The Effect of Graving Extracts as a Million Grower

Juliayanti Ayuningrum S.*, Oslan Jumadi, Irma Suryani Idris
Department of Biology, Faculty of Mathematics and Natural Science, Universitas Negeri Makassar, South Sulawesi, Indonesia

Ernawati S. Kaseng
Department of Agricultural Technology Education, Faculty of Engineering, Universitas Negeri Makassar, South Sulawesi, Indonesia

*Corresponding author: juliayantiayuningrum@yahoo.com

Abstract. This research was aimed to determine the effect of algae extract as a driver of maize growth (Zea mays L.) using Randomized Block Design (RAK) with 3 replications. Making of algae-based organic fertilizer that has been done by extract consisting of three types of algae are Eucheuma sp., Sargassum sp., and Ulva sp. Further liquid fertilizer is tested against corn crops (Zea mays L.). Algae extracts are used in plants, either by spraying or by mixing with soil. The observation parameters included stem circumference (cm), leaf chlorophyll content (%), vegetative vegetative biomass (g), corncob (g), corncob (cm), leaf nitrogen (%), and seed nitrogen (%). The use of algae extracts to improve the quality and quantity of maize growth showed the growth of corn crops that tended to be better than controls. Of all existing treatments, algae extract showed Eucheuma sp. Algae extract on the measurement of vegetative biomass, and leaf nitrogen showed the highest yield, Sargassum sp. Algae extract showed the highest result on the measurement of stem circumference and tuna weight, whereas Ulva sp. Algae extract showed the highest yield on measurements of ear and nitrogen grains.

Keywords: algae extract, corn growth, Eucheuma sp., Sargassum sp., Ulva sp.

1. Introduction
Indonesia is an area with abundant natural resources, so that makes Indonesia known as an agrarian country. Since 2001 the Government has launched a program to increase the production of maize known as Gema Palagung (Rice Self Motivation Movement, Soybean and Maize) aimed at fulfilling domestic food needs through self-sufficiency program. However, to date the domestic corn production is still low so that to offset the increasing consumption needs of the population, animal feed, and industry, some must be imported from several corn producing countries. Every year, 1.5 million tons of imports are used for animal feed and 0.5 million tons for human food. The lack of fulfillment of domestic demand is due to the fact that farmers generally use varieties with low yield potential, inadequate cultivation technical implementation, and pest and disease diseases. Thus, efforts to increase domestic corn productivity need to be done in a way such as the use of improved varieties, and fertilization which is to date is indispensable because urea is the highest N source in solid form and is a key element in increasing production [1].
To improve the development of the agriculture sector, fertilizer is one of the supporting factors to increase corn production which is relatively easy to cultivate. Corn is also a good indicator plant to see the symptoms of nutrient deficiency, so the use of fertilizer is an absolute thing that continues to be done by farmers. The use of fertilizer combination between organic fertilizer and inorganic fertilizer is very good to reduce environmental pollution, especially the level of pollution on the soil. Environmental pollution by this fertilizer occurs due to inefficient use of nitrogen fertilizer by plants where only about 60% can be utilized directly by the plant. The remaining nitrogen that is not utilized by the plant will undergo a washing process that can lead to water contamination. This happens because the nature of urea in non-ionizing soil is easy to wash because it is not absorbed by the soil colloid [2]. Therefore the use of fertilizer combination is very suitable to increase productivity and minimize pollution of one of them the use of fertilizer from algae extract [3]. The use of algae as the basic ingredient of organic fertilizer has not been widely used yet, while Indonesia has various algae species and it is estimated there are about 555 species of algae spread in the waters. Furthermore, recorded 22 species have been used traditionally, both as vegetables and food. Of the 22 species that have economic value only a few species only [4].

Based on the description of the background then the problem formulation of this research is how the influence of algae extract *Eucheuma* sp., *Sargassum* sp., and *Ulva* sp., on the growth of corn crops? The focus of this research is experimental research with the aim to know the effect of *Eucheuma* sp. algae extract, *Sargassum* sp., and *Ulva* sp., on the growth of corn crop.

2. Research method

This research is experimental research with a research design that used is RAK (Randomized Block Design) which consist of 5 treatment and 3 replication, so that obtained 15 unit experiment. The subjects of this study were plant growth, including stem circumference, leaf chlorophyll, the vegetative biomass of plants (roots, stems, leaves), corncobs, corncobs, leaf nitrogen content, nitrogen content. Data processing is done by using variance analysis technique (F test) or ANOVA at the level of α 0.05%. Then proceed with Duncan’s advanced test using SPSS statistic program 20.

