lower than 50% germination. Songkhla 1 seeds had a significant decrease in speed of germination at every accelerated aging temperature and duration, while landrace seeds showed an initial reduction at accelerated aging temperature of 40°C for 96 hours. Accelerated aging reduced shoot length,

Table 1 Moisture content, germination, speed of germination index, shoot and root length, and seedling dry weight of bambara groundnut seeds of Songkhla 1 and landrace varieties.

Variety	Moisture content (%)	Germination (%)	Speed of germination index	Shoot length (cm/seedling)	Root length	Seedling dry weight (mg/seedling)
Songkhla 1	10.66	88.00	11.22	3.08	7.16	23.76
Landrace	10.16	86.50	10.78	2.81	6.04	23.04
F-test	ns	ns	ns	ns	ns	ns
C.V. (%)	14.15	4.61	12.33	16.21	11.85	6.70

ns = non significant.

Table 2 Moisture content, germination, speed of germination index, shoot and root length, and seedling dry weight of bambara groundnut seeds of Songkhla 1 after accelerated aging (AA) at different temperatures and durations.

AA temp/ duration (°C/hrs)	Moisture content (%)	Germination (%)	Speed of germination index	Shoot length (cm/seedling)	Root length	Seedling dry weight (mg/seedling)
0/0	10.66g	88.00a	11.22a	3.08abcd	7.16abc	23.76abc
40/48	15.58f	79.25ab	9.61b	2.58de	5.68cd	22.53bc
40/72	17.78ef	71.50bc	8.77bc	3.10abcd	4.78de	24.63abc
40/96	21.68b	64.50cd	7.70cd	3.38abcd	5.47cd	22.33bc
43/48	16.53ef	73.75bc	8.84bc	2.99abcd	5.40cd	24.54abc
43/72	17.64ef	62.25cd	6.30d	2.98abcd	5.68cd	20.86c
43/96	18.11ef	58.50d	6.79d	3.23abcd	7.04abc	24.28abc
46/48	16.54ef	56.75d	7.19d	3.72a	8.12a	27.88a
46/72	18.87de	43.75e	4.78d	3.42abc	7.55ab	27.00ab
46/96	21.62b	36.25ef	3.85e	2.69bcde	5.51cd	21.40c
49/48	17.91ef	33.25ef	3.89e	3.05abcd	8.19a	23.74abc
49/72	20.59cd	30.00f	3.54e	3.50ab	7.99a	23.42abc
49/96	22.47ab	6.00g	0.67f	3.50ab	5.91bcd	22.61bc
52/48	16.51ef	11.50g	1.25f	2.64cde	6.04bcd	22.56bc
52/72	19.06cde	1.50g	0.15f	2.80bcde	3.50e	19.80c
52/96	20.54bcd	4.00g	0.40f	1.60f	3.10e	9.60d
55/48	21.03bc	1.00g	0.10f	2.10f	4.60de	13.40d
55/72	22.23ab	0.00g	0.00f	0.00g	0.00f	0.00e
55/96	24.20a	0.00g	0.00f	0.00g	0.00f	0.00e
F-test	**	**	**	**	**	**
C.V. (%)	6.50	16.26	17.79	14.11	15.73	12.16

** = significant at $P < 0.01$.

Means not sharing the same letter in each column are statistically different by DMRT.

Table 3 Moisture content, germination, speed of germination index, shoot and root length, and seedling dry weight of bambara groundnut seeds of landrace variety after accelerated aging (AA) at different temperatures and durations.

