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Adaptation Of Sunflowers To Salinity Stress On Coastal Land

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ABSTRACT

Sunflower is one of the oil-producing plants that potentially can be developed as a food raw material, industrial, medicine, and cosmetics. Sunflower cultivation needs to be conducted in various lands in Indonesia; one of them is coastal regions. However, on one side, these lands were included on marginal land because the high level of salinity constrains it. This research aims to determine sunflower growth and thrive on salinity stress in the coastal land. This research applies a random group design with five treatments consisting of two accession and three sunflower varieties with three repetitions. The research result shows that the sunflower accession Ha1 growth and thrive on salinity stress in coastal land was quite significant compared to the accession Ha15 and Kanigara, Helina IPB, and BM1 IPB varieties. Generally, sunflower can adapt to stress salinity in coastal land.

Keywords: *Adaptation, Sunflower, Salinity, Coastal Land*

1. INTRODUCTION

Sunflower is one of the vegetable oil-producing plants with promising potential to be developed. The utilization of sunflowers, primarily as vegetable oil, is widely used as food or industrial raw materials. According to Katja (2012), sunflower seeds contain vegetable oil ranging from about 23-45%. Sunflower seeds oil contain linoleic acid around 44 – 72 % and oleic acid 11,7 %. In addition, every part of the sunflower plant can be utilized such as; the seeds are eatable as snacks, the seeds shell can be used as cattle fodder, the stems are used as a material for making paper, and the leaves are used as a substitute for tobacco (Salunkhe et al., 1992).

Due to the varied benefit of sunflower, it is natural that the demand for sunflower products is constantly increasing every year, ranking the third position on the world's vegetable oil consumption. However, in its cultivation, the production ranked as the fourth position. Meanwhile, in Indonesia, sunflower cultivation existed in Blitar; the production is relatively high, reaching 3 tons /ha (Khotimah, 2007). Even though the sunflower yield is significantly high, people have not been widely attracted to sunflower cultivation, so the sunflower supply becomes limited. In addition to the insufficient quality, this serious problem is also due to the unreliable yield continuity (Katja, 2012).

The high demand for sunflowers becomes an excellent opportunity to flourish sunflower plants in Indonesia.

Nonetheless, in reality, many factors can constrain its implementation. One of them is the lack of fertile land to flourish the sunflower plant. This issue occurred because people have widely used the fertile land for daily primary food cultivation or other land conversion purposes, such as for developing governmental facilities & infrastructure and public housing. Hence, sunflower cultivation is diverted to unmanaged lands and mainly along the coastal lines that have not been cultivated for maximally agricultural land. Obel et al. (2021) state that sunflower can potentially be cultivated in idle land of Pesisir Selatan Regency areas. Nevertheless, the lands have high salinity levels, which will cause the cultivated plants' grow and yield poorly.

Lands with salinity level or marginal lands are vast enough, and people can find it plenty along Indonesian coastal lines, which reaches 99,093 km (Prasetyo et al., 2016), which is about 38% of potential land's wide. Saline land is formed due to the return of seawater after inundation or irrigation in coastal areas and is called alluvial marine (Entisol). According to Lines and Kelly (2000), saline land contains high salinity, indicating the levels of chemical compounds dissolved in the soil. The saline land contains inorganic compounds (Na+, Mg^{2+}, K+, Cl-, SO_4^{2-}, HCO_3^-, dan CO_3^{2-}) in a solution, thereby reducing soil productivity. High salinity land will destroy its fertility because salinity will exterminate soil-fertilizing organisms such as bacteria and earthworms.

A saline land, if contained enough salt, will have enough to disrupt most varieties of plants' growth (Djukri, 2009). Some problems occurred, so that saline lands are rarely used for plant's cultivation, among others (1) low plant osmotic pressure (2) containing less N and K elements (Suprapto, 1991) (3) containing high Na+ and (4) high soil's pH (Hardjowigeno, 2010). Salinity occurs if the amount of salt concentration contained in the soil is excessive, which will cause a change in the physiological and metabolism process; thus, it becomes toxic for the cultivated plants. The availability of million hectares of land spread across Indonesian islands has become an excellent prospect for developing Indonesian agriculture in the future; however, the potential has not been cultivated maximally.

2. RESEARCH METHOD

Research Site and Time

The research was conducted in June – September 2021 in Batu Kalang XI Tarusan Sub-district Pesisir Selatan Regency, West Sumatera Province.

