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Seed Vigour Test of Sweet Corn (*Zea mays* L. var. *sacharata* L.)

Panie Temiesagdie [1] and Taikichi Takano [2]

ABSTRACT

Sweet corn seeds were treated with hot air dry at 70°C for 1 or 3 days, and the vigour of the treated seeds was evaluated. When the seeds were allowed to germinate on moistened rolled sheets of paper towels, the heat-treated seeds showed more rapid water absorption than the control seeds. β-amylase activity in seeds during imbibition decreased with increase in duration of heat treatment at 70°C. The seeds were soaked for 40 hours and leachate from seeds was tested for electrical conductivity (EC), and for protein, amino acids, sugars, potassium and magnesium contents. EC and content in seed leachate increased with increasing temperature and duration of heat treatment on the seeds. Seed leakage was negatively correlated with emergence of the seedling in field tests.

After heat treatment at 70°C for 1 day, the seeds were sealed in tin cans and kept in cold room (10°C, 55 % RH) and their storability was evaluated. Percent germination in the laboratory, seedling height and seedling leaf area in the field were not significantly different between heat treated and non-heated seeds through 12 months of storage. Seedling emergence and dry weight in field test were significantly different between treated and the control seeds after they were stored for 12 months, while EC was significantly different as soon as the storage was initiated. In conclusion EC and composition of the seed leachte were sensitive indicators to determine the rate of deterioration and the vigour of sweet corn seeds.

INTRODUCTION

The definition of vigous adopted by the Association of Official Seed Analysts in 1980 was stated as follows : "Seed vigous comprises those seed properties which determine the potential for rapid, uniform emergence, and development of normal seedlings under a wide range of field conditons." (Mc Donald, 1980). Since field test are time consuming and require high level of manpower, many attemps have been made to establish laboratory tests to assess seed vigour. Seed vigour testing in sweet corn in temperate zones has involved mainly the cold test (Burris and Navratil, 1979; TeKrony et al., 1989), since low soil temperature becomes a major problem encountered during seedling growth. Waters and Blanchette (1983) reported that besides cold test, electrical conductivity test was good indicators for sweet corn vigour test, since its values was highly correlated with field performance. Conductivity was a measurement of electrolyte leakage and was megatively correlated with germination and field emergence in a number of species (Abdul-Baki and Anderson, 1970). Yaklich and Abdul-Baki (1975) reported that more sugars and amino acids were leached from deteriorated seeds than from vigourous ones of soybean. Yaklich et al (1979) also found conductivity, composition of the leachate, protein synthesis and water uptake to be correlated with seed emergence.

The goal of this project is to identify physiological and biochemical parameters that can be used to measure sweet corn seed vigour in order to forecast the potential field performance of the seeds. The seed, being a whole organism, cannot be evaluated for its vigour in a single physiological or biochemical test. Therefore, the variation of field performance should be correlated with physiological traits and with biochemical measurement. In this way a combined test may be established as a measure for seed vigour.

MATERIAL AND METHODS

Seed material

Newly harvested sweet corn seeds were dried at room temperatures (25°-30°C) and then in a circulat-

1 Central Laboratory and Greenhouse Complex, Kasetsart University, Nakhon Pathom 73140, Thailand.
2 Laboratory of Horticulture, FAculty of Agriculture, Meijo University, Nagoya 468, Japan.

ing air oven at 38°-40°C to obtain moisture content of about 7±0.5 %. The seeds were pretreated at 45°C and treated at 70°C for 1 and 3 days. These seeds were used for determining the content of seed leachate. Furthermore, the seeds treated at 70°C for 1 day were used for experiment of seed storability.

Seed quality test.

Moisture content

Seed moisture content was determined according to the method of the International Seed Testing Association (ISTA, 1985). Seeds were dried at 130°C for 2 hours and moisture content was calculated in percent on a wet weight basis.

Seed leachate

After a sample of 100 seeds was soaked in 50 ml of deionized water at 25°C for 40 hours, the content of leachate from seeds was analysed for the following properties.

: Electrical conductivity was measured by a conductivity meter, Model TOA.

