Improvement of Vigor and Early Growth of Two Composite Maize Varieties Through Seed Priming Treatment

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Received: 2023-06-03
Accepted: 2023-06-05
Publication: 2023-06-06

Abstract
One factor affecting productivity is the quality of seeds with good initial seed vigor indicators, but less than optimum growing environment conditions also affect seeds' growth and initial Vigor. One of the technologies that can improve it is giving priming treatment to the seeds before planting. This study aims to see the effect of priming treatment to improve the quality of Vigor and early growth of 2 composite corn varieties, namely Sukmaraga and Bisma. The research was carried out in the laboratory and the Green House, with the experimental method using a Completely Randomized Design (CRD) with each seed of the two varieties treated with Hydropriming (soaking seeds before planting) using Ion-Free Water (IFW) for 30 minutes, 12 hours, and 24 hours plus a control treatment without Priming, and priming using PGR made from sodium ortho-nitrienol 0.2%, sodium 2,4-dinitrophenol 0.05% both as controls. So there are a total of 10 treatments. The results showed that priming treatment greatly influenced the germination, where all Hydropriming treatments gave average germination above 88%, significantly different from seeds without priming below 82%. The hypocotyl length ratio of Sukmaraga and Bisma corn seeds was also different from the treatment without priming. Seeds with hydropriming for 12 hours showed the best field growth percentage, reaching 96.7% (Sukmaraga variety) and 96.98% (Bisma variety).

Keywords—Composite, Priming, Hydropriming, Vigor

Introduction
Increasing crop productivity requires support from the availability of genetically, physically, and physiologically superior seeds that have high adaptability to diverse growing environments with or without high stress. The low physical and physiological quality of seeds is one factor that affects low productivity, because they will be less able to adapt to less favorable agroecological areas (sub-optimal areas). Of the various phases of maize plant growth, the time between seed sowing and emergence of sprouts is one of the critical periods in the plant cycle, as seeds are exposed to various growing environment conditions that affect sprout emergence and Vigor. Priming, one of the seed invigoration techniques, can be done in various ways, one of which is soaking seeds in water or Hydropriming. Some research results show that priming treatment of seeds can increase disease resistance in some plants and other plants can overcome the deficiency of some micronutrients (Moori & Ahmadi-Lahijani, 2020). Studies showing that priming increases plant vigor, number of shoots, seed and stover yield and harvest index have been conducted and increases the resistance of sprouts to less than optimum growing environmental conditions (Ashraf & Foolad, 2005; Farooq et al., 2007).

Priming enhances plant defense against biotic and abiotic stresses (Hossain et al., 2015). It is defined as the initial exposure of seeds or young seedlings to chemical or abiotic stresses that
makes the plant more resistant to subsequent phases and better able to detect a second signal quickly (Kadir et al., 2023). Seed priming, a promising technique, has been successfully used to overcome the problems of poor germination and subsequent erratic plant establishment under normal and stressful conditions, and numerous studies have been conducted on seed priming to improve germination rate and uniformity of plant growth in numerous field crops, including maize. A series of bioassays involving various priming agents, such as CaCl2 (Farooq et al. 2008), Mg(NO3)2 and ZnSO4 (Singhal, et al. 2021), salicylic acid (Farooq et al. 2007), and Moringa leaf extract (Kadir et al. 2023) have been tested to improve maize performance under low-temperature stress.

Quality seeds have high growth vigor and storability vigor. Vigor is a set of properties possessed by seeds that determine the level of potential activity and performance of seeds or seed lots during germination and emergence of sprouts (ISTA, 2015). This research continues the study of how the effect of hydropriming aimed at corn seeds, especially composite varieties, to improve the quality of Vigor and early plant growth in the field.

**Literature Review**

Certain treatments on deteriorated seeds can increase Vigor. The priming technique is a pre-planting treatment for deteriorated seeds, especially old seeds that have been stored for a long time, to increase their germination rate, Vigor and viability. Invigoration is also known as conditioning or priming. Some priming methods are hydropriming or better known as the hydration-dehydration method, osmoconditioning or osmopriming, and matricconditioning which is also a solid matrix priming. The results of Kulkarni and Eshanna (1998) showed that applying 10 ppm IAA improved root length, sprout growth rate and sprout Vigor, especially priming carried out on seed lots that had decreased Vigor in storage.