3. Results and discussion

3.1 Ring road (cm)

Based on the results obtained, the average measurements of stem rods performed at 7 weeks after planting (WAP) can be seen in Table 1.

| Treatment   | Average stem circumference (cm) |
|-------------|---------------------------------|
| Control     | 6.63a                           |
| UPK         | 6.70a                           |
| *Eucheuma* sp. | 6.73a                       |
| *Sargassum* sp. | 7.26a                       |
| *Ulva* sp.  | 6.76a                           |

Description: The average value followed by the same letter are not significantly in Duncan’s advanced test 0.05

The statistical analysis using ANOVA showed significant results, where the value greater than α 0.05. This means there is a significantly different effect for each treatment. The results of Duncan’s advanced test show that the effect is insignificant, but quantitatively the algae extracts treatments show better results than controls.

The results of the stem measurements in Table 1 show that algae extracts provide larger stem circumference than controls. Giving algae extracts on plants that enter the vegetative period will
increase the growth and increase in the number of cells, nutrient uptake including nitrogen which is one of the cell components and the formation of macromolecules [5]. So, as to improve the quality of the stronger rod to reduce resistance to Heard [6]. from the highest average stem rod yield of *Sargassum* sp. algae extract treatment of 7.26 cm, *Ulva* sp. 6.76 cm, *Eucheuma* sp. 6.73 cm, UPK of 6.70 cm, and the lowest stem circumference of the control is 6.63 cm.

The use of algae extracts as fertilizer can help improve soil fertility, provide nutrients, in addition to improving soil structure [7]. In addition, the addition of organic fertilizers facilitates decomposition and increases microbial activity [8]. Jensen [9] reported that spraying algae extracts containing micronutrients (Co, B, Mo, Zn, Cu) as well as macro (N, P, K) as well as growth-promoting hormones (auxin, gibberellin, and cytokines) can increase nutrient uptake, and increase the thickness of the stem. This is consistent with the research in Table 1 which show no statistically significant statistical results, but plants treated with algae extracts have stems that tend to be larger when compared to UPK and controls.

### 3.2 Chlorophyll leaves (%)

Leaf chlorophyll content was taken using SPAD chlorophyll meter (Soil Plant Analysis Development), and measurement was done at 8 WAP, can be seen in Table 2.

| Treatment    | Average leaf chlorophyll content (%) |
|--------------|-------------------------------------|
| Control      | 37.63a                              |
| UPK          | 44.13a                              |
| *Eucheuma* sp.| 43.93a                              |
| *Sargassum* sp.| 43.83a                             |
| *Ulva* sp.   | 43.70a                              |

Description: The average value followed by the same letter are not significantly in Duncan’s advanced test 0.05.

The statistical analysis using ANOVA showed significant results, where the value greater than $\alpha$ 0.05. This means there is a significantly different effect for each treatment. The results of Duncan’s advanced test show that the effect is insignificant, but quantitatively the algae extracts treatments show better results than controls.

Chlorophyll is one of the factors to determine the status of Nitrogen (N) in leaves [10]. The greater the number of green chlorophyll also the leaf. The content of chlorophyll in corn leaves is taken using SPAD (Soil Plant Analysis Development). The SPAD score is accurate enough to measure the level of nutrient N sufficiency in rice, wheat, corn, sorghum and cotton [11].

Mean leaf chlorophyll content in Table 2 showed the highest leaf chlorophyll content of UPK of 44.13%, *Eucheuma* sp. amounted to 43.93%, *Sargassum* sp. amounted to 43.83%, *Ulva* sp. amounted to 43.7% and average leaf chlorophyll content is lowest, i.e., control treatment of 37.63%. This is caused by UPK fertilizers provide more nitrogen for plants. Compared with algae containing nitrogen 2.00% so that UPK treatment showed more results than algae extract. But algae extract quantitatively showed better results than controls, in addition to the provision of algae extract adding organic N, may be an effective step to reduce N$_2$O emissions. Ding [12] reported that there was a significant difference between nitrogen (N), phosphate (P), and potassium (K) (NPK) and organic matter and suggested that an increase in Soil Organic Carbon (SOC) caused by the provision of urea fertilizer [13]. So the use of algae extract is an effective step to reduce N$_2$O emissions. Nutrients that play a role in the formation of chlorophyll is nitrogen. Nitrogen is one of the main components of leaf chlorophyll composition that is about 60% and acts as an enzyme and protein-membrane [14].
3.3 Vegetative biomass of root, trunk, leaves (g)

Biomass measurements include the vegetative organ of the plant (root, stem, leaf), vegetative phase, i.e., the starting phase of the first leaf to silking (before the female flower), the average of vegetative biomass can be seen in Table 3.