: Potassium (K) and Magnesium (Mg) contents were measured by a method of atomic absorbtion with Shimazu Model AA-646.

: Sugar content was analysed by high performance liquid chromatography (HPLC).

: Amino acids were analysed by the use of Hitachi 855-50 amino acid analyzer.

: Protein content was determined according to the Lowry's method.

Seed germination

Germination tests were carried out as described in the International Seed Testing Association (1985). Seeds were allowed to germinate in sand box or in a rolled sheet of paper towels in 25°C germinator.

Water uptake

After the seed samples were imbibed at 25°C in a rolled sheet of paper towels, water uptake was measured by recording the increase in fresh weight of imbibed seeds as percent increase over the original dry seeds.

Field experiments

Field experiments were conducted to determine the influence of heat treatment on seed storability. Seeds were sown by hand in 4-row plots consisting of 24 hills in a latin square design. The row and plant intervals were 75 cm and 50 cm, respectively. The seeds were planted in each hill at a depth of about 1.5 cm. Urea fertilizer was applied as a basal dressing at the rate of 60 kg per acre. Water was applied twice each day as drip irrigation. The data were collected as follows:

Emergence of seedlings in the field : The number of normal seedlings was counted daily after planting until the first two leaves appeared.

Plant height : The height of 14-day seedlings was determined by measuring the distance from the soil surface to the tip of the flag leaf.

Plant dry weight : The harvested seedings were put in a burlap bag and dried at 70°C for 3 days. Thereafter their weight were determined.

Leaf area : The third leaves of 7-day seedlings were harvested to determine leaf area by the use of automatic leaf area meter.

RESULTS AND DISCUSSION

Heat treatment at 70°C for 1 day caused some biochemical changes in seeds but not physiological ones. Germination in the laboratory and emergence in the field were not different between control and heat-treated seeds, except for the seeds treated at 70°C for 3 day (Table 1).

In the previous paper (Termiesagdie and Takano, 1990) it was reported that as the temperature and the duration of the treatment were increased, electrical conductivity (EC) of the leachate from seeds increased, while the germinability of the seeds of soybean, yard long bean and sweet corn were reduced (Fig. 1). These experiments indicated that not only the EC but also the degree of leakage of electrolytes in particular potassium and magnesium content (Fig. 2), the solutes, including amino acids (Fig. 3) and sugars (Table 1) the laboratory and field tests (Table 1). The results of our experiments agreed with earlier reports of Schmid and Tracy (1988), who reported a negative correlation between EC and field emergence in hybrid lines of sweet corn seeds. Waters and Blanchette (1983), also found the EC and rolled-towel germination are negatively correlated with field test resultes for sweet corn seeds. Wann (1986) reported the break of protective layers on the sweet corn seed was contributed to the metabolite leakage. He suggested that protein leakage during germination was not directly related to the amount of soluble protein present in the seed. Our results supported his opinion that control and heat treated seeds contain nearly the same amount of soluble protein, but the heat treated seeds had increased leakage of proteins (Table 1).

Table 1 Effect of 70°C hot dry air treatment on sweet corn seed germination and nutrient leachate from seeds.

Test	Control	70°C	
		1-day	3-day
Protein content (% dry matter)	15.6	16.3	16.1
Seed moisture content	7.7	2.7	2.1
Seed germination (%)			
Paper test	95	90	83
Sand test	96	87	84
Field test	90	86	77**
Seed leachate			
Conductivity (μ S/cm)	61	85**	93**
Magnesium (ppm)	3	4	5
Potassium (ppm)	263	292*	310**
Sugar content (ppm)			
Fructose	1.2	1.3	1.5
Glucose	1.0	1.1	1.2
Total sugar	2.2	2.4	2.7
Amino acid (n mole)			
Lysine	0	0	8
Tryptophan	0	6	11
Histidine	6	8	16*
Proline	225	241	487**
Glutamine	32	37	65**
Glycine	48	59	99**
Alanine	149	154	212**
Protein content (μg/ml)	500	1000**	1200**

*, ** Significant difference between treated and control seeds at 5% and 1% level of probability by LSD, respectively.

