Biomass, Stomata And Chlorophyll Condition Of Several Siperior Varities Of Composit Mize Under Nutrient Stress And Organic Amendment In Ultsoils

Bukhari Bukhari*[1], Jamilah Jamilah[2], Fadzilah Adibah binti Abdul Majid[3]

[1,2]*Agrotechnology Department,Universitas Jabal Ghafur,Sigli,Indonesia*
[3]*Institute of Marine Biotechnology, University Malaysia Terengganu, Kuala Nerus, Malaysia*
**) Email coresponden: bukharimp@gmail.com*

ABSTRACTS

This research was carried out at the platic house of the Faculty of Agriculture, Jabal Ghafur-Sigli University, using a completely randomized design (CRD). There are two factors studied, namely variety and nutrient stress, varieties consist of 6 types, those selected from 9 varieties in previous research, while there are 4 types of nutrient stress treatment, namely organic amendments (OA), provided with complete nutrients (CX), phosphorus stress (P-S), potassium stress (K-S) and magnesium stress (Mg-S). Observations were made on the index and density of stomatal, total chlorophyll content and biomass accumulation. The results of the research showed that the use of varieties and nutrient stress affected the density and index of stomata, total chlorophyll and biomass accumulation. The largest density and index of stomata, the most chlorophyll and the heaviest biomass were found in the Anoman 1 variety and the provision of complete nutrients (V_1CX) while the density and Stomata index, lowest biomass and least chlorophyll were found in magnesium stress and Lamuru varieties. The best combination of treatments was found in the treatment of the Anoman 1 variety with the provision of complete nutrients and the very worst combination occurred in the treatment of the Lamuru variety with magnesium stress (V_6Mg-S). Phosphorus, potassium and magnesium nutrient stress in corn plants grown in ultisol soil can reduce stomatal density and index, total chlorophyte and biomass accumulation respectively by 7.51-37.56%, 5.63 - 18.57%, 16.20 - 24.25% and 4, respectively. 76 – 26.7%, however this reduction can be offset by organic amendments from a mixture of biochar 5 tons ha-1 (75) and crushed rice straw 5 tons ha-1 (75 g).

***Key words**: biomass accumulation, chlorophyll, composite varieties, nutrient stress and stomata.*

1. INTRODUCTION

Corn has an important role in increasing the economic growth of the people of Aceh, market opportunities that are still open and the availability of large areas of land are potential that must be considered, but the problem is that the available land is sub-optimal dry land. However, the larger sub-optimal land in Aceh is Ultisol land [1]. Ultisol soil is a type of soil that is poor in nutrients, organic matter content, base saturation and low water due to advanced weathering. Intensive weathering causes this soil to be deficient in nutrients and low in organic matter. The top soil is thin due to continuous washing, causing the soil to become less fertile. The fertility of the soil becomes lower if burning occurs or the vegetation above it is removed, the soil will quickly become nutrient poor and susceptible to erosion [2]. The results of research [3], it turns out that dry land in tropical areas is generally poor in nutrients, low in organic matter content, base saturation and low cation exchange capacity so that the soil quality index is low [4,5] and soil fertility becomes low and reacts sour [6]. In acid conditions (pH <5.5), this land often contains high levels of Al-DD, which has the potential to cause poisoning in cultivated plants [7].

This tropical soil also has many problems from the physical aspect, such as being sensitive to erosion due to the low aggregate stability index, for this reason soil and water conservation techniques are needed

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[8]. Management of acid mineral soil for the development of land for food crops such as corn, soybeans and peanuts is generally carried out by implementing several dry land agricultural technology packages such as applying soil and water conservation techniques, providing soil amendments and fertilization [9, 10, 11]. Deficiencies of N, P, K and other nutrients can be overcome by providing appropriate fertilizer and other nutrients as well as implementing soil conservation technology and water [`12,13]. Limited nutrients can inhibit the development of roots, leaves, chlorophyll content, number of stomata, photosynthesis and small accumulation of photosynthate. The research results of [14] Lack of the nutrients Phosphorus, Potassium and Magnesium causes imperfect tissue growth. The obstacles faced by the ultisol soil problem can be overcome by using appropriate technology such as the use of superior varieties. The aim of this research is to find out superior varieties that are tested in environmental conditions with stressful nutrients, with the benchmark without stress being the provision of nutrients through Phosphate, KCl and Mg SO4 fertilization.