The results showed positive effects of seed priming on germination and seed establishment under saline conditions. Seed priming increases tolerance to salt content, as shown by the parameter of increasing the value of several traits under salinity stress, such as increasing the vitality index, seedling length and seedling dry weight, and seedling development (Feghhenabi et al., 2020). Research on the African continent showed that priming techniques by soaking corn seeds overnight before planting accelerated sprout growth and increased sprout vigor (Harris et al., 2005). In Indonesia, in some maize growing areas this simple technology has been widely applied by farmers, and the results show an improvement in growth and an increase in sprouting speed.

The hydropriming technique involves moisturizing the seeds in a variety of ways, including soaking, dipping, spraying, and positioning the seeds in air saturated with water vapor. While the process of returning the seed moisture content to its original state can be accomplished by dehydrating the seeds in direct sunlight at a temperature of about 30°C or by aerating the seeds until their initial weight is attained, also known as the hydration-dehydration method, the seeds can also be rehydrated using the hydration-dehydration method (Sun et al., 2010). Research shows that priming treatment causes sprouts to grow faster and more uniformly. In addition, priming treatment increases plant vigor, number of shoots, allometry, seed and stover yield and harvest index (Sharma et al., 2021). Priming treatment of seeds is an alternative to increase sprout resistance to less than optimum growing environmental conditions (Naguib, 2019).

Research by Kadir et al. (2023) indicated that the different priming methods given to the seeds gave different results on upland rice seed viability and seedling growth under drought conditions. The priming method with osmopriming 15% PEG solution gave the best results on seed germination percentage (87.5%). Under drought stress conditions with only 30% field capacity, all priming methods gave longer root lengths than seedlings without priming. The
biggest increase in proline levels was seen with H$_2$O$_2$ redox priming at 3%, and all of the longest roots were demonstrated by osmopriming with 15% PEG. Upland rice grows and physiological activities respond better to seed with priming under various levels of drought stress, throughout the seedlings’ early growth phase.

**Research Method**

The research was conducted in the laboratory and in the Green House of Politeknik Pertanian Negeri Pangkajene Kepulauan, Mandalle village, Pangkajene Kepulauan district, South Sulawesi province. The experiment was conducted using a completely randomized design (CRD) with 2 varieties of composite corn seeds, namely Sukmaraga and Bisma varieties. Both varieties were treated with Hydropriming (soaking seeds before planting) using Ion-Free Water (IFW) with a duration of 30 minutes, 12 hours, and 24 hours, plus a treatment without Priming, and priming treatment using Plant Growth Regulators (PGR) made from *sodium orthonitrifenol* 0.2% and *sodium 2,4-dinitrophenol* 0.05%. The last two treatments were used as a comparison (control) to the main treatment (hydropriming). There were a total of 10 treatments with 3 replicates. The test seeds were germinated on paper media/substrate using the rolled paper in Test in plastic Method (RPTp). The paper as media was moistened with water to create moist conditions for germination. After that, the media is pressed with a pressing tool. The plastic was placed on the bottom and the paper on top. Corn seeds are arranged as many as 25, rolled, labeled, and put into the ecogerminator. Previously in the ecogerminator, the water reservoir must always be filled with water to maintain humidity during the test. Substrate/media humidity must also be maintained until the test is completed. The first observation (first count) will be done on day 5. Final count will be on day 7 (ISTA, 2015). Sproutability is calculated with Equation (1) and Growth rate is calculated with Equation (2).

\[
G = \frac{NS_1 + NS_2}{s} \times 100 \% \hspace{1cm} \text{(1)}
\]

\[
GR = \sum_{t=0}^{tn} \frac{N}{t} \hspace{1cm} \text{(2)}
\]

**Description**:

- \(G\) = Germinability of Seed (%)
- \(NS_1\) = Normal Sprout on First Count (day 5)
- \(NS_2\) = Normal Sprout on Last Count (day 7)
- \(S\) = Number of Seed
- \(GR\) = Growth rate (Sprout Growth rate) (%/etalum)
- \(N\) = Percentage of Normal Sprouts at each Count time
- \(t\) = Count time
- \(tn\) = Last Count time

Hypocotyl and Root Length Ratio was calculated as the ratio between hypocotyl and root length. Percentage of seeds that grow in actual conditions in the field by looking at the seeds that grow when sown in the field (%).