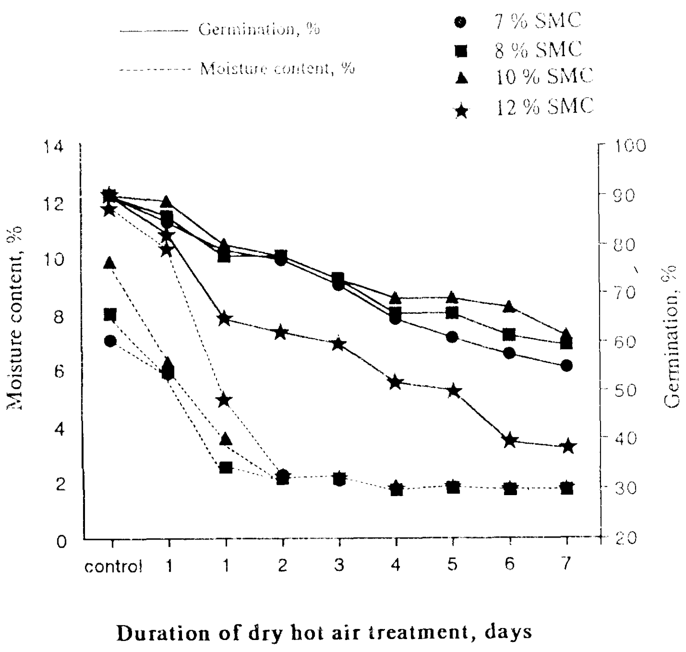

Fig. 1 Effect of seed heat treatment at 70°C on seed moisture content (SMC) and germination of sweet corn seeds.

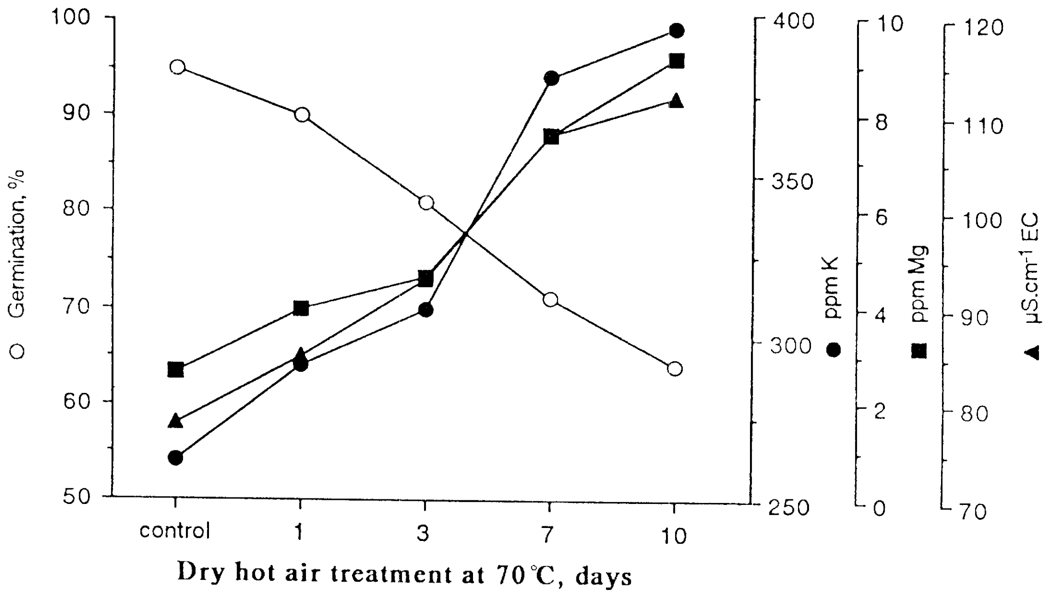

Fig. 2 Effect of heat treatment on germination and electrical conductivity (EC) in leachate from sweet corn seeds.