Table 3. The average vegetative biomass (g)

| Treatment   | Average of vegetative biomass (g) |
|-------------|-----------------------------------|
| Control     | 84.50a                            |
| UPK         | 92.66a                            |
| Eucheuma sp.| 99.66a                            |
| Sargassum sp.| 90.83a                            |
| Ulva sp.    | 84.50a                            |

Description: The average value followed by the same letter are not significantly in Duncan’s advanced test 0.05.

The statistical analysis using ANOVA showed significant results, where the value greater than $\alpha$ 0.05. This means there is a significantly different effect for each treatment. The results of Duncan’s advanced test show that there is no significant effect on any treatment on vegetative biomass of maize, but quantitatively the algae extracts treatments show better results than controls.

Fertilization efficiency is a measure of the ability of plants to produce biomass. Biomass production to vegetative organs such as roots gets the greatest allocation after leaves and stems until the initiation phase of root biomass allocation will decrease [5]. The average levels of vegetative biomass in Table 3 show the highest biomass of Eucheuma sp. 99.66 g, UPK 92.66 g, Sargassum sp. 90.83 g, and the lowest average leaf vegetative biomass, i.e., Ulva sp. and control 84.50 g.

The results showed that, in general, the administration of algae extracts of Eucheuma sp. and Sargassum sp. can increase the quantity of vegetative biomass in corn plants, but the low average biomass in the extract of Ulva sp. algae. Due to the translocation of N from the leaves to other organs including its distribution into the seeds [5]. Jensen [9] reported that spraying algae extract with micronutrient and macronutrient content, as well as growth promoting hormone (auxin, gibberellin, and cytokinin) can increase the vegetative growth of corn crops.

Hormone boosters grow from algae extracts also play a role in increasing the absorption of nutrients by plants [15]. Algae extract contains several growth regulators, polyamines and vitamins that are expected to improve nutritional status, vegetative growth, and fruit quality [16]. The same is reported by Sarhan [17], that spraying algae extract gives a significant positive result on the growth of plant sprouts. Featonby & Van Staden [18] received faster growth of buds and plant roots when algae extracts were used in plants, either by spraying (foliar spray) or by mixing with soil. In addition, Stephen [19] also reported that the application of algae extracts Eucheuma sp. and Sargassum sp. as an additive of fertilizer can increase the yield of some important commercial crops by 12-36%.

3.4 The weight of corn cobs (g)

Based on the results obtained, the average result of the measurement of cob weight after harvest (dry weight), can be seen in Table 4. The statistical analysis using ANOVA showed significant results, where the value greater than $\alpha$ 0.05. This means there is a significantly different effect for each treatment. The results of Duncan’s advanced test show that there is a significant effect on any treatment on the weight of corn cobs, in which the tendency of algae extracts yields better results than controls.

This is according to the results of research that shows that the algae extract has a significant effect on the weight of corn cobs. The highest average cob weights were Sargassum sp. 115.39 g, Ulva sp. 113.32 g, UPK 108.68 g, Eucheuma sp. 102.36 g, and the lowest average cob weight of control treatment was 55.83 g. This is thought to be due to the availability of nutrients that are largely
transferred in the generative phase that can stimulate the formation of corn cobs (jenggel and seeds). Agromedia [20] states that the effect of N use on the quality and quantity of yields is the completion of the full seeding process so that it can harden and prevent the reduction of seeds on the ends of cobs. This is correlated with the weight of the seeds in corn plants where the highest average seed weight namely *Sargassum* sp. 91.12 g, UPK 90.45 g, *Ulva* sp. 88.46 g, *Eucheuma* sp. 77.69 g, and the average seed weight of the lowest control of 37.22 g. In addition, growth hormones possessed by algae such as cytokinins play a role in cell division that causes the fruit growth response to increasing [21].

