The Effect of Seed Immersion Duration on Membrane Leakage and Maize Seed Vigor (*Zea mays L.*)

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ABSTRACT. Electric Conductivity test determines indirectly the integrity of seed membrane systems. It is used to assess seed vigor as this test detects the seed deterioration process at early stage. The objective of this reasearch was to evaluate the effects of seed immersion duration (30, 60, 90, 120, 720, and 1440 minutes) on membrane leakage and vigor of four maize varieties' seed lots; Lamuru, Srikandi Putih, Bisma, Srikandi Kuning. Completely radomized design with four replications was used to arrange the experiment. The result of the experiment showed that as the duration of seed immersion longer; the membrane leakage was higher in all seed lots tested. The high amount of membrane leakage indicates the decrease of seed vigor.

Keywords: maize,seed, immertion, duration, vigor

Introduction

There are several factors which cause seed vigor in the field to be low; for instance genetic, physiological, morphological, cytological, mechanical, and microbial factors (Sutopo, L. 1999). Seed vigor indicates the potential of seed to grow fast, uniform, and developed into normal seedling in various environmental conditions (AOSA 1983). Seed vigor is determined through biochemical and physiological approaches. One of the biochemical indicators is electrical conductivity of seed immersed water, proposed by Osterhout (1922) in Mc Donald and Nelson (1986) which suggested the relation of cells death with the release of electrolyte. The electrical conductivity is based on the premise that low quality seed will leak more seed inner matters through cell membrane than the good quality one. The high conductivity values indicate high seed metabolite leakage, meaning the seed quality has dropped (Copeland *et al*. 2001).

Low seed vigor has decreased its membrane integrity as a result of deterioration during storage and mechanical damage. During imbibitions, a weak structured membrane will release cytoplasmic colloidal that carries electrical charge. This electrical charge is detected using conductivity meter and the value of conductivity indicates the level of seed metabolites leakage (Copeland *et al*, 2001). The objective of the research was to determine the relation of immersion duration with the level of membrane leakage and initial vigor of maize seed.

Methodology

The experiment was conducted from October to November 2011, in the laboratory and greenhouse of Indonesian Cereal Research Institute in Maros, South Sulawesi, Indonesia. Four varieties were used in the experiment, namely Lamuru, Bisma, Srikandi kuning-1 and Srikandiputih. The treatments were five different durations of immersion, which were (1) 30 minutes, (2) 60 minutes, (3) 120 minutes, (4) 720 minutes (5) 1440 minutes. The experiment was arranged in completely radomized design with 4 replications. There were five variables observed in the experiment, they were seed germination, germination speed, electrical conductivity (EC), shoot and root dry weight.

Germination Speed

The data to calculate the germination speed was collected from the substrate of seed germination test. Germination speed was calculated at every observation by dividing the percentage of normal seedling by *etmal* (1 *etmal* equal to 24 hours). The cumulative etmal value was obtained from the sowing until the time of observation (AOSA, 1983). The formula to calculate germination speed is as follow:

$$GS = \frac{(Xi - X_{i-1})}{Ti}$$

GS = growth rate/germination speed (%/etmal)
Xi = the percentage of normal shoot at etmal i
Ti = time observation (in etmal)

Electrical Conductivity (EC)

EC was measured using conductometer tool Methron type E 38. A total of 5 g seed was randomly taken from the sample, followed by immersing the seed in 50 ml of ion-free water for 24 hours. The EC was measured on immersion water of 30, 60, 120, 720 and 1440 minutes immersion.

Shoot and Root Dry Weight

Shoot and root were dried in the oven at temperature of 60º C for 3 x 24 hours. The dried shoot and root were placed in desiccators and air cooled. Shoot and root were weighed using electric scale.

Results and Discussion

The intial seed moisture of four varieties was ranging from 10.8-12.83 % and 100 seed weight were ranging from 22.24-26.55 g. The initial seed viabilty of four vaieties tested were not different (Table 1).

Immersion duration of 30, 60 and 120 minutes were not influenced the percentage of germination and germination speed of four varieties. Although a significant different were detected on the germination speed of Lamuru, Srikandi Putih and Srikandi Kuning-1 at immersion duration of 720 minutes. Germination speed of Bisma was slightly decreased at different immersion durations, even though there was significant decrease between immersion duration 30 and 1440 minutes. The result above showed that longer seed immersion duration tends to decrease germination speed of four varieties tested. The decrease of germination speed indicates the potential of seedling to grow fast and uniform in the field was disrupted. It is caused by the lysis of cell membrane thus releases organic and inorganic electrolyte which influence the germination at early stage (Mc Donald and Nelson 1986, and Copeland *et al*. 2001).

The electrical conductivity of four varieties tested was increased with the increasing of seed immersion duration as shown in Table 2. Electrical conductivity indicates the level of membran leakage of the seed (Mc Donald and Nelson 1986 and Copeland *et al.* 2001). When the electrical conductivity is high, the leakage from cell membrane is also increase. It indicates the decrease of seed vigor as shown in the decrased of germination speed in Table 2.

Shoot and root length and dry weight is an indicator for seed deterioration quality. According to Mungnisyah and Nakamura (1984), shoot length and shoot:root dry weight can be used to assess seed vigor. Different seed immersion durations were not influenced shoot and root dry weight ratio as shown in Table 3.