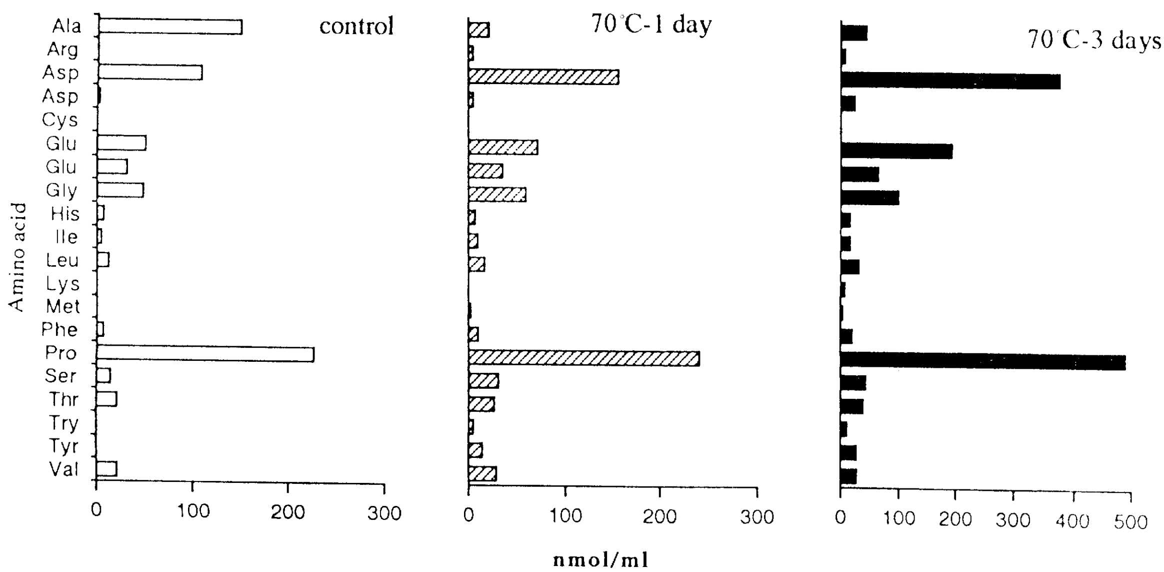

Fig. 3 Effect of seed heat treatment on amino acids in the leakage from sweet corn seeds. Seeds were held at 70°C for one or three days and then placed in water for 40 hours.

The observation on the increased leakage of seeds is considered to support the hypothesis that membrane deterioration is associated with imbibition. Damage during imbibition is caused by rapid uptake of water through cracking the seed coat during processing. (Powell and Matthews, 1979). Seed heat treatment accelerated imbibition and heat treated seeds showed more rapid water uptake than the control ones (Fig. 4). The rate of water uptake was associated with leakage form the seeds. As water uptake was more rapid, the degree leakage form the seeds became higher. A number of reports in the literature, predominately regarding with legume seeds, indicate that rapid water uptake into dry seeds is assiciated with low seedling vigour (oliver *et al*, 1984). However, seeds placed between moistened papers imbibed more slowly than those soaked in water (Fig. 5). Reducing the rate of water uptake is supposed to be one possible way to maintain germinability of seeds after heat treatment.

β-amylase activity in seeds during imbibition decreased with the increase in duration of heat treatment at 70°C (Fig. 6). β-amylase activity was positively correlated with seed emergence (Tabel 1). The results of our experiments are supported by earlier statemints of Powell and Matthews (1978) who found high levels of EC in seed leachates as an indication of damage during imbibition. The results of this damage was to reduce respiration and the mobilization of food reserves from cotyledons to other parts and decreased the relative growth rate of seedlings. Ashford and Gubler (1984) found amylase activity to increase in the endosperm of whole grains during germination as well as other starch hydrolases. In this experiment, longer term of heat treatment reduced the β-amylase activity.

the heat-treated at 70°C for 1 day and non-heated seeds stored under the circumstaneds of low temperature and low relative humidity (10°C, 55% RH) maintained the viability up to 12 months (Teble 2). However, storage at ambient tempatature caused deterioration in heat-treated seeds in 7 months (Temiesagdic