| Treatment        | The average weight of cob (g) |
|------------------|-------------------------------|
| Control          | 55.83<sup>a</sup>             |
| UPK              | 108.68<sup>b</sup>            |
| *Eucheuma* sp.   | 102.36<sup>b</sup>            |
| *Sargassum* sp.  | 115.39<sup>b</sup>            |
| *Ulva* sp.       | 113.32<sup>b</sup>            |

Description: The average value followed by the same letter are not significantly in Duncan’s advanced test 0.05

In this study, the tendency of algae extract can increase the growth and development of maize plants, where giving algae extracts show the best results which ultimately produce the highest cob weight. This is because the nutrient content and growth hormone found in algae is high enough. The length of the commercial cob is a cob with a minimum of 90% containing seeds, fully grown seed, long cobs> 12 cm and cobs are not attacked by pests [22]. The highest average length of cobs was *Ulva* sp. algae extract of 16.67 cm, *Sargassum* sp. of 15.67 cm, UPK of 15.00 cm, *Eucheuma* 14.17 cm, and the average length of the lowest ear of treatment control of 10.50 cm. This suggests that giving algae extracts to the growth of maize crops produces long commercial cob.

### 3.5 Leaf nitrogen (%)

Based on the results obtained, the average result of the measurement of nitrogen content in the leaves after harvest (dry weight), can be seen in Table 5.

| Treatment   | The average leaf nitrogen (%) |
|-------------|-------------------------------|
| Control     | 2.03<sup>a</sup>              |
| UPK         | 2.01<sup>a</sup>              |
| *Eucheuma* sp. | 2.16<sup>a</sup>           |
| *Sargassum* sp. | 2.16<sup>a</sup>           |
| *Ulva* sp.  | 1.99<sup>a</sup>              |

Description: The average value followed by the same letter are not significantly in Duncan’s advanced test 0.05

The statistical analysis using ANOVA showed significant results, where the value greater than α 0.05. This means there is a significantly different effect for each treatment. The results of Duncan’s advanced test show that there is no significant effect on any treatment on leaf nitrogen content, although statistically significant but not quantitatively giving *Eucheuma* sp. algae extracts and *Sargassum* sp. shows better results than controls. Nutrient elements that play a role in plant-generative growth are nitrogen. Marschener [23] revealed that N nutrients play a role in flowering, but the role of N is not as great as the role of nutrients P in the formation of flowers. That formation influences the formation and size of cobs since
tuna is a development of female flowers. Nitrogen is one of the main components of leaf chlorophyll composition, which is about 60% and acts as an enzyme and membrane protein. Sitompul & Guritno [24] states that nitrogen fertilization affects the increase of photosynthesis rate, stomatal conductivity to CO2, and respiration rate.

From the results of the research that has been done (Table 5) shows the average of nitrogen content in the highest leaves that is the extract of algae *Eucheuma* sp. 2.16%, *Sargassum* sp. and control of 2.03%, UPK of 2.01%, and average nitrogen content in the lowest leaves, i.e., treatment of *Ulva* sp. 1.99%. This shows that the administration of algae extracts *Eucheuma* sp. and *Sargassum* sp. by spraying (foliar spray) on the leaves is better because the nitrogen contained in the algae is small but very efficient, but the high level of N in control when compared with UPK and *Ulva* sp algae extract. Allegedly because the N contained in the soil is quite high, other than that the genetic variation of maize varieties HJ 21 Agritan that stay green also can affect the nitrogen content in the leaves because corn plants need N to maintain the nature of stay green, and according to Probowati [25] N contained in the leaves can be translocated at the time of filling the seeds so it can affect the N content on the leaves.

Although it is known that nitrogen nutrients in the leaves are needed in large quantities, but nitrogen also plays a role in the translocation of carbohydrates from the leaves to other plant organs. In this case, nitrogen plays a role in the reshuffle of carbohydrates into proteins so as to accelerate the process of carbohydrate translocation, so that in such conditions there is no accumulation of carbohydrates in the leaves. The specialty of algae as an organic fertilizer is its HPT content which can increase fruit and seed production. Relation to nitrogen fertilizers has been known that this element is a chlorophyll constituent that allows increasing the rate of photosynthesis. Besides, it also plays a role in the translocation of photosynthesis from leaves to other organs including its distribution into seeds [5].

