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Some Effects of an Accelerated Ageing Technique on Germination and Vigour of Marrow and Wheat Seeds

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ABSTRACT. An accelerated ageing technique was used to determine viability and vigour in fresh (seeds stored at 4°C before used as a control) and aged marrow and wheat seeds. Germination percentage, germination speed, seedling length and seedling fresh weight were decreased in aged seeds. Moreover, the time to reach 50% final germination, percentage fall in growth and percentage and type of abnormal seedlings increased in aged seeds.

Seed deterioration may result in loss of vigour shown by delayed germination, and seedling emergence, followed by a decline in germinability (Byrd and Delouche 1971, McDonald 1976, Woodstock 1973). A number of different damaging processes have been suggested to cause the deterioration of seeds including, loss of activity of various enzymes (Woodstock 1973), degradation of the respiratory system (Abdul-Baki and Anderson 1972), loss of ATP production and/or ATP storage capacity (Anderson 1977, Ching 1973), deterioration of membrane system (Berjak and Villiers 1972, Abdul-Baki and Baker 1973, Simon 1974, Petruzzelli and Taranto 1989) and inability of repair system to operate (Villiers 1973).

In general, the lower the temperature and moisture content at which seeds are stored, the slower will be their rate of deterioration (Roberts 1972). Accelerated ageing treatment involve exposing seeds to severe adverse storage conditions, *i.e.* raised temperature and high moisture contents for specific periods of time. The process of deterioration which occurs under these special ageing conditions is assumed to be similar to those which occur during natural ageing (Delouche and Baskin 1973, Perl *et al.* 1978). The main difference being the speed at which these changes occur.

The objective of this study was to compare deteriorative changes in aged and unaged batches of marrow and wheat samples of different viabilities. To determine the effects of seed deterioration, Presley (1958) developed a method of artificially ageing batches of seeds, known as accelerated ageing. Delouche and Baskin (1973) used accelerated ageing as a mean for predicting the storability of seeds.

A related test which offers more precise control over the degree of stress applied to a seed sample is the "controlled deterioration test" devised by Powell and Mathews (1981).

Materials and Methods

Seeds of wheat (*Triticum aestivum* L.) and marrow (*Cucurbita pepo* L.) of the 1987 harvest were obtained from Booker Seeds Ltd., Salford, Lincolnshire, U.K. in May 1988. Marrow seeds were received in eight aluminum foil packs each containing 250 g, while wheat seeds were received in plain cotton bags containing 5 kg.

Seeds were kept at the cold room, late in 1990 seeds were prepared for different treatments. Two packs of marrow seeds, and 500 g of wheat seeds from above were stored at 35°C / 60% RH for 4.5 months. Moreover, two packs of marrow seeds, 500 g of wheat seeds, and some of stored seeds were prepared for accelerated ageing as below, and the rest were kept at the cold room for use as control. A single layer of seeds were placed in a tray above a water layer in a plastic box with a sealed lid. The boxes were then incubated for a period of 72 hours at 43°C for marrow seeds, and 48 hours at 43°C for wheat seeds (ISTA 1987). The seeds were then removed and used in a standard germination test. To determine germination percentage, three replicates of 100 seeds of marrow, and four replicates of 100 seeds of wheat, were placed in 9 cm Petri-dishes on "Seed Test Thick" 9 cm filter papers (Whatman's) moisted with 5 ml of distilled water. Seeds were distributed evenly within each dish and one sheet of moisted 9 cm filter paper was placed over the seeds. In order to avoid excessive loss of water through evaporation, each Petri-dish was watered daily. The germination was assessed as the percentage of radicles emerged each day for 8 days. Seeds were germinated at 25°C ± 1°C in the case of marrow, and at 20°C ± 1°C in the case of wheat.

Germination percentage, germination speed, time to 50% of final germination, seedling lengths, fresh weights, and the numbers and type of abnormal seedlings were recorded.

Abnormal seedlings of *Cucurbita pepo* were allocated to the following categories (Tables 1 and 2).

Ia no primary root or well-developed secondary roots.

Ib primary root short and stunted, or short and weak secondary roots.

Ic primary root damages, with weak secondary roots.

VIb short and weak, or watery seedling.

