# Conditioning Effects on Physiological and Biochemical Characteristics of Maize Seed (*Zea mays* L.)

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**ABSTRACT**. Low seed vigor causes poor seedling emergence which later on create poor plant establishment and eventually reduce yield. Various seed invigoration have been extensively carried out to improve deteriorated seed vigor due to storage. Matriconditioning is advanced method that effectively increases seed vigor. This research was conducted at Indonesian Cereals Research Institute from July to September 2010, which aimed to evaluate the effect of matriconditioning treatments on physiological and biochemical characteristics of maize seed. The treatments were arranged in Completely Randomized Design, with three kind of matrix media i.e., straw, ash and sawdust. Seeds used were freshly-harvested and 6 months-storage and each treatment used three replications. Results shows that straw matrix gave the best value on seed germination (98%) and germination speed (30,69%) of freshly-harvested seeds. Whereas, stored seed gave significant result only in seed germination (91%). Shoot-root length ratio highest value was obtained in ash matrix media (1,18 cm), which correlate with the best treatment for root length (12.62 cm). Electrical conductivity observation proved that matriconditioning using straw matrix media gave the lowest conductance, thus confirmed its ability to improved seed vigor for both new and storage seed.

Key words: Maize, matriconditioning, seed, vigor

## Introduction

One critical point to achieve excellent plant establishment is the period after seed sowing and before seedling emergence. This is because germination of seed is influences by genetic as well as environment factors, which affect the ability of seedling to emergence thus the level of seed vigor. When there is an environment stress occurred during early stage of seedling, even viable seed would not have the optimum vigor to develop into a normal plant. Therefore, various methods were developed aimed to improve seed vigor and increase seedling emergence, these methods are commonly described as seed invigoration. Some treatments of invigoration were used to create uniformity growth of shoot and increase growth rate. One simple way of seed invigoration is by soaking the seed in water containing both ionic and nonionic compound (Bradford 1986; Smith and Cobb 1991; Arief and Koes 2010). Another extensive research was carried out of priming seeds in low water potential, e.g. Polyethylene Glycol (PEG) and salts (Bradford 1986; Heydecker and Coolbear 1977, Khan *et al.* 1978). Effective priming result on sweet corn seed using PEG was reported by Murray (1990) with significant improve in seedling emergence rate. Recent progress of seed conditioning used Micro-Cel E and expanded vermiculite was proven effective to aid seedling emergence (Khan *et al.* 1992).

Seed conditioning primarily functions to prepare seed to germinate which has not developed the morphological structure of germination. Various kind of conditioning materials has been extensively used to enhance the rate and uniformity of germination. And the most effective and easy to apply is by utilization of solid carries with high water adsorptive capillary forces, which is known as matriconditioning technique (Khan 1990). According to Ilyas (2003), matriconditioning in some horticultural plants is able to increase seed germination by 90%. Simultaneous growth and seed vigor index also increased in treated seed compared to untreated seed (control). The best medium for matriconditioning are materials that have low potential matrix, negligible osmotic potential, low solubility, able to remain intact during treatment, non-toxic, high water absorption and holding, high water flow capability, has a large surface area, low specific weight and able to adhere to the seed coat (Khan *et al.* 1990).

Currently, matriconditioning treatment is not only aim to improve seed viability and vigor, but further advance application with addition of pesticides to control seed-borne diseases. And another advantage of incorporating pesticides is to protect seed from seed-borne pathogens. According to Suryani (2003) with application of advanced matriconditioning and addition of fungicide proved able to increase viability and vigor of seed as well as minimized contamination levels of (*Colletotricum capsici*) on chili. Furthermore, various studies indicate that deteriorated

seed, with the help of matriconditioning seedling performance can be significantly improved.

## Materials and Methods

The research was conducted at Seed Testing Laboratory of Indonesian Cereals Research Institute from July to September 2010. The research statistical method was carried out by Completely Randomized Design, with three replication and four treatments as follows : (1) without matriconditioning ($M_0$), (2) matriconditioning with straw ($M_1$), (3) matriconditioning with ash ($M_2$), and (4) matriconditioning with sawdust ($M_3$). The variety used was Bima with two different kind, i.e., freshly harvested (A) and seed that have been stored for 6 months (B).

All materials were weighed using an analytical balance as much as 150 grams in each Matrix. Materials that have weighed as much as 150 grams is then inserted into plastic bag as much as 12 bags, each Matrix was then mixed with 100 grams of seeds and also 50 ml of distilled water. Matriconditioning material which was mixed with the seed is then allowed to stand for 24 hours in a cool room.

### Observation Parameters

#### Seed Germination

A total of 50 seeds from each replication were grown in sand media. Observations were carried out on day three, four and five after planting. In addition to seed germination testing, this treatment was also measured seeds growth rate. Observations were made on the basis of normal shoot criteria, abnormal and died. The normal shoots are grouped into two kind of seedling, which is strong normal shoot and weak normal. The number of normal shoot at day 4 (cumulative) was simultaneity data of seeds growth.

