

## RESEARCH NOTES

# Relationships Between Electrical Conductivity of Imbibed Seeds Leachate and Subsequent Seedling Growth (Viability and Vigour) in Omid Wheat

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## ABSTRACT

Electrical conductivity (EC) has been evaluated as a possible method for measuring viability and seedling vigour in wheat and other crops. A study was conducted using dormant, stock, naturally-aged (5 years) and artificially-aged (10 and 15 days) wheat seeds (*Triticum aestivum* cv. Omid) to evaluate the effect of different seed lots on electrical conductivity. All seed lots were subjected to the following tests: standard germination; speed of germination; germination rate; time to reach 50% germination; electrical conductivity and seedling growth rates. C.K.I), experimental design was used. Solute leakage from imbibed wheat seeds increased with treated or accelerated aging in a linear manner in the range over which vigour was depressed. Significant differences were observed among selected seed lots in most of the parameters of seed quality.

Keywords: Electrical conductivity , Seedling growth , Wheat

## INTRODUCTION

The electrical conductivity test measures the amount of electrolytes which leach from seeds during imbibition. There is a need for the development of rapid seed quality tests that determine viability (defined as the viability to germinate) without the necessity for completion of germination [9, 11, 12, 19]. The increase in conductivity has been found to be correlated with the decrease in germination and seed vigour in several crop species [3, 4, 6, 8, 14, 15, 18, 26, 27]. Abdul-Baki and Anderson [1] found that aging barley seeds showed increased leaching of sugars during imbibition coupled with reduced seed viability and stated that a negative correlation of sugar

leachate and germination of seed may be a practical test for a rough estimation of seed viability.

When seeds are set to germinate, the imbibition of water is accompanied by a leaching of substances out of the seeds. These substances are mainly potassium, phosphates, sugars and amino acids [20]. Heydecker [10] stated that the exudation of sugars and other electrolytes, resulting from membrane damage, could become food material for soil microorganisms (especially fungi) and lead to seed decay and poor stand establishment.

A direct correlation between electrical conductivity and seed viability has been reported by several researchers [4, 5, 11, 14, 16, 17, 24, 29]. As seed vigour declines with

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age, the ability of the seed to retain solutes also reduces [7, 14, 21, 22]. The aim of this experiment is to determine the effect of selected seed lot treatments on leachate electrical conductivity, vigour and viability of Omid wheat.

## MATERIALS AND METHODS

Five seed lots of wheat *Triticum aestivum* cv. *Omid*, grown widely in Azarbayjan were collected from the Urmia University, Experimental Farm. Varying vigour were obtained by using dormant seeds drawn from a seed lot harvested two days before the beginning of the experiment. Stock seeds (seeds which were dried in a current of hot air at  $34\pm 1^\circ\text{C}$  and kept under refrigeration) served as stock, naturally aged seeds for 5 years and accelerated aging treatment at  $40^\circ\text{C}$  and 100% relative humidity for 10 and 15 days. AH treatments were subjected to the following tests:

### Electrical Conductivity Test

Five grams of seeds were surface sterilized by soaking in 1% sodium hypochloride for 2 minutes, followed by 3-4 successive washings with distilled water. A conductimeter (Type CD6N) was then used to measure the electrical conductivity of the leachate obtained by soaking 5g samples of seeds in 20 ml of distilled water at  $20^\circ\text{C}$  for 8 hours. Three replicates of each seed lot were evaluated. The conductivity measurements were expressed in mmhos/cm /5g seed.

### Standard Germination Tests

Germination tests were carried out in an incubator maintained at  $20^\circ\text{C}$ . Four hundred seeds were uniformly placed in 9cm Petri dishes on two layers of filter paper. Distilled water was added at intervals to keep the paper moist. Germination was recorded as

the percentage of radicles which emerged during 8 days.