2. MATERIALS AND METHODS

Place and time of research

Research on P, K and Mg nutrient stress on 6 superior composite varieties was carried out by the Hidrophonic House, Faculty of Agriculture, Jabal Ghafur University, which took place from August to November 2022.

The research was carried out on ultisol soil as in previous research conducted by Bukhari et al. In 2022, the Ultisol soil taken from Teureubeh Jantho Village, Aceh Besar Regency will be used in further research. Based on the results of the initial analysis of Ultisol soil, it can be seen that this soil has a clayey clay texture, the physical form of the soil has a density of 0.97-1.24 g m-3. water content pF 2.5, namely 22.6-39.2%. pF 4.2, namely 12.5-15.8%. Water availability 9.6-23.4%. Permeability is 24.0-4.14 cm/day. the porosity is 36.5-41.8%. The aggregate index is 34.1-36.7. Furthermore, the pH of H2O is 6.02-6.60. The organic C content is only 0.32-1.79 while the total N is 0.11-0.20%. For total P it only reaches 6-10 Mgkg-1., Total K is only available 3-4 mg 100 g-1 while available P is 0.9-2.8 ppm. The Ca content value is 1.54-4.75 Cmol kg-1. Mg is 0.67-0.81 Cmol kg-1. K is 0.10-0.20 Cmol kg-1. For Na it is 0.75-0.85 Cmol kg-1. the cation exchange capacity (CEC) value is 3.13-6.59 Cmol kg-1. For CEC, it is 20-26. Potential acidity is based on the negative Al value while the H value is negative Cmol kg-1. EC 0.04 mscm-1 Base is 12-33%. Soil fertility status is low.

Corn varieties

The corn varieties used were the result of previous research which selected 6 out of 9 varieties, the three varieties that were more resistant to nutrient stress were Noman 1, Srikandi Kuning, Laga-ligo, and three more that were more sensitive, namely Bisma, Sukmaraga and Lamuru.

Experimental Design

The research was carried out using a 6 x 5 factorial design which was prepared based on a Completely Randomized Design (CRD) with variety as the first factor consisting of Anoman 1 (V_1), Lamuru (V_2), Srikandi Kuning (V_3), Laga Ligo (V_4), Bisma, Sukmaraga (V_5), and Lamuru (V_6). Meanwhile, the second factor analyzed was nutrient deficiency which consisted of organic amendment (OA) and complete nutrient provision (CX) as a comparison. Phosphorus Deficiency (C-P); Potassium deficiency (C-K); and magnesium (C-Mg) deficiency. Corn is planted in polybags with a capacity of 15 kg, which have been filled with ultisol soil, then each soil in the polybag is treated with phosphorus, potassium and magnesium nutrient stress compared to organic amendment treatment and complete nutrient supplementation (control). The fertilizer used is SP-36, KCl and $MgSO_4$ with the same dose for all types of fertilizer, namely 4.5 g per polybag, which is given according to the stress treatment, for each complete application it is given to the three types of fertilizer as well as those that receive organic treatment amendment no using fertilizer but only using 75 g of rice husk biochar plus 75 g of crushed rice straw. The use of biochar and rice straw is because in previous research the use of a mixture of 75 g of biochar and 75 g of rice straw resulted in better corn growth.

Observation variables

Plant physiological parameters were observed at the end of the vegetative phase and the beginning of the generative phase (40 days old) by analyzing samples of the last two leaves under the flag leaf, because these leaves receive full sunlight. The physiological characters analyzed include: (a) stomatal density, (b) stomatal index, (c) chlorophyll content, and (d) biomass weight.

Stomatal density and index were observed by taking parts of plant leaves that had completely opened using a plunger to form leaf circles with a diameter of 0.5 cm from the top 3 leaves, then fixing them in 70% alcohol, discarding the fixative solution then washing with distilled water and then soaking in the solution. 25% HNO3 for 20 minutes to destroy the mesophyll tissue and washed again with distilled water, then the lower leaves are slashed with a razor blade. The epidermis incision was soaked in bayclin solution for 3 minutes to remove chlorophyll from the mesophyll then washed again with distilled water, the leaf epidermis incision was then placed on a glass object then dripped with 10% glycerin and covered with a cover glass then the number of stomata and epidermis were observed, so that the density and index Stomata can be obtained by the formula:

$$\text{Stomata dencity (SD)} = \frac{\text{Number of stomata}}{\text{Unit of View}} \quad (1)$$

$$\text{Stomata index (SI)} = \frac{\text{Number of stomata}}{\text{Number of stomata} + \text{epidermal cells}} \times 100 \quad \text{................(2)}$$