3.6 *Nitrogen seed (%)*

Based on the results obtained, the average result of the measurement of nitrogen content in the seed (%) made after harvest (dry weight), can be seen in Table 6.

| Treatment       | The average leaf nitrogen (%) |
|-----------------|-------------------------------|
| Control         | 1.26*a                        |
| UPK             | 1.26*a                        |
| *Eucheuma* sp.  | 1.33*b                       |
| *Sargassum* sp. | 1.25*a                       |
| *Ulva* sp.      | 1.39*b                       |

Description: The average value followed by the same letter are not significantly in Duncan’s advanced test 0.05

The statistical analysis using ANOVA showed significant results, where the value greater than α 0.05. This means there is a significantly different effect for each treatment. The results of Duncan’s advanced test show that there is a significant effect on the nitrogen content of the seeds, in which the extracts of *Ulva* sp. and *Eucheuma* sp. Quantitatively show better results than controls.

Sonbai [26] argues that seed crops require relatively high nitrogen supply during the filling of seeds for relatively high production of photosynthates for seeds. When the nitrogen supply decreases during this phase, then the plant will move the nitrogen from the leaf to the seed, which in turn accelerates leaf aging. The highest rate of nitrogen in the seeds is *Ulva* sp. 1.39%, *Eucheuma* sp. 1.33%, UPK and control 1.26%, and the average nitrogen levels at the lowest seeds, i.e., *Sargassum* sp. algae extract treatment 1.25%. This shows that algae extract of *Ulva* sp. and *Eucheuma* sp. which contain growth hormone in addition to increasing growth in corn crops can also improve the quality and quantity of fruits and seeds.
However, the high N-seeds in the controls were compared with the treatment of algae extract of *Sargassum* sp., because the N elements mostly translated in the generative phase stimulated the formation of the woven corncob. Where the number of cobs weighing on 3 control treatment only amounted to 5, while the number of cobs on the 3 treatment of algae extract *Sargassum* sp. amounting to 7. Presumably, it is causing high N-seed in control compared with algae extract of *Sargassum* sp.

4. Conclusion

Giving algae extracts to corn crops results in better quality and quantity of corn crops. Of all the existing treatments algae extract showed, algae extract *Eucheuma* sp. in the measurement of vegetative biomass and leaf and nitrogen showed the highest yield. Algae extract of *Sargassum* sp. showed the highest yield on the measurement of stem circumference and the weight of the cob, during the algal extract of *Ulva* sp. showed the highest yield on measurements of cob and nitrogen grains, and on measurements of UPK leaf chlorophyll content showed the highest value.

References

[1] E. Patola, “Analisis pengaruh dosis pupuk urea dan jarak tanam terhadap produktivitas jagung hibrida P-21 (Zea mays L.),” *J. Inov. Pertan.*, vol. 7, no. 1, pp. 51–65, 2008.

[2] N. Anggrahini, “Dinamika n-nh4+, n-no3-dan potensial nitrifikasi tanah Di alfisols, jumantono dengan berbagai perlakuan kualitas seresah (albisia falcatoria (sengon laut) dan swietenia mahogany (mahoni)).” UNS, 2010.

[3] N. A. Subekti, R. E. Syafruddin, and S. Sunarti, “Morfologi tanaman dan fase pertumbuhan jagung,” *Di dalam Jagung, Tek. Produksi dan Pengembangan. Jakarta Pus. Penelit. dan Pengemb. Tanam. Pangan*, 2007.

[4] J. Basmal, “Prospek pemanfaatan rumput laut sebagai bahan pupuk organik,” *Squalen Bull. Mar. Fish. Postharvest Biotecnol.*, vol. 4, no. 1, pp. 1–8, 2009.

[5] W. G. Hopkins, *Introduction to plant physiology.*, no. Ed. 2. John Wiley and Sons, 1999.

[6] J. Heard, “Nutrient Uptake And Removal Patterns In High Yielding Manitoba Corn Manitoba Agriculture.” 2004.

[7] V. K. Dhargalkar and N. Pereira, “Seaweed: promising plant of the millennium,” 2005.

[8] O. Jumadi, S. F. Hiola, Y. Hala, J. Norton, and K. Inubush, “Influence of Azolla (Azolla microphylla Kaulf.) compost on biogenic gas production, inorganic nitrogen and growth of upland kangkong (Ipomoea aquatica Forsk.) in a silt loam soil,” *Soil Sci. plant Nutr.*, vol. 60, no. 5, pp. 722–730, 2014.

