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The Effect of Osmopriming on Germination and Seedling Growth of *Glycine Max* L. Under Salinity Stress

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Abstract

Soybean (*Glycine max* L.) is a staple food crop in Indonesia. Soybean plants have decreased in quality and production due to salinity factors. Planting media with high salinity conditions have limited potential for plant cultivation, but each plant has different resistance and adaptability. Osmotic priming of seeds or osmopriming could increase plant resistance to salinity. This experiment was conducted at Universitas Muria Kudus Field. The objective of this study was to determine the germination and seedling growth of *Glycine max* L. as treated by NaCl osmopriming. A randomized complete design was used with two factors. The first factor was osmopriming concentration which consisted of the control, 50 mM (K1), 100 mM (K2), and 150 mM (K3). The seeds of the control did not receive osmopriming NaCl treatment. The second factor was osmopriming duration which consisted of 24 hours (T1) and 48 (T2). The results showed that the treatment of osmopriming with a concentration of 50 mM NaCl for a duration of 24 hours had a positive impact on seed germination under salinity conditions of 150 mM NaCl. However, this did not significantly affect the seedling growth in salinity conditions of 150 mM NaCl.

Keywords: osmopriming, salinity, soybean

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1. Introduction

Salinity is one of the many environmental factors that limit germination. Cultivated crops such as soybeans are sensitive to the effects of salinity. Research on the sensitivity of soybean plants to salinity has been carried out previously by [1] that there was a decrease in soybean, peanut, and green beans yields respectively at a salinity level of 5 dS/m, 3.2 dS/m, and 1-2.65 dS/m.

The decrease in yield due to salinity is due to inhibition of absorption and transport of water into plant tissue caused by osmotic disturbances [2]. The effect of high salt solution concentrations can damage and poison plants caused by osmotic forces. Planting media with high salinity conditions have limited potential for crop cultivation. However, each plant has different resistance and adaptability.

Salinity in the planting medium can affect the seed germination process. In saline conditions, the water potential in the planting medium is lower than that in seeds, thus inhibiting water absorption. Osmotic priming of seeds (often known as osmopriming or osmoconditioning) describes the relationship between seeds and the movement of compounds at low water potential. It is usually done by duration and rinsing afterward. This is still used as a guideline by many researchers to become a standard for priming techniques [3].

Pre-planting treatment has been widely used as a form of plant adaptation to environmental stresses such as inundation, drought, and low temperatures. Research that has been conducted by [4] provided an osmopriming NaCl treatment to increase wheat plant resistance to drought stress. [5] researched to increase the resistance of local and national superior rice varieties to inundation stress through pre-planting treatment.

The osmopriming technique on soybean plants implemented by [6] shows that soybean plants can increase germination and harvest both under adequacy and lack of water. Osmopriming techniques in soybean plants for salinity stress have not been widely studied. Through osmopriming treatment, plants are expected to have an adaptation to salinity when in the field.

2. Material and Method

The research had been conducted in August 2020 in the experimental field of Agricultural Faculty, Universitas Muria Kudus. Materials used in this study are soybean (*Glycine max* L.), soils, NaCl, and Aquadest. The used tools are the tray, sprayer, TDS meter, and beaker glass.

The experiment was arranged in a completely randomized design (CRD) with two factors. The first factor is osmopriming concentration NaCl which consists of Control, 50 mM (K1), 100 mM (K2), 150 mM (K3). Seed in the control treatment did not receive osmopriming NaCl treatment. The second factor is osmopriming duration, which consists of 24 hours of duration (T1) and 48 hours of duration (T2).

The NaCl solution of 50 mM, 100 mM, and 150 mM concentrations was obtained by dissolving 2.5 g, 4.5 g, and 6.5 g with 500 mL water respectively. For each concentration, 50 seeds were immersed for 24 and 48 hours. The finished seeds are soaked, then rinsed with aquadest, and ready to germinate.

The size of this experimental unit used was 50 seeds in each tray. Saline stress condition in the field was used by 150 Mm NaCl. The NaCl irrigation was started 2 days after planted. The seedlings were observed after 7 days. The data of germination were observed on germination rate, vigor index while the seedling growth observed was shoot length and root length. The observational data obtained were further analyzed using analysis of variance (ANOVA) based on a complete randomized design at an error rate of 5% and will be further tested with LSD test if the results of the analysis of variance show significant differences.

3. Result and Discussion

3.1. Germination

Germination is the most sensitive phase in the plant life cycle [7]. Seedlings derived from superior varieties with good management from an early age will be able to face obstacles and competition in the field, allowing them to produce high production.