Leaf chlorophyll was analyzed by first grinding the leaves with a mortar, then weighing 50 mg, mixing with 2.0 mL of 80% acetone solution, and stirring thoroughly. 2.0 mL was put into a tube of this mixture and then centrifuged at 5,410 rpm for 20 seconds to separate the supernatant solution from the mixture. Extraction is carried out several times until the color disappears. The supernatant solution was then diluted with distilled water to a volume of 10 ml. This solution was then measured colorimetrically using a spectrophotometer at a wavelength of 645 nm for measurement of chlorophyll A and chlorophyll B observed at 663 nm. Total chlorophyll (A + B) is calculated using the following formula:

$$\text{Total chlorophyll (mg/g)} = 20.2 \times A\ 645 \times 8.02 \times x\ \frac{V}{1000 \times Wl} \text{..................................(3)}$$

Where; **v** is the chlorophyll extract, and **wl** is the fresh weight of the leaves.

Corn biomass weight was measured by weighing the entire corn plant at the end of the study. The total weight of the plant after drying in this case is the dry weight of the roots plus the dry weight of the crown including the cob.To determine the effect of varieties and nutrient deficiency treatments on changes in the physiological characteristics of corn, statistical analysis was used using the F test (analysis of variance) at $\alpha = 0.05$, while to determine differences between treatments, BNT cluster analysis (0.05) was used.
Data analysis uses the Microsof Excel application.

3. RESULTS AND DISCUSSION

Stomata Density

The results of the Variety Analysis showed that differences in varieties and nutrient stress as well as organic amendments had a very significant effect on stomata density. The average stomata density of several varieties when organic amendments and nutrient stress were applied can be seen in table 1.

From Table 1, it can be seen that there is a difference in stomata density between the composite corn varieties that were treated with nutrients and organic amendments, the stomata were denser in the complete nutrient treatment and the corn that received organic amendments. While those who received stress generally experienced a decrease in stomata density, this decrease was not significant when there was a lack of phosphorus in two corn varieties, namely Anoman 1 and Srikandi yellow with stomata densities of 100.2 and 96.6 stomata/mm2 respectively with a decrease rate of 9.32 and 7. .63%. However, for the other four varieties, stomata density decreased sharply as a result of phosphorus stress, reaching 13.69 – 20.12%.

Table 1. Average stomata density in several varieties when subjected to organic amendment and nutrient stress(stomata/mm^2)

Treatment	Organic Amendment	CX	P-S	K-S	Mg-S	LSD = 0,.05
V_1 Anoman 1	105.9 aA	110.5 aA	100.2 aAB	97.4 aB	95.8 aB	9.5
V_2 Srikandi Kuning	101.6 abA	104.6 abA	96.6 aAB	94.0 aB	93.6 abB	9.3
V_3 Laga-ligo	101.3 bcA	102.3 bA	88.3 bB	83.3 bBC	76.0 bcC	7.6
V_4 Bisma	100.3 bcA	102.3 bA	85.0 bcB	83.2 bB	73.3 cC	7.3
V_5 Sukmaraga	99.7 bcA	101.7 bA	83.0 cB	81.9 bB	70.6 cC	7.0
V_6 Lamuru	99.8 cA	100.9 bA	80.6 cB	77.1 cB	63.0 dC	6.3
LSD=0,05	5.3	6.7	4.9	4.4	5.8	

Note: Numbers followed by the same letter notation in the same row and column are not significantly different at the α = 5% level (LSD Test)

The heaviest stress was seen in the Lamuru variety. This is thought to be closely related to the ability of each variety to form stomata, where the Anoman 1 variety has a greater ability so that it can produce a high density of stomata. Stomata density was also influenced by differences in nutrient stress, where the six varieties did not show different stomata densities between stress treatments when they received phosphorus and potassium nutrient stress, but when they received magnesium nutrient stress, the four composite varieties showed different stomata densities, namely the Laga-ligo, Bisma varieties. , Sukmaraga and Lamuru with a very sharp decline rate occurring in the Lamuru variety, the decline was only 7.51-20.12% under phosphorus nutrient stress, 11.86 - 23.59% due to potassium nutrient stress and the decline reached 13.30 - 37.56% due to magnesium nutrient stress. This means that very severe stress when there is a Mg deficiency is experienced by the high-yielding composite corn variety Lamuru variety. Mg deficiency can affect the density of stomata which in turn can affect respiration activity in the plant body. The research results of [15] showed that Mg deficiency can reduce the rate of respiration, besides that it also causes the accumulation of amino acids which results in the intermediate tricarboxylic acid (TCA) cycle. Mg deficiency can increase the glucose, fructose and sucrose content in Citrus cinensis leaves, but the glucose and fructose content in the roots decreases [16].