### Speed of Germination

The germination rate was calculated by dividing the number of germinated kernels per 100 seeds obtained at each counting. The values obtained at each count were then summed to obtain the germination rate (Vandeventer, and Grobbelaar) [25].

$$GR = \frac{\text{No. of germinated seed}}{\text{Days to first count}} + \dots + \frac{\text{No. of germinated seeds}}{\text{Days to final count}}$$

### Time to Reach 50% Germination

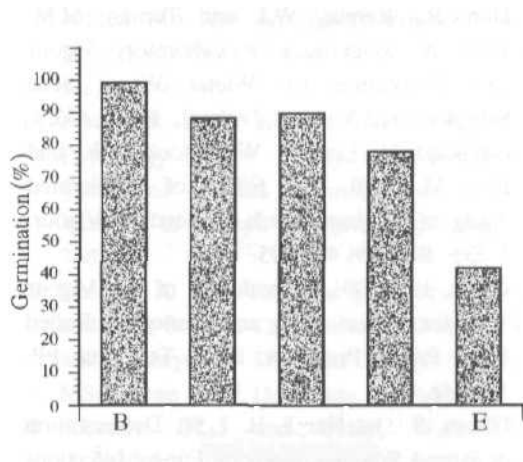
Time to reach 50% of the final germination count ( $T_{50}$ ) was calculated according to the formula of Coolbear *et al* [2] as:

$$T_{50} = t_i + \left[ \frac{(N+1)/2 - n_i}{n_j - n_i} \right] \cdot (t_j - t_i)$$

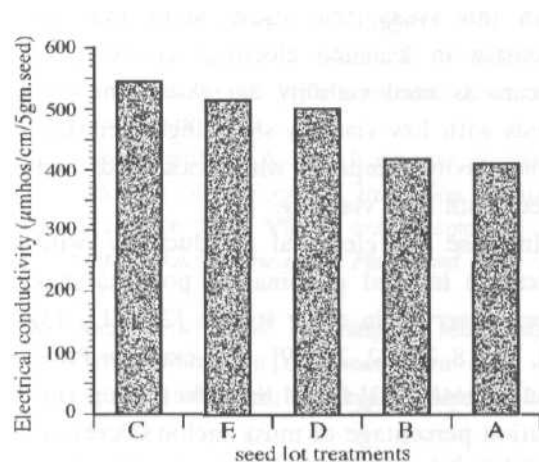
where N is the final number of seeds germinating, and  $n_i$  and  $n_j$  are total number of seeds germinated by adjacent counts at time  $t_j$  and  $t_i$ . Elongation of each radicle was determined by laying each one on graph paper and measuring with a ruler, following weighing of 10 seedlings to get fresh weight per seedling. Data were analyzed in a completely randomized design and the separation of means was performed by Duncan's new multiple range test.

## RESULTS

The seed lots used in this study had germination percentages ranging from 37 to 99% (Fig. 1). The vigour index of stock seeds was found to be significantly higher than that of either natural or artificially aged seeds (Fig. 2). Root length and fresh weight per seedling of stock seeds also indicated a significant difference in seed vigour (Table 1).



**Fig. 1.** Relationship between percent germination and seed lot treatments of Omid wheat. A=dormant seeds, B=stock seeds, C=naturally-aged seeds, D=artificially-aged seeds for 10 days and E=artificially-aged seeds for 15 days.



**Fig. 2.** Relationship between seed lot treatments and electrical conductivity of leachate from imbibing seeds of wheat. A=dormant seed, B=stock seeds, C=naturally-aged seeds, D=artificially-aged seeds for 10 days and E=artificially-aged seeds for 15 days.

Leakage of electrolytes (i.e. water soluble compounds from the seeds upon imbibition) was not similar and the electrical conductivity measurements of the leachate from treated seeds were significantly higher than the stock or dormant seeds used in these tests. The seeds with low viability had higher electrical conductivity when compared with the stock and highly viable seeds. Therefore, the results presented show that the electrical conductivity rate increases in deteriorated seeds, which depends on the degree of deterioration compared with the stock or dormant seeds.