AA temp/ duration (°C/hrs)	Moisture content (%)	Germination (%)	Speed of germination index	Shoot length (cm/seedling)	Root length	Seedling dry weight (mg/seedling)
0/0	10.16i	86.50a	10.78ab	2.81a	6.04cde	23.04bcd
40/48	14.94fgh	88.00a	11.17a	3.05a	5.45def	22.22cd
40/72	16.59defgh	83.50ab	10.72abc	3.23a	5.88cde	28.41a
40/96	18.74defgh	75.50bc	9.36cd	3.36a	5.32ef	26.14abc
43/48	13.92gh	74.25bc	8.80d	3.05a	5.50cdef	23.19bcd
43/72	15.30efgh	73.50bc	7.24e	2.79a	5.91cde	23.80abcd
43/96	17.04defgh	67.50c	8.98d	3.06a	6.49bcd	24.82abcd
46/48	13.18hi	74.50bc	9.42bcd	2.80a	6.62bc	23.34bcd
46/72	14.27gh	52.50de	6.81ef	3.08a	5.97cde	23.96abcd
46/96	16.66defgh	42.00e	4.80g	2.74a	4.50f	21.04d
49/48	17.17defg	44.75de	5.54fg	3.08a	7.17ab	27.04ab
49/72	19.72cd	54.00d	7.18e	3.41a	7.98a	27.07ab
49/96	21.23bc	17.75f	2.22h	3.44a	6.53bcd	20.16e
52/48	16.10defgh	17.25f	2.07h	2.96a	5.19ef	24.04abcd
52/72	18.80cdef	3.50g	0.41i	1.40b	2.30g	16.50e
52/96	24.28ab	0.00g	0.00i	0.00c	0.00g	0.00f
55/48	19.07cde	0.00g	0.00i	0.00c	0.00g	0.00f
55/72	17.53cdefg	0.00g	0.00i	0.00c	0.00g	0.00f
55/96	25.61a	0.00g	0.00i	0.00c	0.00g	0.00f
F-test	**	**	**	**	**	**
C.V. (%)	10.54	12.22	12.63	16.58	11.45	11.70

** = significant at $P < 0.01$.

Means not sharing the same letter in each column are statistically different by DMRT.

root length and seedling dry weight of both varieties at 52°C for 72 hours and at more stressful aging conditions.

Differences in seed germination after various accelerated aging between the two varieties are shown in Figure 1. The difference in germination between two varieties varied with accelerated aging regimes. However, the differences were mostly lower than 10%.

DISCUSSION

Germination of aged seeds of Songkhla 1 was mostly lower than that of landrace seeds in most accelerated aging temperatures and times. This suggests that Songkhla 1 seeds were more sensitive to accelerated aging than landrace seeds. Therefore, Songkhla 1 seeds might have a slightly lower potential to germinate in adverse conditions than landrace variety. This might be due to the presence of different genotypes in the same seed population of landrace variety and thus increasing

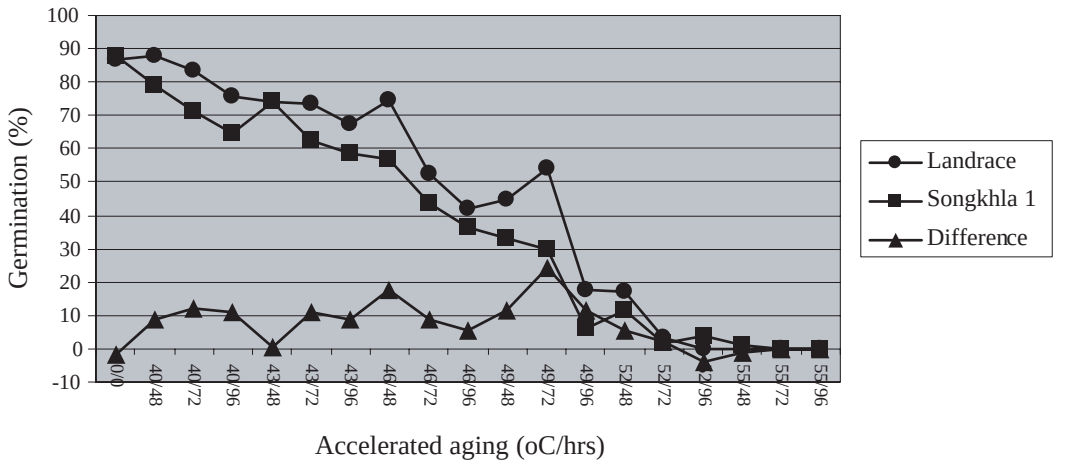

Figure 1 The differences in germination between bambara groundnut cv Songkhla 1 and landrace variety accelerated aging at different temperatures and durations.