Plants with a higher stomata density have greater adaptability than plants to environmental conditions, even if the environment is deficient in nutrients. Light intensity affects environmental temperature. The higher the light intensity, the higher the environmental temperature. The opening and closing of stomata is influenced by environmental temperature. Apart from temperature, other environmental factors also influence stomata density. From the results of this research, it turns out that the environment can also influence the density of corn stomata, where when corn planted in ultisol soil is given organic material mixed with biochar and crushed rice straw, the density of stomata increases by 5.38 - 36.87%, almost the same as the density of stomata when given complete nutrients to the composite corn variety. try it. The research results [17] also found that organic amendments could increase stomata by up to 10.5%.

Stomata Index

The results of the Variety Analysis showed that differences in varieties and nutrient stress as well as organic amendments had a very significant effect on the stomata index. The average stomata index for several varieties when organic amendments and nutrient stress were applied can be seen in table 2.

Table . 2. Average stomata index in several varieties when subjected to organic amendment and nutrient stress(%)

Treatment	Organic Amendment	CX	P-S	K-S	Mg-S	LSD=0.05
V_1 Anoman 1	0.81aA	0.82 aA	0.75 aB	0.74 aB	0.76 aB	0.082
V_2 Srikandi Kuning	0.80 abA	0.81 abA	0.69 abB	0.67 aB	0.72b B	0.069
V_3 Laga-ligo	0.76bcA	0.77 bcA	0.66 bB	0.64 bc B	0.67b B	0.085
V_4 Bisma	0.70 cAB	0.72 cA	0.67 bAB	0.63 cB C	0.65c B	0.052
V_5 Sukma raga	0.70 bcA	0.71 cA	0.67 bAB	0.63 cB	0.63 cd B	0.045
V_6 Lamuru	0.6 8 cA	0.70 cA	0.61 cB	0.62 cB	0.57 dC	0,044
LSD = 0.05	0.073	0.084	0.042	0.046	0,051	

Note: Numbers followed by the same letter notation in the same row and column are not significantly different at the α = 5% level (LSD Test)

Table 2 shows that there are differences in the stomatal index values between composite corn varieties that were treated with organic amendments and nutrient stress, the stomatal index was greater in corn that received organic amendment treatment and complete nutrient supply. Nutrient stress treatment can generally reduce the stomata index of the composite corn varieties tested. The decline occurred from 5.63 - 14.81%, the decline was only slight in the Sukmaraga and Bisma varieties, the decline in the stomatal index due to phosphorus stress occurred very quickly in the Srikandi Kuning variety. A great decrease in the stomatal index also occurred when potassium and magnesian stress were treated, where a decrease in the stomatal index ranging from 9.76 -17.28% was seen in potassium stress, while a decrease in the stomatal index in magnesium stress reached the range of 7.32-18.57%. The negative effect of stress is very large in the absence of magnesium, and the effect is very large in the Lamuru variety. Stomata density can be indicated by changes in carbon dioxide concentration. Carbon dioxide and light intensity are factors known to be used to control the development of stomata of epidermal cells. The effect of changes in carbon dioxide on leaf growth can be determined by measuring the stomatal index (SI), which describes the ratio between the number of stomata and the number of epidermal cells on the leaf surface [18]. When composite varieties of corn are generally planted on ultisol soil which is treated with organic amendments from a mixture of 75 g of biochar and 75 g of crushed rice straw, it can increase the corn stomata index to match the stomata index in the complete nutrient treatment which reaches 6.17 – 16.18%, in this condition There is an increase in the concentration of carbon dioxide in corn leaves which will then increase the rate of the photosynthesis process which can increase photosynthate which in turn can increase corn biomass.

Kandungan Klorofil

The results of the Variety Analysis showed that differences in varieties and nutrient stress and organic amendments had a very significant effect on the chlorophyll content. The average chlorophyll of several composite corn varieties when organic amendments and nutrient stress were applied can be seen in table 3.

