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Viability, Vigor, and Electrolytic Leakage of Muskmelon Seeds Subjected to Accelerated Aging

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Abstract. **Seeds of 2 cultivars of muskmelon (*Cucumis melo* L.) were subjected to accelerated aging at 45°C and 100% relative humidity (RH) for periods up to 288 hours. In general, longer periods of aging resulted in greater declines in seed quality as measured by laboratory, greenhouse, and field emergence and germination. Seeds of 'Iroquois' were more sensitive to aging than 'Hale's Best #36'. Significant declines in germination occurred prior to any significant increases in electrolytic leakage from decorticated seeds indicating that electrolytic leakage is not a suitable test for seed quality with muskmelon.**

A frequently observed symptom of deterioration in aging seeds is an increase in leakage of cellular contents, particularly electrolytes, upon soaking in water (4, 9). This phenomenon has been observed in many crops including cotton (2), pea and french bean (11), fava bean (16), and soybean (6, 20). The increase in leakage has been attributed to a loss of cell membrane integrity (4, 9, 10); the loss of metabolites may also lead to secondary effects such as a decline in metabolic efficiency and an encouragement of microorganismal growth (1, 8, 10, 18).

Because of this increase in leakage with seed deterioration, electrical conductivity measurments of seed leachates have been proposed as a seed vigor test for some crops (14). The advantage of this test over standard germination tests is that it is rapid, inexpensive, and relatively simple to perform. However, test results can be influenced by initial seed moisture (17), seed size (19), and the use of fungicides (12).

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Seeds subjected to accelerated aging tend to deteriorate rapidly (5). The purpose of the present study was to determine whether the viability and vigor of muskmelon seeds subjected to different periods of accelerated aging were related to the electrical conductivity of leachates from these seeds.

Seeds of 2 muskmelon cultivars, 'Iroquois' (IRQ) and 'Hale's Best #36' (HBT), were produced in 1980 at the University of Maryland Vegetable Research Farm at Salisbury. Seeds were extracted from mature fruits, fermented for 24 hr, cleaned, dried for 48 hr at 35°C, and stored in closed containers at 5° without pesticide treatment. Moisture content of the stored seeds was 6–8% on a dry-weight basis.

Seeds were subjected to accelerated aging (AA) at 45°C and 100% RH in a covered water bath for periods up to 288 hr. After AA treatments, the seeds were again dried for 48 hr at 35° and stored at 5°. The moisture contents again ranged from 6 to 8%.

Initial studies investigating the electrolytic leakage from muskmelon seeds revealed that virtually all of the electrolytes in leachates from intact seeds were contributed by the seedcoat (data not shown). Hence, for electrical conductivity measurements, seeds were decorticated by surgically removing the seedcoat. Twelve decorticated seeds per replicate were placed in a 25-ml flask along with 6 ml of deionized water. Flasks were covered with parafilm and orbitally agitated at 90 rpm for 3 hr at 25°C. The imbibing solution was decanted and made up to 6 ml by washing the seeds with a small aliquot of water. A new aliquot of 6 ml of deionized water was then added to the same seeds, which were further agitated for 17 hr under the same conditions. The imbibing solutions were individually filtered via a 1.2-millipore filter and electrical conductivity was measured with a conductivity bridge (Yellow Spring Co. Model 31) using a glass electrode with a cell constant of 1.0.

Laboratory germination studies were conducted in accordance with methods prescribed in the Association of Official Seed Analysis (AOSA) Rules for Testing Seeds for Cucurbitaceae (3) except that decorticated seeds were used. Decorticated seeds of IRQ and HBT from the various AA treatments were germinated in the dark on moistened, folded paper towels in an alternating temperature germinator (12 hr 20°C/12 hr 30°C) with 100% RH at the Maryland State Seed Laboratory in College Park. Germination was monitored daily and both percent emergence (based on normal and abnormal seedling produced) and a germination index (13) (based on normal seedlings produced) were determined.