Material and Tools

The material used in this research is sunflower seeds, cow dung fertilizer, urea fertilizer, Mutiara NPK fertilizer, liquid organic fertilizer, chemical pesticides. While, the tools used are digital scale, ruler, drill, hoe, knife, corded, sickle, scissors, raffia fibre, camera, stationery, plastic bag, paper bag (envelope), wooden stake, plastic sack, label paper, tape measure, shovel, machete, permanent paper and marker.

Research Design

This research employs a random group with treatment to sunflowers consisting of two accessions, e.g., Ha1, Ha15, and three varieties, i.e., Helina IPB, Kanigara, and BM1 IPB varieties. Every treatment was repeated three times with a 25 x 60 cm planting distance. The research data obtained were analyzed using the 5% level F-test method and continued using DNMRT on a 5% level.

Research Implementation

Land Preparation

Two weeks prior to the planting, the land was cultivated with a depth of 20cm and leveled. It was made of beds with 120 cm x 6, and each bed distance is around 50 cm. After finishing making

beds, manure and essential fertilizer were poured into the beds. Later on, we wait for two weeks before planting sunflowers.

Planting

Planting sunflower seeds were conducted by making a planting hole earlier with a depth of 5 cm using a dibble stick. The planting hole was made with a 60 cm x 25 cm distance.

Fertilization

The fertilizer used was organic liquid fertilizer with a 2gr/liter dose per plant, carried out once a week.

Maintenance

Maintenance carried out includes replanting if there are plants that die at 14 DAP, weeding at 15 DAP, watering in two times, in morning and afternoon if there was no rain coming down, and spraying chemical pesticides to prevent pests and diseases.

Crop

Harvesting occurs when the sunflowers are 90-105 days after planting. The criteria of sunflower ready for harvesting are the flower stalk color change to brownish yellow, flower petals drying, and flower seeds turning to black with white stripes.

Observation Parameter

The observation parameter includes plant's height, leaves quantity, stem's diameter, perfect blooming age, total seeds per plant, the weight of 100 seeds.

3. RESULT AND DISCUSSION

3.1 Plant's Height

The average sunflower plant's height is around 161.76 cm to 191.63 cm. This height indicates that sunflower's plant height was excellent in coastal areas with high salinity. The data of the plant's height can be seen in Table 1.

Table. 1. The average sunflower plant height in the 7th WAP

Sunflower	Plant's height (cm)
Accession Ha 15	188.00 ^{a}
Accession Ha1	191.63 ^{a}
Kanigara IPB Varieties	171.42 ^{ab}
Helena IPB Varieties	161.76 ^{b}
BM1 IPB Varieties	172.32 ^{ab}

Remark: the score followed by the same letters in the same column is not significantly different on the advanced DMRT test

The sunflower plant's growth either from accession or varieties planted in coastal land was categorized sufficiently good. This result can be observed from the numbers of sunflower plants growing more than 1 meter and some almost 2 meters high. The condition is assumed because of the planting location in the open lands with full sunlight every day. Even though sunflowers were planted in sandy land only 5 meters next to the shoreline, the sunflowers could well-adapt although the location was threatening with high salinity level. According to Khotimah (2007), the sunflower plant has a vast adaptation area and needs a hot area with full sunlight. Moreover, Rina (2014) adds that sandy land is suitable for sunflower cultivation and the plants also resistant to drought and has good rooting to absorb nutrient in the soil (Maryati, 2008).

Based on the measurement result, it is found that there is a difference in the plant's height of every sunflower seed used. Both accessions showed better growth response in plant height than some other sunflowers. This result alleged that the adaptation ability level in every seed variety is different despite being planted in the same location. As a result, the difference in height and appearance is due to the incapability to express their potential maximally. Sumarni et al. (2012) claim that different varieties will produce different high plants. Additionally, Mehran et al. (2016) reveal that a plant's genetic potential will

maximally flourish if supported with the correct environmental factor.

3.2 Leaves Quantity

Based on the data, the average sunflower leaves quantity until the seventh week after planting (WAP) are between 24.26 leaves until 43.06 leaves. The Ha1 accession produces the highest number of leaves, with an average of 43.06 leaves compared to other varieties. The average of the sunflower leaves quantity can be viewed in Table 2.