## DISCUSSION

The results of this investigation (Table 1) show that the electrical conductivity of soaking water from wheat ranges from 412.7 micromhos for dormant seeds to as high as 552.5 micromhos for naturally-aged seeds. Effects of seed aging on electrolyte leakage have been reviewed by several researchers who found that as the aging period increased, leachate conductivity also increased (e.g. in musk melon seeds [13] tomato seeds [2] pearl millet [29], barley, wheat and maize [23]).

Table 1. Effect of different seed lot treatments on leachate electrical conductivity, germination percentage, germination rate, time to reach 50% germination and seedling growth of Omid wheat (Treatment means compared by Duncan's new multiple range test at .05 probability level; vertical lines show means grouping).

Germination %	Electrical conductivity (µmhos/cm/g/seed)	Germination rate	Time to reach 50% germination (days)	Root length (mm)	Fresh weight per seedling (mg)
E 37.2	A 412.7	E 13.1	B 1.20	E 64.50	E 180.5
D 72.5	B 422.7	A 21.0	A 2.50	D 85.70	A 228.5
A 83.0	D 509.0	D 21.4	C 2.50	A 108.5	D 242.2
C 83.5	E 540.5	C 38.5	D 2.70	C 116.5	C 252.2
B 89.7	C 552.5	B 41.1	E 2.97	B 132.7	B 285.0

A=dormant seeds, B=stock seeds, C=naturally-aged seeds for 5 years, D=artificially-aged seeds for 10 days and E=artificially-aged seeds for 15 days

In this study, the results show that an increase in leachate electrical conductivity occurs as seed viability decreases, and the seeds with low viability show high electrical conductivity compared with stock seeds and seeds with high viability.

Increase in electrical conductivity with decrease in seed germination potential has been observed in other studies [2, 4, 11, 13, 14, 15, 18, 21, 22, 23, 29]. For example Pesis and Timothy [13] found that when the germination percentage of musk melon decreased from 94.4 to 41.6 the electrical conductivity increased from 128 to 287. The electrical conductivity also has been shown to correlate with seedling vigour in seeds of barley [1], wheat [16], corn [28] and barley, wheat and maize [23].

The correlation between seed deterioration and leakage of electrolytes from seeds may be related to the hypothesis of some researchers that the increase of electrical conductivity is due to the loss of ability to re-organize cellular membranes completely and rapidly during early imbibition [1, 10, 25].

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## بررسی رابطه بین هدایت الکتریکی عصاره حاصل از بذور خیسانده شده با رشد گیاهچه (قوه نامیه و قابلیت حیات) در گندم امید

### چکیده

یکی از روش‌های ممکن در بررسی قوه نامیه و قدرت حیات بذر در گندم و سایر گیاهان، اندازه‌گیری هدایت الکتریکی عصاره حاصل از بذور خیس شده آنها است. برای نیل به این هدف، تعداد ۵ تیمار از بذور گندم امید را با در نظر گرفتن شرایط: بذور در حال رکود، بذور شاهد (تازه، سالم و فاقد رکود)، کهنه بودن بذر (با ۵ سال سابقه انباری در شرایط آزمایشگاه) و بذوری که در مدت ۱۵-۱۰ روز به طور مصنوعی کهنه شده بودند، انتخاب و آزمون‌های مربوط به اندازه‌گیری قوه نامیه، سرعت جوانه‌زنی (میزان رشد و مدت زمانی که طول می‌کشد تا ۵۰ درصد بذور جوانه بزنند)، هدایت الکتریکی و مقدار رشد (طول ریشه و وزن ماده تر) در قالب طرح بلوک‌های کامل تصادفی انجام گرفت. نتایج آزمون‌ها نشان می‌دهد که در اغلب موارد اختلاف معنی‌داری بین هدایت الکتریکی، قوه نامیه و شاخص‌های رشد تیمارها وجود داشته و با زیاد شدن مقدار املاح تراوش یافته، قوه نامیه و بنیه بذر شدیداً کاهش یافت.