Table 3. Average total chlorophyll in several varieties when subjected to organic amendment and nutrient stress (mg/g)

Perlakuan	Organic amendment	CX	P-S	K-S	Mg-S	LSD=0,05
V_1 Anoman 1	115.4 a AB	121.3 aA	105.2 aC	109.1 aBC	96.8 aD	8.2
V_2 Srikandi Kuning	107.2 bA	108.7 bA	102.0 aAB	103.9 abAB	87.6 abB	7.3
V_3 Laga-ligo	102.4 bcA	103.7 bA	100.7 abA	102.5 abA	86.9 abB	9.2
V_4 Bisma	104.1 bcA	104.5 bA	95.7 bB	101.7 bAB	86.3 abC	8.3
V_5 Sukmaraga	103.0 bcAB	103.2bAB	94.9 bcB	106.5 abA	81.1 bC	8.9
V_6 Lamuru	96.4 cAB	103.5 bA	94.2 cAB	90.9 cB	78.4 bC	9.8
LSD = 0,05	7.8	8.4	6.8	7.4	10.6	

Note: Numbers followed by the same letter notation in the same row and column are not significantly different at the α = 5% level (LSD Test)

From Table 3, it shows that there are differences in chlorophyll content between composite corn varieties treated with organic amendments and nutrient stress, the total chlorophyll content is greater in corn treated with organic amendments and complete nutrient supply. Nutrient stress treatment can generally reduce the chlorophyll content of composite corn varieties that are planted in ultisol soil. The chlorophyll content of the Anoman 1 variety is significantly higher than the chlorophyll content of other corn varieties. From Table 3 it can also be seen that the Lago-ligo composite corn variety has less chlorophyll than the Anoman 1 variety, but when this variety experiences phosphorus and potassium stress, the chlorophyll content is no different from the chlorophyll content when it is not stressed. The chlorophyll content of the Srikandi Kuning variety when subjected to phosphorus and K nutrient stress did not appear to be different from the chlorophyll content of the variety given complete nutrients (Control). The Bisma variety also showed chlorophyll content that was no different from the control when subjected to potassium stress. The Lamuru variety showed lower chlorophyll content when experiencing nutrient stress, however, when experiencing nutrient stress, this variety visually looked lower than the control but statistically did not show a significant difference. The Srikandi Kuning, Laga-ligo varieties are more tolerant to Phosphorus and Potassium stress, the Bisma and Sukmaraga varieties are only tolerant to potassium stress and the Lamuru variety is only tolerant to phosphorus stress. All varieties tried were intolerant (sensitive) to magnesium stress. The decrease in chlorophyll content due to stress reached 16.20 - 24.25%, with a very large decrease occurring in the Lamuru variety. It is suspected that Anoman1's adaptability to various environmental conditions, whether stressful or not, results in total chlorophyll production exceeding other varieties, on the other hand, the Lamuru and Sukmaraja varieties have lower adaptability and thus obtain less total chlorophyll. Chlorophyll is a very important part of a plant. Chlorophyll plays a role in the photosynthesis process, with the main function being to utilize solar energy in the form of light energy and convert it through the assimilation process into chemical energy in the form of carbohydrates, this compound provides the energetic basis for the ecosystem as a whole. Chlorophyll has atomic cells made from magnesium, and has the same important function as blood in humans.[19] stated that the age of the leaves and the physiological stage of the plant are factors that determine the chlorophyll content of a plant's leaves. [20] added that loss of chlorophyll in a plant will cause the leaves to fall and the plant to grow very miserable.

Nutrient stress will reduce total chlorophyll levels because the presence of nutrients is very important for the growth of corn plants [21] stated that Mg is an element that forms the structure of chlorophyll while Fe is needed as an enzyme cofactor which is important for the formation of chlorophyll. Fe deficiency causes a decrease in enzyme activity which plays a role in the conversion of protoporphyrin to chlorophyll, while Mg deficiency causes a decrease in chlorophyll function. However, when receiving organic amendment treatment, it is suspected that the nutrient Mg also increases. This increase results in the chlorophyll content of corn in this study reaching 15.14 - 18.67%. This can also increase the rate of photosynthesis which can also increase the accumulation of corn biomass.

Plant Biomass

The results of the Variety Analysis showed that differences in organic amendment varieties and nutrient stress had a very significant effect on the biomass accumulation of the composite corn varieties tested. The average accumulated biomass of several composite corn varieties when organic amendments and nutrient stress were applied can be seen in table 4.