#### Seed Growth Rate

Data obtained from substrate of seed germination test. Every observation time, total percentage of normal shoot is divided by *etmal* (24 hours). Cumulative *etmal* value is obtained when seeds are planted until the time of observation. The formula used as follows:

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

KT = growth rate (%/etmal)
Xi = the percentage of normal shoot etmal i
Ti = time of observation in (etmal)

#### Primary Root Length

Shoot which are observed was measured in the length of primary root by using a ruler.

#### Electrical Conductivity (EC)

EC was observed with conductivity meter tool i.e., Methron type E 38. A total of 5 g of seed was taken in random, and then each sample was immersed in to distilled water with a volume of 50 ml of water in a glass bottle. After soaking then samples were measured using conductivity meter. Electrical conductivity measurements performed on seed immersion for 30, 60, 360 and 1440 minutes.

## RESULTS AND DISCUSSIONS

The seeds were considered to have germinated when plumule and radical emerged. Germination testing is aim to germinate seed under suitable conditions for research required observation. Seed germination results provide information about the ability of seeds to grow normally. And then becomes plants that produce reasonable yield in optimum environment. Table 1 shows that Bima seed freshly harvested with treatment of straw matriconditioning obtained the best germination (98%) compared to other matriconditioning treatments. The reason in high germination percentage of matriconditioning media made of straw is that it has high humidity. Because it is able to maintain moisture in media matrix, thus it will help to speed up the germination rate of seeds. Same result also obtained in seeds stored for 6 months, which improve the seed germination by applying straw matriconditioning (91%) compared to other treatments.

Result from table 1 in treatment of Bima freshly harvested with matriconditioning matrix made of ash and sawdust found that there are not significantly different from control. Which mean these two kinds of media matrix are ineffective in improving seed vigor although the ability to maintain moisture are also high.

Germination rate is closely related to the seed vigor, where the seeds have a high germination rate, plant emerged tend to have more resistant to sub-optimum environmental (Suseno Hari, 1974). In the benchmark of growth rate, results shows that freshly Bima treated with matriconditioning made of straw gave the highest value (30.69%/etmal) compared to other matriconditioning treatments made of ash, sawdust also control.

Data obtained in observation parameters of primary root length (Table 2). Results shows that all of matriconditoning treatments were significantly different, which treatment of freshly harvested Bima with matriconditioning matrix made of ash showed the highest value among other treatments (12.62). This result differs from data obtained in seed germination and germination speed, in which matrix made of straw gave the best result. Although, the values of shoot-root length ratio are not significantly different in three treatments (straw, ash and sawdust) of freshly harvested Bima seeds. Primary root length can be used as an indicator of seed deterioration, due to the statement by Mugnisyah and Nakamura (1984), which stated that the primary root length and hypocotyl/ shoot length can be used to assess seed germination vigor. Root length was affected by the ability of seedling to absorb nutrients. Incomplete absorption of nutrients, especially Nitrogen nutrient can cause metabolic disorders. Especially plants during photosynthesis which can result in disrupted plant growth. Long roots also an indication that those seeds still have a sufficient stock of food in order to have the ability to develop normal epicotyls and radicle.

Shoot-root length ratio observation in this research shows that freshly harvested Bima seed treated with all 3 kind of matrix gave significantly different result compared to control. Whereas, all treatments applied in stored seeds did not have significant effect on shoot-root length ratio. It seems that control in freshly-harvested seed gave the same result as stored seed. Meaning in term of shoot-root length ratio the treatments is able to enhance the value of freshly-harvested seed. However, for deteriorated seed all treatments did not have the capacity to increase shoot-root length ratio.

One indication of biochemical characteristic which can indicate seed deterioration beside declined in vigor and seed viability is electrical conductivity of soaked seeds. Measurement of electrical conductivity is based on the fact that quality deteriorated seed when it soaked in water over period of time will leached electrolytes from its membrane cells. Leakage in the cells membrane is the main area of the seed responsible for the decay and deterioration of seeds.

Table 1. Data observational of seed germination (%) and germination speed (% /etmal).