In the greenhouse experiments, seeds of IRQ and HBT subjected to 0, 72, 144, 216, and 288 hr of AA were planted in pots (12 seeds/pot, 3 replicates/treatment, 1 sphagnum peatmoss:1 vermiculite) which were arranged in a randomized block design. Emergence was recorded daily up to 15 days, after which an emergence index, similar to the germination index, was calculated for each cultivar-AA combination. Germination was based on the number of seedlings surviving 7 days after the termination of the emergence study.

On May 27, 1981, seeds of IRQ and HBT exposed to 0, 72, 144, and 216 hr of AA were planted at the Vegetable Research Farm at Salisbury. Seeds were planted through holes punched in black plastic mulch. Four replications of each cultivar-AA combination were planted; each replicate consisted of 4 holes with 3 seeds/hole. Replicates were read every 2 days for 21 days and an emergence index, as in the greenhouse study, was computed for each seedlot. Seedling survival was determined as previously described in the greenhouse experiment.

The data collected were subjected to analyses of variance. Data expressed as percentages were subjected to an $\arcsin\sqrt{p}$ transformation prior to analysis.

AA decreased seed vigor and viability as measured by percentage of emergence, percentage of germination, and the emergence or germination indices for both cultivars in

Table 1. Effect of accelerated aging (AA) on leachate electrical conductivity and germination of seeds of 2 muskmelon cultivars.

Cultivar	AA (hr)	Electrical conductivity (μmho/g fresh weight decorticated seed) 3 hr	20 hr	Normal seedlings (%)	Abnormal seedlings (%)	Germination index
Hales's	0	118 a[z]	177 a	97.2 a	2.7 a	11.2 a
Best	96	108 a	167 a	94.4 a	5.5 a	11.4 a
#36	192	145 a	184 a	75.0 b	11.1 a	8.2 b
	288	129 a	178 a	72.2 b	16.6 a	7.8 b
Iroquois	0	122 a	128 a	94.4 a	0.0 a	11.1 a
	96	138 a	182 a	83.3 ab	11.1 ab	9.5 ab
	192	216 b	217 ab	69.4 bc	19.4 bc	7.1 b
	288	209 b	287 b	41.6 c	30.5 c	4.2 c

[z]Mean separation in columns within each group by Duncan's multiple range test, 5% level. All variables expressed as % were subjected to arcsin transformation prior to analysis.

the laboratory germination tests (Table 1) and in the greenhouse studies (Table 2). Longer periods of AA resulted in greater declines in seed quality.

IRQ and HBT differed markedly in the conductivity of their leachates from unaged and AA-decorticated seeds (Table 1). HBT demonstrated no significant differences in leachate conductivity between unaged and AA seeds; all aging treatments, including the severe 288 hr of AA, resulted in conductance measurements similar to those of the control seeds. However, in IRQ the seeds subjected to 192 and 288 hr of AA leaked more electrolytes into the imbibing solution than the unaged seeds and those aged for 96 hr.

In terms of laboratory germination, seeds of IRQ were more susceptible to decline when subjected to AA than those of HBT. After 288 hr of AA, 72% of the HBT seeds produced normal seedlings, whereas only 42% of the IRQ seeds produced normal seedlings. In addition, the IRQ seeds produced a higher proportion of abnormal seedlings than did HBT as evidenced by abnormal root development. The germination index declined much more rapidly after AA in IRQ than it did for HBT.

The 2 cultivars also differed in their response to AA in greenhouse and in field emergence and germination studies (Table 2). Again, IRQ was more sensitive than HBT to AA treatments in the field study, but greenhouse results were not as conclusive with the exception of the percentage of germination variable. Declines in emergence for IRQ and HBT were similar in the greenhouse study, but only 21% viable IRQ seedlings were detected 22 days after sowing. In contrast, HBT seeds subjected to 288 hr of AA produced 53% viable seedlings. The discrepancies between percentage of emergence and percentage of germination may have been due to the production of abnormal seedlings, which could have been included in the emergence counts but not in the germination counts.