**Results and Discussion**

Vigor is reflected by at least two pieces of information on the viability of the respective growing vigor and seed storability or germination. These two physiological values place the sprouts on the likelihood of their ability to grow into normal plants, despite suboptimum biophysical conditions of the production field or after the sprouts have gone through a long storage period.
The test results showed that there was a significant effect of Priming and length of priming time on Vigor of Sukmaraga and Bisma Composite seed varieties from the parameters of Germinability (%) and Hypocotyl-root length ratio, although it was not significantly different in the parameter of Growth rate (%/etmal) (Table 1).

### Table 1. Effect of Priming and length of priming time on Vigor of Sukmaraga and Bisma Composite seed varieties

<table>
<thead>
<tr>
<th>Varieties, priming and length of priming time</th>
<th>Germinability (%)</th>
<th>Growth rate (%/etmal)</th>
<th>Hypocotyl-root length ratio *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sukmaraga + No Priming</td>
<td>81.91 a</td>
<td>28.57</td>
<td>0.44 c</td>
</tr>
<tr>
<td>Sukmaraga + IFW Priming 30 minutes</td>
<td>88.15 bc</td>
<td>27.04</td>
<td>0.79 a</td>
</tr>
<tr>
<td>Sukmaraga + IFW Priming 12 Hours</td>
<td>87.06 bc</td>
<td>28.96</td>
<td>0.61 cd</td>
</tr>
<tr>
<td>Sukmaraga + IFW Priming 24 Hours</td>
<td>91.15 bc</td>
<td>27.66</td>
<td>0.66 ab</td>
</tr>
<tr>
<td>Sukmaraga + PGR Priming 12 Hours</td>
<td>90.57 bc</td>
<td>26.82</td>
<td>0.71 ab</td>
</tr>
<tr>
<td>Bisma + No Priming</td>
<td>80.11 a</td>
<td>28.28</td>
<td>0.48 c</td>
</tr>
<tr>
<td>Bisma + IFW Priming 30 minutes</td>
<td>88.65 bc</td>
<td>27.91</td>
<td>0.57 cd</td>
</tr>
<tr>
<td>Bisma + IFW Priming 12 Hours</td>
<td>91.95 c</td>
<td>27.99</td>
<td>0.68 ab</td>
</tr>
<tr>
<td>Bisma + IFW Priming 24 Hours</td>
<td>90.80 bc</td>
<td>28.16</td>
<td>0.69 ab</td>
</tr>
<tr>
<td>Bisma + PGR Priming 12 Hours</td>
<td>91.75 c</td>
<td>27.64</td>
<td>0.66 ab</td>
</tr>
</tbody>
</table>

Description:
*Significant, numbers followed by the same letter in the same column, show no significant difference with DMRT 0.05  
ns = non significant  
IFW = Ion-Free Water  
PGR = Using PGR With active ingredients Natrium orthonitrifenol 0.2%, Natrium 2,4-dinitrofenol 0.05%

The results shown in Table 1 indicate that priming such as hydpriming using Ion-free water should be done as a minimum, because the lowest soaking time (only 30 minutes) can already increase the germination value better than seeds that are not primed before germination. Both in Sukmaraga and Bisma varieties, all primed seeds showed a higher average germination rate and were significantly different from the control (without priming), as well as the hypocotyl-root length ratio showed a significant effect of hydpriming and priming treatments with PGR.

The effect of priming on the early growth performance of Sukmaraga and Bisma composite varieties of corn based on the percentage of seedling growth in the field showed a significant effect. Based on the DMRT 0.05 test results in Table 2. Priming with IFW for 12 hours showed the highest percentage in both Sukmaraga and Bisma varieties.