Table 1: The effect of osmopriming on the seed germination rate of *Glycine max* L

Treatment	Germination rate (%)
Control	92.33 a
50 mM, 24 hours	89.33 b
50 mM, 48 hours	86.33 c
100 mM, 24 hours	87.33 c
100 mM, 48 hours	85.00 d
150 mM, 24 hours	83.00 e
150 mM, 48 hours	82.33 e

Note: numbers followed by the same letters at the column was not significantly different based on LSD 5%

Germination observation data (Table 1) showed that plants with control treatment still had the highest germination rate. Compared to other osmopriming treatments, the combination of 50 mM NaCl treatment with 24 hours of duration showed a better germinating force when exposed to 150 mM salinity stress. This condition is thought to occur because the concentration has not been responded to as a tense condition by the plants. [8] stated that priming using a salt solution can improve the performance of seed germination rate. Seeds can control the rate of water entering the cell and allow the seeds to germinate under unfavorable conditions.

Based on the data in table 2, the osmopriming NaCl treatment with a concentration of 150 showed the lowest results, both with duration of 24 hours and 48 hours. This is because the concentration of NaCl, which is too high could inhibit the germination. [9] stated that NaCl can suppress plant growth processes with effects that inhibit cell enlargement and division, protein production, and the addition of plant biomass.

Table 2: The effect of osmopriming treatment on the germination rate of *Glycine max* L.

Treatment	Treatment	Germination rate (%)
Osmopriming Duration	24 hours	86.56 a
	48 hours	84.56 b
NaCl Concentration	50 mM	87.84 p
	100 mM	86.17 q
	150 mM	82.67 r

Note: numbers followed by the sample letters at the column was not significantly different based on LSD 5%

The success of osmopriming to increase plant resistance to salinity is reportedly influenced by the complex interaction of several factors and conditions, one of which is the duration of soaking the solution [10]. Observation data showed that 24 hours of duration showed higher results than 48 hours of duration. This shows that 48 hours of duration time resulted in a delay in the emergence of the priming indicator.

Table 3: The effect of osmopriming treatment on vigor index of *Glycine max* L.

Osmopriming treatment	Vigor index (%)
Control	88.33 a
50 mM, 24 hours	86.67 b
50 mM, 48 hours	84.67 e
100 mM, 24 hours	86.00 c
100 mM, 48 hours	85.33 d
150 mM, 24 hours	86.33 bc
150 mM, 48 hours	84.33 e

Note: numbers followed by the same letters at the column was not significantly different based on LSD 5%

Table 4: The effect of osmopriming duration on vigor index of *Glycine max* L.

Osmopriming duration	Vigor index (%)
24 hours	86.56 a
48 hours	84.56 b

Note: numbers followed by the same letters at the column was not significantly different based on LSD 5%

Tables 4 and 5 showed that the seedling vigor index of *Glycine max* L. under saline condition with osmopriming treatment was recorded and significantly highest. It was noticed in the treatment of 50 Mm NaCl concentration with 24 hours of soaking time. Osmopriming for 48 hours with 50 mM and 150 mM recorded the lowest seedling vigor index. Enhancement of seedling vigor index by priming with NaCl was earlier documented in upland rice seeds [11]. The improvement in vigor index may be due to an increase in several biochemical processes such as respiration [12] and an increase in the activity of several enzymes that are initiated during osmopriming treatment.

3.2. Seedling Growth

The seedling growth of Glycine max L. was obtained by root length and shoot length. The data show no significant difference in both shoot length and root length parameters. Control treatment still had the best results on stem length and root length parameters. Osmopriming treatment does not affect seedling growth because the stress level received by plants in the field is not high enough so plants do not feel stress by salinity yet. In addition to this, seedling growth is also influenced by several environmental factors. [13] states that temperature, moisture oxygen, and soil condition within the seed zone can affect soybean germination and emergence.

TABLE 5: The effect of osmopriming on shoot length of *Glycine max* L.

Osmopriming treatment	Shoot length (cm)
Control	2.67
50 mM, 24 hours	2.33
50 mM, 48 hours	2.67
100 mM, 24 hours	3.17
100 mM, 48 hours	3.33
150 mM, 24 hours	3.33
150 mM, 48 hours	3.00

Note: numbers followed by the same letters at the column was not significantly different based on LSD 5%

TABLE 6: The Effect of Osmopriming on Root Length of *Glycine max* L.

Osmopriming treatment	Root Length (cm)
Control	17.67
50 mM, 24 hours	15.17
50 mM, 48 hours	17.00
100 mM, 24 hours	14.33
100 mM, 48 hours	14.83
150 mM, 24 hours	17.00
150 mM, 48 hours	16.83

Note: numbers followed by the same letters at the column was not significantly different based on LSD 5%

4. Conclusions

It was showed that NaCl osmopriming treatment positively affected the germination of soybean under salinity stress however it does not significantly affect the seedling growth. It was also proved that NaCl osmopriming treatment at 50 mM NaCl concentration with 12 hours duration time can be used as a way to enhance salinity tolerance when soybean is grown under 150 mM NaCl.

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