In the field study (Table 2), IRQ, which had a higher field germination than did HBT with unaged seeds, lost a significant amount of its germinability after 216 hr of AA. In contrast, there was no significant decline in emergence and germination with AA in HBT. As in the greenhouse study, the survival of IRQ seedlings was lower than that of HBT. IRQ seedlings from 216 hr of AA exhibited 44% survival, while the HBT survival was 75% under similar AA and germination conditions. As in the previous studies, this indicated that the HBT seedlot was less susceptible to AA treatments than the IRQ seedlot.

It is interesting to note the similarity in decline of germination in the laboratory and field studies, particularly since the laboratory study used seeds with the seedcoat removed. However, the presence of an intact seedcoat has been reported to inhibit germination (7, 15) and it is possible that changes may also occur in the testa during aging that affect germination. Further studies would be necessary to evaluate this hypothesis.

Seed leachate conductivity does not appear to be a promising test for seed quality in muskmelon. For both IRQ and HBT, significant declines in emergence and germination occurred prior to any significant increases in electrolytic leakage. Thus, standard germination tests and field evaluations appear to be better measurements of seed quality than electrical conductivity, assuming that AA effects were similar to those of natural seed deterioration. Another drawback to the electrical conductivity test is the necessity for decortication. This is a tedious process and, if done improperly, may cause injury to the embryo, which may alter the amount of electrolytic leakage. This may have occurred in this study despite the fact that the technique used actually improved germination as measured in laboratory germination tests.

Table 2. Effect of accelerated aging (AA) on emergence and germination of seed of 2 muskmelon cultivars in the greenhouse and in the field.

Cultivar	AA (hr)	Greenhouse Emergence (%)	Greenhouse Emergence index	Greenhouse Germination (%)	Field Emergence (%)	Field Emergence index	Field Germination (%)
Hale's	0	97.2 a[z]	10.13 a	97.2 a	87.5 a	13.9 a	83.3 a
Best	72	83.3 b	8.55 ab	75.0 b	85.4 a	13.6 a	83.3 a
#36	144	77.7 bc	7.52 b	72.2 b	87.5 a	13.5 a	85.4 a
	216	80.5 bc	7.44 b	72.2 b	81.3 a	11.6 a	75.0 a
	288	61.1 c	5.47 c	52.7 b	---	---	---
Iroquois	0	91.6 a	9.74 a	86.1 a	95.8 a	15.8 a	95.8 a
	72	86.1 a	9.19 ab	83.3 a	85.4 a	13.7 a	83.3 a
	144	97.2 a	9.91 a	97.2 a	89.6 a	14.0 a	87.5 a
	216	83.3 a	8.16 b	69.4 a	64.6 b	9.5 b	43.7 b
	288	55.5 b	4.77 c	21.1 b	---	---	---

[z]Mean separation in columns within each group by Duncan's multiple range test, 5% level. All variables expressed as % were subjected to arcsin transformation prior to analysis of variance.

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Stock-scion Interaction and Tuber Dry Matter in Potato

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Additional index words. *Solanum tuberosum*

Abstract. **In reciprocal grafts of 'Denali' and 'Norchip' potato (*Solanum tuberosum* L.), tuber percentage of dry matter was significantly higher at harvest when 'Denali' was the stock. In field plantings of 'Norchip' and 'Denali', tubers from 'Denali' had higher percentage of dry matter than those from 'Norchip' at tuber initiation and remained higher until harvest.**

Percentage of dry matter (total solids) in potato tubers affects tuber textural qualities, chip yield, and oil content when processed (6). Potato cultivars differ in dry matter; however, differences may be inconsistent from year to year (4, 5). 'Denali', a new potato cultivar which was released in 1979 (1), has consistently had higher total solids and yield in Ohio than does 'Norchip', a standard chipping cultivar (3, 8).

Grafting techniques have been used to study movement of transmissable hormones (7). This technique seemed appropriate to study dry-matter accumulation in potato tubers, since photosynthates must move from the leaves to the underground tubers. Reciprocal grafting should distinguish whether cultivar differences in total solids are due to supply of photosynthates from the leaves or to the inherent physiological characteristics of the tubers or to both.