Shoot dry weight showed the fluctuation data with seed immersion duration. Root dry weight showed that 1440 minutes of seed immersion duration have the higher root dry weight compare to others seed immersion duration treatments on all varieties tested. Shoot: root dry weight ratio tend to increase with increasing seed immersion duration on Lamuru and Srikandi Putih varieties (Table 3). The higher shoot : root dry weight ratio indicated that root dry weight was reduced but shoot dry weight was increased at longer seed immersion duration. Results from Sikder *et al.* (2009) on maize showed that shoot : root ratio of maize increased with increased germination temperature. In this study, the temperature germination on all treatments same, but increased seed immersion duration caused the incerased leakage in membran cell that affect seedling growth at the first stage of germination.

Table 1. Moisture content, 100 seed weight, initial germination and germination speed of four maize varieties. Maros, 2011.

Varieties	Moisture content (%)	100 seed weight (g)	Germi-nation (%)	Germination speed (%/etmal)
Lamuru	12.63 a	26.44 b	96,667	29,377
Srikandi putih	12.83 a	22.24 a	96,667	29,377
Bisma	11.03 b	26.55 b	98,667	29,767
Srikandi kuning-1	10.80 b	25.92 b	98,667	29,343

*) values followed by the same letter in the same column are not significantly different at 5% level of Duncan test.

Table 2. Seed germininations, germination speed, and electrical conductivity of seed from different immersion duration. Maros 2011.

Maize varieties/ Immersion duration (minutes)	Germination (%)	Germination speed (%/etmal)	Electrical conductivity (uS/cm/g)
Lamuru/30	96.667a	29.377a	6.377 e
Lamuru/60	92.667 ab	26.833 abcd	10.317 d
Lamuru/120	89.333 abcd	27.000 abcd	10.030 d
Lamuru/720	81.333 cd	23.300 efg	10.813 d
Lamuru/1440	81.333 cd	22.067 g	15.327 a
Srikandi putih/30	96.667 a	29.433 ab	6.217 e
Srikandi putih/60	98.667 a	28.267 abc	9.983 d
Srikandi putih/120	96.667 a	28.667 abc	11.977 cd
Srikandi putih/720	89.333 abcd	24.390 defg	10.170 d
Srikandi putih/1440	89.333 abcd	21.900 g	16.903 a
Bisma/30	96.667 a	29.767 ab	5.143 e
Bisma/60	97.333 a	28.333 abc	10.127 d
Bisma/120	87.333 abcd	25.400 cdef	12.293 cd
Bisma/720	92.000 abc	25.600 cdef	11.003 d
Bisma/1440	88.667 abcd	22.400 fg	14.573 abc
Srikandi kuning-1/30	94.000 ab	28.167 abc	7.097 e
Srikand kuning-1/60	93.333 ab	26.533 bcd	11.097 d
Srikandi kuning-1/120	84.000 bcd	26.000 cde	12.920 bcd
Srikandi kuning-1/720	80.000 d	22.433 fg	11.493 d
Srikandi kuning-1/1440	67.333 e	17.567 h	15.327 ab

*) values followed by the same letter in the same column are not significantly different at 5% level of Duncan test

Table 3. Dry weight of shoot, root, shoot and root ratio at different immersion durations. Maros 2011.

Maize varieties/ immersion duration (minutes)	Dry weight (g/seedling)		
	Shoot	Root	Shoot : root
Lamuru/30	0,029 ab	0,034 bcd	0,874
Lamuru/60	0,033 ab	0,039 bcd	0,876
Lamuru/120	0,024 b	0,027 d	0,883
Lamuru/720	0,033 ab	0,032 cd	1,082
Lamuru/1440	0,038 a	0,040 bcd	0,974
Srikandi putih/30	0,033 ab	0,038 bcd	0,878
Srikandi putih/60	0,035 ab	0,041 bcd	0,839
Srikandi putih/120	0,024 b	0,030 cd	0,789
Srikandi putih/720	0,310 ab	0,040 bcd	1,054
Srikandi putih/1440	0,034 ab	0,054 a	0,660
Bisma/30	0,029 ab	0,037 bcd	0,812
Bisma/60	0,025 b	0,042 abc	0,612
Bisma/120	0,025 b	0,036 bcd	0,698
Bisma/720	0,034 aqb	0,040 bcd	0,845
Bisma/1440	0,029 ab	0,047 ab	0,626
Srikandi kuning-1/30	0,024 b	0,037 bcd	0,652
Srikandi kuning-1/60	0,023 b	0,031 cd	0,790
Srikandi kuning-1/120	0,026 ab	0,027 d	0,964
Srikandi kuning-1/720	0,032 ab	0,033 bcd	0,890
Srikandi kuning-1/1440	0,025 b	0,034 bcd	0,731

*) values followed by the same letter in the same column are not significantly different at 5% level of Duncan test

Conclusion

- The longer of seed immersion duration, the higher cell membrane leakage as indicated by high electrical conductivity value of four varieties seed.
- Srikandi Putih and Bisma didn't show any difference of germination percentage at five different immersion durations.
- Immersion duration of 1440 minutes decreased the germination percentage of Lamuru and Srikandi Kuning
- The increased of seed immersion duration decreased the germination speed of four varieties tested.
- The germination speed of Lamuru, Srikandi Putih and Srikandi Kuning-1 were significantly decreased at immersion duration of 720 minutes. While Bisma were significantly decreased at 1440 minutes of immersion.
- Different seed immersion durations were not influenced the dry weight of shoot and root ratio.

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