Table. 2. The average of sunflower leaves quantity at 7th WAP

Sunflower	Leaves Quantity (Sheets)
Accession Ha 15	29.20 [b]
Accession Ha1	43.06 [a]
Kanigara IPB Varieties	27.40 [b]
Helina IPB Varieties	24.26 [b]
BM1 IPB Varieties	26.20 [b]

Remark: the score followed by the same letter in the same column is not significantly different on the advanced DMRT test

In the above table 2, it can be seen that accession Ha1 yields the highest leaves quantity compared to the other sunflowers varieties. This result is likely caused by accession's ability to neutralize the current condition to benefit the plant during its growth phase. Additionally, it was found out that sunflower has deep roots to absorb nutrients to support its maximal growth. The observable plant's growth indicators are the leaves quantity and plant's height (Saidah et al., 2019). Obel et al. (2020) add that leaves are one of the plant's organs that contribute crucially to photosynthesis and determine the plant's growth and thrive. Awas et al. (2010) research show that every variety shows different responses because every variety has different roots and leaves growth although planted in the same soil.

Moreover, the average leaves quantity from other seeds shows promising results and is suitable to the existing description. This yield was allegedly sunflower adaptive ability toward the saline sandy land setting during the growth phase. Cuartero et al. (2006) convey that an environment containing salt in certain growth phases can increase plants' capacity to adapt to salinity to be more tolerant. Latuharhary and Saputro (2017) add that the leaves quantity shows a significant decrease caused by the dissolved salt. Thus, it decreases water potential, making it difficult to absorb water and its growth process abnormal; for instance, cells formation and enlargement affect leaf area and result in the leaf aging; as a result, reducing the leaves quantity.

3.3 Stem's Diameter

Based on the observation until the seventh week, the average sunflower stem's diameter is between 21.14 mm until 30.56 mm. The average stem diameter can be seen in Table 3.

Table. 3. The average of sunflower stem's diameter in the 7th WAP

Sunflower	Stem's diameter (mm)
Accession Ha 15	26.43 [a]
Accession Ha1	30.56 [a]
Kanigara Varieties	26.14 [ab]
Helina IPB Varieties	21.22 [b]
BM1 IPB Varieties	27.34 [a]

Remark: the score followed by the same letter in the same column is not significantly different on the advanced DMRT test

In table 3, it can be seen that the sunflower stem's diameter is varied, with the minor average by Helina IPB varieties of 21.22 mm and the largest is by accession Ha1 of 30.56 mm. This difference is assumed by the sunflower types' ability to absorb and translocate nutrients from the soil to a particular plant's part on the unfavorable land's setting. A plant's organ growth, including stem's diameter, is affected by sufficient nutrient availability, remarkably plenty of nitrogen. In addition, enlarged stem diameter indicates the occurrence of cells enlargement because of the availability of enough carbohydrates, water, hormone, and vitamin necessary for the plant to undertake the metabolism process. Munawar (2011) mentioned that nutrient uptake would determine the continuity of the metabolism process to provide positive responses to the stem's diameter.

3.4 Flower's Perfect Blooming Age

It was found out that accession Ha15 and BM1 IPB varieties are faster in sunflower's perfect blooming age phase with the consecutive average of 64.00 days after planting (DAP) and 65.30 days after planting (DAP). In comparison, accession Ha1 and Helina IPB varieties are slower than before in terms of sunflower's perfect blooming age phase. They have the same average of 78.67 days after planting (DAP). The average sunflower's perfect blooming age can be seen in Table 4.

Table. 4. The Average Of Sunflower Perfect Blooming Age

Sunflower	sunflower's perfect blooming age (DAP)
Accession Ha 15	64.00 [b]
Accession Ha1	78.67 [a]
Kanigara Varieties	69.33 [ab]
Helina IPB Varieties	78.67 [a]
BM1 IPB Varieties	65.30 [b]

Remark: the score followed by the same letter in the same column is not significantly different on the advanced DMRT test

The average sunflower's perfect blooming age describes the flower's response to adapt in an unfavourable location because it was planted in coastal sandy land and has salinity. Based on the data obtained, the average flower's perfect blooming age is between 64.00 DAP and 78.67 DAP. This data is not too different from the average sunflower's description and age, harvested between 120 – 130 DAP. Additionally, this yield is likely caused by the climate settings suitable with the sunflower's growth requirements. As we know, sunflower includes the C4 plant's category, which has a vast adaptation area and requires a hot region with full sunlight to grow and flourish well.

Cahyaningrum et al. (2014) state that the environmental setting of a plant's cultivation influences its growth and product yield. This effect is because a plant's appearance is highly influenced by the interactional correlation between its environmental cultivation setting and its genotype. Every plant has the ability to respond to every environmental factor of its growth. The response emerges if there is environmental stress that can affect its growth. Thus, it develops a specific adaptation strategy, both morphologically, anatomically, physiologically, and biochemically to avoid unfavorable environmental settings (Djukri, 2009).