` . Table 4. Average biomass of several corn varieties when subjected to organic amendment and nutrient stress (g/batang)

reatment	Organic amendment	L	-P	-K	-Mg	LSD = 0.05
V1 Anoman 1	18.8 aA	19.8 aA	16.4 aB	15.8 aB	14.5 aB	1.72
V2 Srikandi Kuning	17.2 abA	17.9a bA	15.5 abB	14.7 abBC	13.6 abC	1.68
V3 Laga-ligo	15.9 bA	16.8 bA	14.7 bBC	14.2 abBC	13.3 bcC	1.56
V4 Bisma	15.8 bAB	16.6 bA	15.8 abAB	14.8 abBC	13.8 abC	1.51
V5 Sukma raga	16.7 abAB	17.9 bA	15.3 abBC	15.5 abBC	13.4 bC	1.46
V6 Lamuru	16.5 abA	16.4 bA	14.2 bB	13.9 bBC	12.7 bC	1.37
LSD = 0.05	1.70	1.91	1.52	1.41	1.34	

Note: Numbers followed by the same letter notation in the same row and column are not significantly different at the α = 5% level (LSD Test)

Table 4 it can be seen that there are differences in biomass accumulation between composite corn varieties that were tested with organic amendments and nutrient stress, greater biomass accumulation was found in corn that received organic amendment treatment and complete nutrient supplementation. Nutrient stress treatment can generally reduce the biomass accumulation of composite corn varieties planted in ultisol soil. The biomass accumulation of the Anoman 1 variety was significantly greater than the biomass accumulation of other composite superior corn varieties, except for the Srikandi Kuning variety. Biomass accumulation of the Anoman1 and Srikandi Kuning varieties did not differ in both stressed and non-stressed conditions, but the effect of nutrient stress on the biomass accumulation of composite superior varieties of corn was relatively the same, only that the Anoman 1 variety had a higher biomass accumulation capacity compared to other varieties, whereas The Lamuru variety has a lower ability to accumulate biomass. The results of this study are in line with the results of research by [24] while the rate of decrease in accumulation was almost the same for all varieties except the Anoman 1 variety. Nutrient stress resulted in different corn biomass where corn that did not receive nutrient stress showed heavier biomass compared to corn under all three nutrient stresses, corn that received P nutrient stress , K and Mg nutrient stress did not show different biomass. The biomass of corn that received complete nutrient treatment was on average heavier than corn that received nutrient stress treatment. Therefore, it can be said that the biomass of corn under nutrient stress does not only depend on the genetic characteristics of the variety, but varieties that have greater adaptability can show heavier biomass than varieties that have low adaptability.

Plant biomass is the accumulation of photosynthesis products and nutrient absorption in the form of organic compounds that make up all tissues in the vegetative and generative organs of plants [23]. Biomass is usually used as an indicator for plant growth, the better the plant growth, the heavier the biomass displayed by the plant [24]. Plant biomass reflects the nutritional status of plants and is an indicator that determines whether or not plant growth is good and is related to nutrient availability, nutrients that are available in sufficient quantities for the needs of corn plants, resulting in greater biomass accumulation [25].

All composite corn varieties that were tested responded very well to organic amendments so they could produce biomass that was statistically no different from the control treatment. The increase in biomass accumulation ranged from 12.66% in the Sukmaraga variety to 20.93% in the Srikandi Kuning variety. The results of this research are also in line with research by [26] where organic amendments can increase the number of stomata and biomass accumulation of corn plants.

CONCLUSIONS AND RECOMMENDATIONS

Conclusion.

1. Nutrient stress: Nutrient stress, phosphorus, potassium and magnesium can reduce the density and stomatal index of corn leaves. There are differences in adaptability between corn varieties to nutrient stress. The bad effects of nutrient stress are very clearly visible when magnesium stress occurs.
2. Higher adaptability when nutrient stress occurs is shown by the Anoman 1 variety, while weak adaptability is shown by the Lamuru and Sukmaraga varieties
3. All composite corn varieties responded very well when organic amendments were made which could increase the percentage of stomata density by 5.38 - 36.87%, Stomata index was 6.17 – 16.18%, chlorophyll content was 15.14 – 18.67% and biomass accumulation increased by 12.66 – 20.93%.

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Recomendations

1. If corn development is carried out on suboptimal dry land such as ultisol, an organic amendment is needed, a mixture of 5 tons ha-1 of biochar and 5 tons ha-1 of crushed rice straw.
2. Further research is needed to test the adaptability of corn to acid mineral soils, other than ultisol, to meet the increasing need for corn due to increased consumption of corn, especially for the animal feed industry.

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