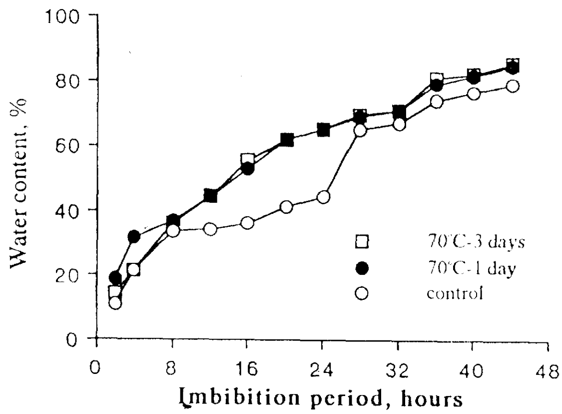

Fig. 4 Changes in water uptake of sweet corn seeds. Seeds were held at 25°C between moistened paper towels.

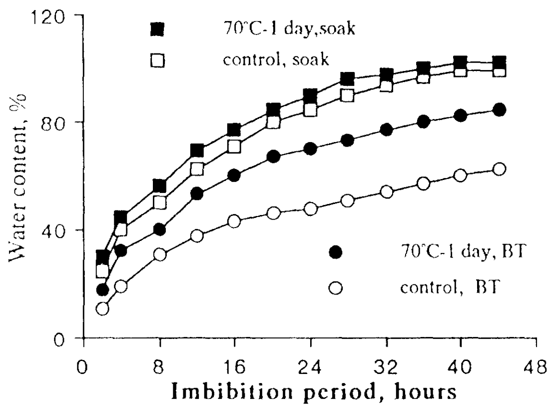

Fig. 5 Changes in water uptake of sweet corn seeds. Seeds were held at 25°C between moistened paper towles. The test was started after seeds were treated at 70°C for 1 day.

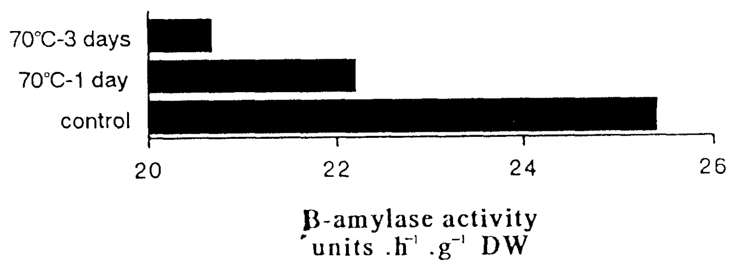

Fig. 6 Effect of seed heat treatment on ß-amylase activity of sweet corn seeds 40 hours after imbibition.

Table 2 Effect of heat treatment of sweet corn seeds on their storability. Seeds were sealed in a tin can and kept in a cold room at 10°C and %% % RH after heat treatment with 70°C for 1 Day.

Kind of testing	Storage period (month)		
	0	6	12
Electrical conductivity (μ S/cm)			
untreated seed	40	77	85
heat treated seed	65**	96*	113**
Seed germination (%)			
untreated seed	95	94	88
heat treated seed	90	93	85
Field test			
10 day-seedling emergence (%)			
non-heated seed	90	88	87
heat treated seed	86	82	72*
14 day-seedling height (mm)			
non-heated seed	420	359	207
heat treated seed	400	432	204
1 day-seedling dry weight (mg/plant)			
non-heated seed	142	102	124
heat treated seed	139	101	104**
10 day-seedling-second leaf-area (mm^2)			
non-heated seed	112	130	128
heat treated seed	101	125	110

* ** Significant difference between treated and control seeds at 5% and 1% probability in each storage period.

and Takano, 1990). Germination in the laboratory, seedling height and seedling leaf area in the field were not singificantly differint between heat-treated and non-heated seeds during the 12 months of storage. seedling emergence and seedling dry weight in field test of treated seeds became significantly lower than those of the untreated seeds after 12 months storage, while electrical conductivity (EC) was significantly different as soon as the storage was the initiated. The results of this ezperiment agreed with the report of Thiraporn et al. (1987) who found that when the seeds were not severely damaged, their physiological changes were shown only after they were stored, while biochemical changer occurred earlier. It may be suggested that the notion of seed viability, germenability and vigour namely implies to its storability.

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