3.5 Total Seeds Per Plant

Based on the observation, the total seeds per plant of the cultivated sunflower are between 978.33 seeds

until 1329.00 seeds. The highest average of total seeds per plant is on accession Ha1, while the lowest average of total seeds is on the Kanigara varieties. The average of total seeds per plant can be seen in Table 5.

Table. 5. The average of sunflower's total seeds per plant

Sunflower	Total seeds per plant (Seeds)
Accession Ha 15	990.67 [b]
Accession Ha1	1329.00 [a]
Kanigara Varieties	978.33 [b]
Helina IPB Varieties	1060.67 [b]
BM1 IPB Varieties	1145.00 [b]

Remark: the score followed by the same letter in the same column is not significantly different on the advanced DMRT test

The number of sunflower plants' seeds are affected by the flower's size tube formed. In accession Ha1, the plant visually has a more comprehensive flower tube to accommodate many seeds. Nevertheless, Helina and BM1 IPB varieties are affected by the flower's tube and the seeds' size. The smaller the seeds' size, the most likely many seeds contained in the sunflower flower's tube. This yield is assumed because the difference in sunflower used is quite substantial in influencing the difference in nature (genetic) or environmental difference or both factors. This result conforms to Utama et al. (2009) opinion stating that being environmentally tolerant to stress has the ability to adapt morphologically and physiologically. Sitompul and Guritno (1995) add that the difference in plant's appearance due to genetic makeup is always possible to occur even though the plant used to come from the same type. Genetic diversity will be expressed on the different growth phases can be expressed on various plants' traits, including the plant's form and function producing varied plant's growth.

In addition, this condition is also influenced by sunflower with different genetic potential in responding to its environmental growth, which contributes to flower tubes and seeds formation. Qadir et al. (2014), salinity pressures a plant's growth process by inhibiting cell division and enlargement, protein production, and the addition of plant biomass. Agustian (1994) adds that every variety's growth and production component depend on genetic traits. The difference in growth and production of a variety is influenced by its ability to adapt to the plant's growth environment. This variety's ability is more adaptive to yield better growth than the other varieties. Although genetically, there are other varieties with better production, it is affected by the plant's growth environment factor, decreasing its production (Simatupang, 1997).

3.6 Weight of 100 Seeds

Based on the observation data, the weight of 100 seeds of sunflower plants is varied, between 3.27 g until 7.27 g. The average weight of 100 seeds can be viewed in Table 6.

Table. 6. The average weight of 100 seeds of the sunflower plant

Sunflower	Weight of 100 seeds (g)
Accession Ha 15	3.59 [b]
Accession Ha1	7.27 [a]
Kanigara Varieties	7.18 [a]
Helina IPB Varieties	4.09 [ab]
BM1 IPB Varieties	3.27 [b]

Remark: the score followed by the same letter in the same column is not significantly different on the advanced DMRT test

In Table 6 above, it can be viewed that the average weight of 100 seeds in accession Ha1 has a more incredible amount compared to other types. The features of accession Ha1 possibly cause this yield, if seen visually, to be bigger and longer than the other seeds, making the weight also heavier. The circumstances also occurred in Kanigara varieties, different from accession Ha1. It is different from other seeds, with smaller sizes, so the weight is lighter than the other. The weight of 100 seeds was derived by drying it for two weeks in a place not exposed to direct sunlight. According to Munns and Tester (2008), the effect of saline stress influences the plant's biochemical and physiological process, which causes accumulation effect on overall plant's level; as a result, the plant eventually dies or decreases its productivity. Venkateswarlu and Visperas (1987) state that yield differences between varieties were caused by the difference in the seeds filling due to the supply of assimilating to seeds by the different sink and source strength conditions. This yield occurs because the plant's photosynthate sources that get stress will be less than the one that does not.

Seed yields are the principal storage form of photosynthesis during the reproductive phase; the energy in the generative phase is derived from photosynthate during the vegetative phase. The optimum growth affected by the intensity of sunlight indicates the influence on the yields, precisely to sunflower seeds. The better the sunflower growth, the seeds yield will also be high. Goldsworthy and Fisher (1996) state that generative growth is influenced by the energy stored during the vegetative growth phase.

3. CONCLUSION

Based on the above discussion, it can be concluded that sunflower growth and yield of accession Ha1 on the salinity stress in coastal land is quite excellent compared to accession Ha15 and Kanigara, Helina IPB, and BM1 IPB variety. Generally, sunflowers can adapt to the salinity stress in coastal land.

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