[9] E. Jensen, “Seaweed: fact or fancy,” *Org. Broadcast.*, vol. 12, p. 16, 2004.

[10] C. A. Shapiro, J. S. Schepers, D. D. Francis, and J. F. Shanahan, “Using a chlorophyll meter to improve N management,” *Univ. Nebraska-Lincoln Extension, Lincoln, NE*[Online] Available https://efotg. sc.egov. usda. gov/references/public/MI/Chlorophyll_Meter_N. pdf [20 Nov. 2015], 2006.

[11] G. Argenta, P. R. F. da Silva, and L. Sangoi, “Leaf relative chlorophyll content as an indicator parameter to predict nitrogen fertilization in maize,” *Ciência Rural*, vol. 34, no. 5, pp. 1379–1387, 2004.

[12] W. Ding, J. Luo, J. Li, H. Yu, J. Fan, and D. Liu, “Effect of long-term compost and inorganic fertilizer application on background N2O and fertilizer-induced N2O emissions from an intensively cultivated soil,” *Sci. Total Environ.*, vol. 465, pp. 115–124, 2013.

[13] A. Hadi, O. Jumadi, K. Inubushi, and K. Yagi, “Mitigation options for N2O emission from a corn field in Kalimantnan, Indonesia,” *Soil Sci. Plant Nutr.*, vol. 54, no. 4, pp. 644–649, 2008.

[14] E. Purwanti, “Pengaruh dosis pupuk majemuk dan konsentrasi Em-4 terhadap pertumbuhan bibit stek tebu (Saccharum officinarum L.).” Universitas Sebelas Maret, 2008.

[15] I. J. Crouch and J. Van Staden, “Evidence for the presence of plant growth regulators in commercial seaweed products,” *Plant Growth Regul.*, vol. 13, no. 1, pp. 21–29, 1993.
[16] E. A. A. El-Moniem and A. S. E. Abd-Allah, “Effect of green algae cells extract as foliar spray on vegetative growth, yield and berries quality of superior grape vines,” *J. Amer. Eur. Agric. Environ. Sci.*, vol. 4, no. 4, pp. 427–433, 2008.

[17] T. Z. Sarhan, “EFFECT OF BREAD YEAST APPLICATION AND SEAWEED EXTRACT ON CUCUMBER (Cucumis sativus L.) PLANT GROWTH, YIELD AND FRUIT QUALITY.,” *Mesopotamia J. Agric.*, vol. 39, no. 2, pp. 26–32, 2011.

[18] B. C. Featonby-Smith and J. Van Staden, “The effect of seaweed concentrate on the growth of tomato plants in nematode-infested soil,” *Sci. Hortic. (Amsterdam)*, vol. 20, no. 2, pp. 137–146, 1983.

[19] S. A. B. Tay, J. K. Macleod, L. M. S. Palni, and D. S. Letham, “Detection of cytokinins in a seaweed extract,” *Phytochemistry*, vol. 24, no. 11, pp. 2611–2614, 1985.

[20] R. AgroMedia, *Budi Daya Jagung Hibrida*. AgroMedia, 2007.

[21] Y.-T. Wu and C.-H. Lin, “Analysis of cytokinin activity in commercial aqueous seaweed extract,” *Gartenbauwissenschaft*, vol. 65, no. 4, p. 170, 2000.

[22] P. Suratmini, “Kombinasi pemupukan urea dan pupuk organik pada jagung manis di lahan kering,” *J. Balai Pengkaj. Teknol. Pertanian, Bali*, vol. 28, no. 2, pp. 83–88, 2009.

[23] H. Marschner, “Mineral Nutrition of Higher Plants. Academic Press Limited,” *London, UK*, 1995.

[24] S. M. Sitompul and B. Guritno, “Analisis pertumbuhan tanaman.” Gadjah Mada University Press. Yogyakarta, 1995.

[25] R. A. Probawati, B. Guritno, and T. Sumartini, “Pengaruh Tanaman Penutup Tanah dan Jarak Tanam Pada Gulma dan Hasil Tanaman Jagung (Zea mays L.),” *J. Produksi Tanam.*, vol. 2, no. 8, 2015.

[26] J. H. H. Sonbai, “Pertumbuhan dan hasil jagung pada berbagai pemberian pupuk nitrogen di lahan kering regosol,” *Partner*, vol. 20, no. 2, pp. 154–164, 2013.