the ability to adapt to a wider range of germination conditions. However, seeds of both varieties had a reduction in germination and vigor after accelerated aging at 40°C for 96 hours and at 43 °C for 48-72 hours with germination and speed of germination of 75.50-62.25% and 9.36-6.30, respectively. The data suggests that these accelerated aging conditions should be considered as the potential regimes for further investigating in storability evaluation of bambara groundnut seeds by accelerated aging test. Aging at these conditions (40°C for 96 hours and 43°C for 48-72 hours) in this study can provide a separation between Songkhla 1 and landrace variety with a germination difference of about 10%. However, there was a greater separation after aging at 46°C for 48 hours with a germination difference of around 20%. This result was in agreement with previous findings in muskmelon seeds, in which increasing the aging condition had a better separation in seed vigor (Pesis and Timothy, 1983). However, longer aging and higher aging temperatures resulted in a marked reduction in germination of all seed varieties to very low values. The different germination between two varieties at the same aging temperature and period indicated they had different seed vigor. The data suggests that accelerated aging test had the potential to evaluate vigor of bambara groundnut seed. Bambara groundnut seeds showed a greater response to accelerated aging than groundnut seeds, which had only a slight reduction in germination (85.25-90.25%) after accelerated aging at 50°C for 96 hours (Wongvarodom, 1995).

Germination and speed of germination index of bambara groundnut seeds showed a greater response to accelerated aging with a gradual reduction as accelerated aging temperature and duration increased. In contrast, the seedling growth rate in terms of shoot length, root length and seedling dry weight showed marked reductions at the higher temperatures of 52°C for 72 hours. These were found in both Songkhla 1 and landrace varieties, suggesting that seedling growth rate could not be used to evaluate the deterioration after accelerated aging of bambara groundnut seeds as in groundnut seeds (Wongvarodom, 1995).

CONCLUSION

It is concluded that the response of bambara groundnut seeds to accelerated aging could differ within varieties and seed quality characteristics. The Songkhla 1 seeds were more sensitive to accelerated aging than landrace variety. Seeds of both varieties had a reduction of viability and vigor after accelerated aging at 40°C for 96 hours and at 43°C for 48-72 hours with germination of 75.50-62.25%. These aging regimes provided seed vigor separation between varieties with a germination difference of about 10%, while a greater separation (around 20%) occurred after aging at 46°C for 48 hours. Germination and speed of germination index showed a greater response to accelerated aging. Seedling growth rate in terms of shoot length, root length, and seedling dry weight could not be used to evaluate the deterioration of the acceleratingly aged seed.

ACKNOWLEDGEMENTS

Thanks are due to the Faculty of Science and Technology, Prince of Songkla University, for financing this research. We wish to thank the Songkhla Field Crop Research Center for supplying the seeds. Authors are thankful to Dr. Alan Geater for his help in proofing the English.

LITERATURE CITED

Association of Official Seed Analysts. 2001. **Rules for Testing Seeds**. The Association of Official Seed Analysts.

Association of Official Seed Analysts. 2002. **Seed Vigor Testing Handbook**. Contribution No.32 to the Handbook on Seed Testing.

Delouche, J.C. and C.C. Baskin. 1973. Accelerated ageing techniques for predicting the relative storability of seed lots. **Seed Sci. & Technol**. 1: 427-452.

Demir, I., Y.S. Ozden and K. Yilmaz. 2004. Accelerated ageing test of aubergine, cucumber and melon seeds in relation to time and temperature variables. **Seed Sci. & Technol**. 32: 851-855.

Hampton, J.G. and D.M. TeKrony. 1995. **Handbook of Vigour Test Methods**. 3rd ed. International Seed Testing Association. Zurich.

Kocabas, Z., J. Craigon and S.N. Azam-Ali. 1999. The germination response of Bambarra groundnut (*Vigna subterranean* (L.) Verdc.) to temperature. **Seed Sci. & Technol**. 27: 303-313.

Pesis, E. and Ng. J. Timothy. 1983. Viability, vigor and electrolytic leakage of muskmelon seeds subjected to accelerated ageing. **HortScience** 18: 242-244.

Santipracha, W., Q. Santipracha and V. Wongvarodom. 1997. Hybrid corn seed quality and accelerated aging. **Seed Sci. & Technol**. 25: 203-208.

Swanevelder, C.J. 1998. **Bambara Food for Africa (*Vigna subterranean* – Bambara groundnut)**. The National Department of Agriculture and obtainable from the Resource Centre, Republic of South Africa.

Wongvarodom, V. 1995. **Accelerated Aging of Groundnut Seed for Longevity Evaluation in the Humid Tropics**. M.S. Thesis, Prince of Songkla University, Hat Yai.