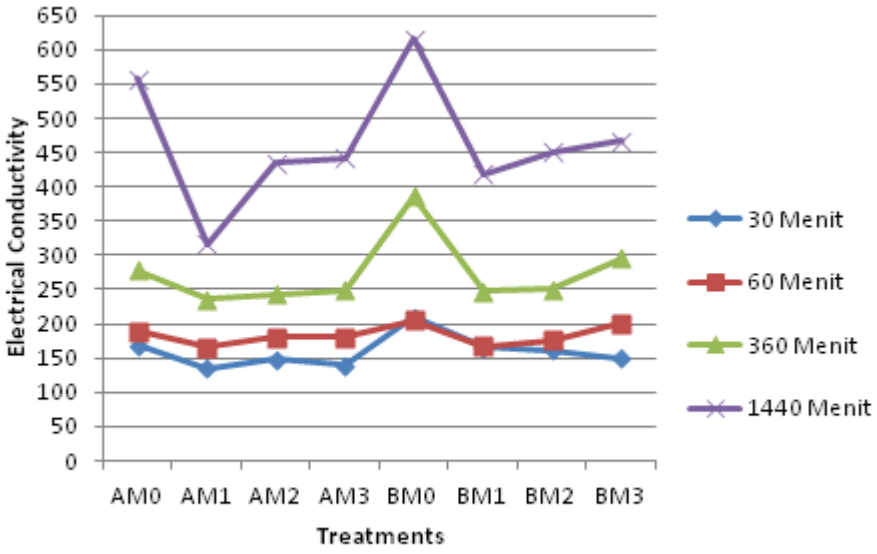
| Treatments | Observations parameters | |
|---|---|---|
| | Shoot-root length ratio (cm) | Root length (cm) |
| Freshly harvested Bima without Matriconditioning | 91 bc | 25,70 b |
| Freshly harvested Bima + Matriconditioning straw | 98 a | 30,69 a |
| Freshly harvested Bima + Matriconditioning ash | 93 b | 24,17 bc |
| Freshly harvested Bima + Matriconditioning sawdust | 93 b | 24,39 bc |
| Bima seeds stored for 6 months without Matriconditioning | 85 d | 22,69 c |
| Bima seeds stored for 6 months + Matriconditioning straw | 91 bc | 23,89 c |
| Bima seeds stored for 6 months+ Matriconditioning ash | 84 d | 24,17 bc |
| Bima seeds stored for 6 months +Matriconditioning sawdust | 87 cd | 22,87 c |

Note : Figures in columns followed by the same letter are not significantly different at 0.05 by DMRT Test

Table 2. Data observations of shoot-root length ratio (cm) and primary root length (cm).

| Treatments | Observations parameters | |
|---|---|---|
| | Shoot-root length ratio (cm) | Root length (cm) |
| Freshly harvested Bima without Matriconditioning | 0,74 b | 11,60 d |
| Freshly harvested Bima + Matriconditioning straw | 1,16 a | 12,51 b |
| Freshly harvested Bima + Matriconditioning ash | 1,18 a | 12,62 a |
| Freshly harvested Bima + Matriconditioning sawdust | 1,09 a | 10,91 f |
| Bima (6 months stored) without Matriconditioning | 0,75 b | 11,98 c |
| Bima (6 months stored) + Matriconditioning straw | 0,87 b | 10,44 g |
| Bima (6 months stored) + Matriconditioning ash | 0,78 b | 12,51 b |
| Bima (6 months stored) +Matriconditioning sawdust | 0,76 b | 11,40 e |

Note : Figures in columns followed by the same letter are not significantly different at 0.05 by DMRT Test




Note :
AM0 : Freshly harvested Bima without Matriconditioning
BM0 : Bima (6 months stored) without Matriconditioning
AM1 : Freshly harvested Bima + Matriconditioning straw
BM1 : Bima (6 months stored) + Matriconditioning straw
AM2 ; Freshly harvested Bima + Matriconditioning ash
BM2 : Bima (6 months stored) + Matriconditioning Ash
AM3 : Freshly harvested Bima + Matriconditioning sawust
BM3 : Bima (6 months stored) + Matriconditioning Sawdust

Figure 1. Graph of electrical conductivity (ìhos/cm3) by immersion for 30, 60, 360 and 1440 minutes at different types of matrix media.

The results of electrical conductivity are shown in figure 1, which illustrated the effect of all treatments towards the value of conductivity. Trends of the graph show that both control in the research had the highest conductance in comparison with others in the same type of seeds it used. Which mean effects of treatments are able to preserve and keep electrolytes from leaching out of the cell membrane. Significant result is shown after 1440 minutes of soaking in water, which proven the effect of matrix made of straw gave the lowest conductance in both type of seeds. Thus the vigor and viability of the seeds is higher compared to others. The observation also found that longer soaking time of seeds increase the value of electrical conductivity and made large gap between control and treatments. This is caused by the accumulation of electrolytes leakage over periods of time, even for freshly-harvested seed. Which is responsible for the increase value of electrical conductivity compared to 30 minutes of seed soaking time. Overall, High conductivity values indicate higher metabolite leakage, which means the seeds quality has decreased. Seed with low vigor decreased its membrane integrity as a result of deterioration during storage and mechanical damage. Instead, high vigor seed will demonstrate the low value of electrical conductivity compare to others.

Figure 1 shows that the duration of immersion affect the value of electrical conductivity. The longer of seed immersion, the higher electrical conductivity value of soaked seeds. Duration of immersion aims to provide an opportunity for imbibitions of water into the seeds. Lakitan (1996) stated that the occurrence of water imbibitions into seeds is the beginning process of germination and seedling emergence.

## Conclusion

Matriconditioning treatment with matrix media made of straw proven to be effective in increasing seed germination and germination speed rate for both type of seed. For freshly-harvested seed the seed germination percentage was 98%, whereas stored seed gained 91 %, and highest value for germination speed was 30.69 %/etmal. Longer immersion duration time affected the electrical conductivity value, which higher for untreated seeds

indication of lower vigor. For soaking time of 1440 minutes the best vigor achieved when seed applied with matrix made of straw.

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