### Table 2. Effect of Priming and Length of priming time on Early Growth Percentage of Sukmaraga and Bisma Composite seed varieties in the field

<table>
<thead>
<tr>
<th>Varieties, priming and length of priming time</th>
<th>Early Growth Percentage in Field (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sukmaraga + No Priming</td>
<td>85.46 a</td>
</tr>
<tr>
<td>Sukmaraga + IFW Priming 30 minutes</td>
<td>85.51 a</td>
</tr>
<tr>
<td>Sukmaraga + IFW Priming 12 Hours</td>
<td>96.75 c</td>
</tr>
<tr>
<td>Sukmaraga + IFW Priming 24 Hours</td>
<td>88.78 ab</td>
</tr>
<tr>
<td>Sukmaraga + PGR Priming 12 Hours</td>
<td>89.91 b</td>
</tr>
<tr>
<td>Bisma + No Priming</td>
<td>85.71 ab</td>
</tr>
<tr>
<td>Bisma + IFW Priming 30 minutes</td>
<td>86.61 ab</td>
</tr>
<tr>
<td>Bisma + IFW Priming 12 Hours</td>
<td>96.98 c</td>
</tr>
<tr>
<td>Bisma + IFW Priming 24 Hours</td>
<td>90.13 b</td>
</tr>
<tr>
<td>Bisma + PGR Priming 12 Hours</td>
<td>95.59 c</td>
</tr>
</tbody>
</table>
These results are in line with the research of Arief et al. (2010), in the laboratory and greenhouse showed that hydropirmining by soaking seeds in ion-free water for 12 hours had an effect on improving the initial Vigor of seeds with an increase in germination, speed of growth in hybrid corn sedes, Likewise, the conclusion of Sun et al., (2010) research states Even moderate concentrations of priming intensity can improve metabolism, germination, and seed quality under drought stress conditions in all seed cultivars.

Biochemical processes that occur in hydropirmining treatment of seeds, starting with the process of imbibition, increasing cell metabolic processes and respiration, and accelerating germination. In land conditions with light soil texture (sandy), the soil's ability to hold water is low, so evaporation takes place quickly with high ambient air temperatures. Planting seeds by relying on residual soil moisture can inhibit the initial growth of sprouts in the field if the existing soil moisture is not sufficient to support the seed germination process. With hydropirmining, seed moisture at the beginning of sprout growth is sufficient for germination. Some research results show a positive effect of hydropirmining on early seed vigor (Murungu et al., 2004), Vitality is an essential agronomic attribute that determines the efficacy of germination. Priming treatment stimulates numerous natural compounds that act as stimulators of physiological plant responses to abiotic agents, including germination, growth, osmotic adjustment, photosynthesis, and ionic and biochemical status (response to stress) (Ellouzi et al., 2017). Another study found that seed priming increased germination ratio and vigor index. This increase is associated with improved lipid metabolism. This increase was confirmed in increasing lipase, lipoxygenase and isocitrate lyase enzyme activities (Naguib, 2019).

From the results of several priming studies on corn seeds, in the laboratory and in the field, showed a positive effect on improving seed vigor. Technically, hydropirmining treatment is relatively easy to implement in the field and economically relatively cheap. Thus, this simple technology can be applied at the farm level, especially in dry climate drylands with suboptimal land conditions.

**Conclusion**

Priming positively affects the early Vigor of plants and will indirectly affect the yield through better early plant growth indicators with Priming treatment. Hydropirmining treatment on Bisma and Sukmaraga varieties at all priming durations gave germination above 85%, significantly different from seeds without Priming treatment. Early seed growth in the field shows that 12 hours of hydropirmining on both Sukmaraga and Bisma varieties show results above 90% better than seed treatment without priming.

**Acknowledgments**

For the successful completion of this research, the authors would like to express their special thanks to the Center for Research and Community Service of the Pangkep State Polytechnic of Agricultural for this Institutional Research Program and Funding.

**References**