Greenhouse study. Reciprocal grafts of scions and stocks of 'Denali' and 'Norchip' were made in 2 experiments during Feb.–July 1979 and 1981. Seedpieces were placed in 8-cm pots containing Pro-Mix and grafts were made 2 weeks after emergence. Grafted scions were put into a small vial of water until the graft union formed (Fig. 1). Twist ties held the stock-scion union together and were left during the entire growing season for convenience (Fig. 2). One week later the plants were transplanted into 20-cm pots containing a soil mix of 1 Wooster silt loam:1 sphagnum peatmoss:1 perlite. All leaves and side shoots were removed from the stock; thereafter, newly formed shoots were removed immediately. Greenhouse temperatures were kept between 18 and 30°C. Pots were arranged on benches in a randomized complete block design with 6 single plant replicates per treatment. Photosynthesis was determined on a newly mature leaf between 70 and 90 days after planting, using the method described by Ferree and Hall (2). One hundred days after transplanting, tubers were harvested and dried at 70°C to a constant weight.

'Denali' tubers had higher total solids than did 'Norchip' tubers in the greenhouse (Table 1). Scions had an effect on total solids in one of the 2 years when tubers with a 'Denali' scion had higher total solids than did tubers with 'Norchip' scion in 1981. There was no difference in photosynthesis between the 4 graft combinations (Table 1). These results indicate that the tubers are the major factor in determining differences in total solids. Scion source had an effect in one of 2 experiments, but stock had highly significant effects in both experiments.

Field study. 'Norchip' and 'Denali' were compared in field plots over 2 seasons. Plots received standard cultural practices. Samples of tubers from 3 plants were taken several times between days 50 and 120 of the growing season and were dried at 70°C to a constant weight. Vines were killed with dinoseb at 120 days and tubers harvested 7 days later.

Table 1. Influence of reciprocal grafts of 'Norchip' and 'Denali' potatoes on percent dry weight of tubers and photosynthesis, greenhouse experiments.

	Tuber dry wt (%)		Photosynthesis (mg $CO_2 dm^{-2} hr^{-1}$)	
Scion/Stock	1979	1981	1979	1981
Norchip/Norchip	16.9	17.0	13.9	16.2
Norchip/Denali	20.6	18.0	15.3	16.8
Denali/Norchip	15.7	17.8	15.9	16.7
Denali/Denali	20.8	18.6	14.7	18.4
Significance				
Scion	NS	*	NS	NS
Stock	**	**	NS	NS
Scion x stock	NS	NS	NS	NS

NS,*,**Nonsignificant (NS) or significant at 5% (*) or 1% (**) level by F test.

Total yield and tuber dry weight were measured at harvest. Plots were arranged in a randomized complete block design with 6 replications.

'Denali' had higher total solids than did 'Norchip' as soon as tubers formed and remained so throughout the season in the field (Fig. 3). 'Norchip' vines began senescing at about 95 days, whereas 'Denali' continued to grow until vine kill. It appears that differences in total solids between 'Denali' and 'Norchip' are inherent in the tuber and not the result of continued dry-matter accumulation by 'Denali' late in the season. Yield

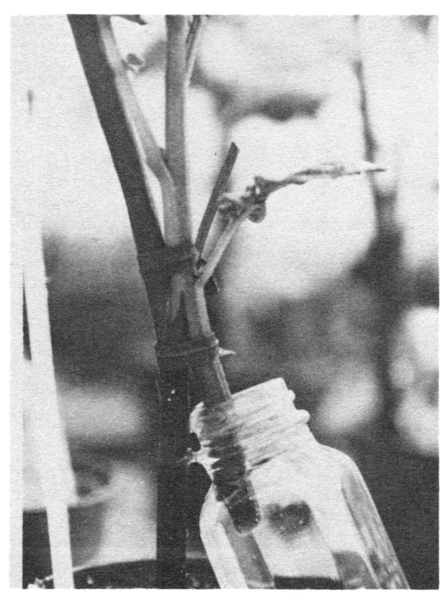

Fig. 1. New graft showing graft union and scion in small vial of water.

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