Abnormal seedlings of *Triticum* spp were listed in section 5.8.2 of the 1966 International Rules for Seed Testing (Tables 1 and 2).

Ia no seminal roots.

IIIe plumule short and thick, usually with short and stunted seminal roots.

Vg completely decayed seedling.

VIa short and weak, or spindly, or watery seedling.

Results and Discussion

There was a significant decline in germination capacity after 43 hours of the accelerated ageing treatment for marrow and wheat seeds. Also there were decreases in seedling vigour and germination speed, and decreases in the time to reach 50% of final germination, in both marrow and wheat seeds, comparing the results of aged seeds with fresh seeds and seeds stored at 35°C / 60% RH in both of Table 1 and 2.

Table (1) shows that, the germination percentage of marrow seeds decreased from 88% in unaged seeds to 69% for aged seeds, while the germination percentage decreased from 100% in unaged seeds to 94% for aged seeds in case of wheat. It is also clear from Table (2) that an increase in T_{50} occured from a mean of 39.4 h in unaged seeds to 81.8 h for aged seeds in the case of marrow, while T_{50} increased from a mean of 34.6 h in unaged seeds to 85.1 h for aged wheat seeds.

Table (3) shows changes in germination characteristics of marrow and wheat seeds following subjection to accelerated ageing. Percentage change in T_{50} for marrow seeds increased from 80% to 108%, while percentage change in T_{50} for wheat seeds increased from 94% to 146%.

Table 1. Some effects of accelerated ageing technique on germination and vigour of marrow and wheat seeds

Vigour parameters	Seed treatments			
	Marrow		Wheat	
	Fresh (Stored at 4°C)	Aged seeds	Fresh (Stored at 4°C)	Aged seeds
% Germination	88 ± 0.4	69 ± 0.5	100 ± 0.0	94 ± 0.6
Germination speed	21.9 ± 0.3	18.3 ± 0.3	21.0 ± 0.2	18.3 ± 0.3
T_{50} (h)	33.4 ± 0.3	60.0 ± 0.4	24.7 ± 0.1	47.8 ± 0.2
Root length (mm)	129.1	71.5	106.0	81.0
Shoot length (mm)	147.0	99.2	126.0	99.6
Seedling length (mm)	276.1 ± 6.7	170.7 ± 8.2	232.0 ± 3.0	180.6 ± 3.6
% reduction in growth	–	38.2	–	22.2
Seedling fresh wt. (mg)	1782.3	911.1	231.6	189.2
% of abnormal seedlings	2.8	8.7	1.0	7.5
*Number and Type of abnormal seedlings	2Ib	1Ib 2Ib 2Ic 1VIb	1Ia	3Ia 2VIa 2Vg

*Marrow abnormal seedlings.

Ia no primary root or well-developed secondary roots.

Ib primary root short and stunted, or short and weak secondary roots.

Ic primary root damages, with weak secondary roots.

VIb short and weak, or watery seedling.

Table 2. Some effects of accelerated ageing technique on germination and vigour of marrow and wheat seeds, stored at 35°C/60% R.H. for 4.5 months

Vigour parameters	Seed treatments			
	Marrow		Wheat	
	35°C / 60%	Aged seeds	35°C / 60%	Aged seeds
% Germination	83 ± 0.5	61 ± 7.4	97 ± 0.3	90 ± 1.2
Germination speed	19.6 ± 0.5	16.8 ± 0.4	20.3 ± 0.3	18.0 ± 0.4
T_{50} (h)	39.4 ± 0.3	81.8 ± 0.5	34.6 ± 0.2	85.1 ± 0.2
Root length (mm)	103.1	61.4	96.8	68.8
Shoot length (mm)	109.2	91.8	106.0	86.5
Seedling length (mm)	212.3 ± 4.2	153.2 ± 8.3	202.8 ± 3.4	155.3 ± 4.8
% reduction in growth	–	27.8	–	23.4
Seedling fresh wt. (mg)	1511.9	703.5	198.7	159.5
% of abnormal seedlings	8.4	18.0	4.1	11.1
*Number and Type of abnormal seedlings	1Ia 3Ib 2Ic 1VIb	3Ia 4Ib 2Ic 2VIb	3Ia 1VIa	4Ia 3VIa 2Vg 1IIIe

*Wheat abnormal seedlings.

Ia no seminal roots.

IIIe plumule short and thick, usually with short and stunted seminal roots.

Vg completely decayed seedling.

VIa short and weak, or spindly, or watery seedling.

Table 3. Changes in germination characteristics of marrow and wheat seeds following subjection to accelerated ageing technique

Vigour parameters	Seed treatments			
	Storage conditions (temp./RH)			
	Marrow		Wheat	
	Fresh (Stored at 4°C)	35°C / 60%	Fresh (Stored at 4°C)	35°C / 60%
Diff. in germination	19	22	6	7
Percentage reduction	22	27	6	7
% change in speed	16	14	13	11
% change in T_{50}	80	108	94	146
% change in fresh wt.	49	54	18	20
% change in abnormal seedling	6	10	7	7

The results indicate that, when exposed to accelerated ageing, there was a greater decline in germination capacity and vigour of marrow and wheat seeds stored for 4.5 months at 35°C/60% RH as compared with fresh seeds treated by accelerated ageing.

The deteriorative effects of accelerated ageing increased compared with control seeds, resulting in reductions in the rate of germination potential, overall seedling growth and increase in the number of abnormal seedlings. The results are in agreement with the findings of Ram and Wiesner (1987), who showed that seedling emergence in the field was much delayed in wheat seed lots artificially aged for 36 h as compared with unaged seed lots. Purkar and Negi (1982) also showed that seed viability, root and shoot growth, percentage, field emergence, and plant survival of wheat and pea all decreased with increase in the duration of the accelerated ageing treatment.

Results indicated that accelerated ageing test is a good vigour test. It appeared then, that for maximum viability and longavity seeds must be dried and stored under cool and dry conditions. Further work is need to study the use of cold test technique and compare its results with accelerated ageing technique to obtain the better germination and emergence of seeds in the field.

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بعض تأثيرات الإسراع في العمر الزمني على إنبات وحيوية بذور القرع والقمح

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في ظروف مناخية مختلفة تمت دراسة بعض التأثيرات الناتجة عن تقنية الإسراع في العمر الزمني لبذور القرع والقمح ، وذلك باستخدام ثلاث مجموعات من كل من بذور القرع والقمح ، اذ خزنت المجموعة الأولى للبذور تحت درجة حرارة (٣٥°م) ورطوبة قدرها (٦٠٪) لمدة أربعة أشهر ونصف الشهر .

بينما أخضعت المجموعة الثانية للبذور بالاضافة للمجموعة الأولى (التي سبق خزنها لمدة أربعة أشهر ونصف الشهر وتحت ٣٥°م و٦٠٪ رطوبة) لتقنية الاسراع في العمر الزمني لمدة (٧٢) ساعة في درجة حرارة (٤٣°م) بالنسبة لبذور القرع و(٤٨) ساعة في درجة حرارة (٤٣°م) بالنسبة لبذور القمح .

أما المجموعة الثالثة للبذور فقد استخدمت بمثابة التجربة الضابطة (control) حيث أن هذه المجموعة من البذور خزنت في (٤°م) ولم تخضع لتقنية الإسراع في العمر الزمني الذي خضعت له المجموعتان السابقتان .

وقد أجريت مجموعة من التجارب على المجموعات البذرية الثلاث لقياس نسبة الإنبات والحيوية فيها فكانت النتائج كالتالي :

١ ـ انخفضت النسبة المئوية للإنبات ، وسرعته ، وطول البادرات والوزن الجاف والرطب (الطري) في المجموعات المعالجة مقارنة بالمجموعة غير المعالجة (control) .

٢ ـ ازداد الزمن المطلوب للوصول لنسبة (٥٠٪) من البذور النابتة كما ازدادت أيضاً نسبة الإنخفاض في النمو ، وعدد ونوع البادرات غير السوية في البذور المعالجة لكل من بذور القرع والقمح بالمقارنة بالبذور غير المعالجة (control) .

يتضح مما سبق أنه للمحافظة على حيوية ونشاط البذور لأطول فترة ممكنة يجب أن تخزن في درجة حرارة ونسبة رطوبة منخفضتين ، وبهما يمكن المحافظة على حيوية البذور وقابليتها للإنبات لفترة أطول .