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# The Use of Sentinel-2 Image Vegetation Index for Biomass Growth Analysis of Corn Plants at Various Plant Spacings

**Destriana Mayo Elsa[1], Haerani[*1], and Ahmad Munir[1]**
[1] Agriculture Engineering Study Program, Department of Agricultural Technology, Faculty of Agriculture, Hasanuddin University

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**ABSTRACT**

Biomass growth can affect the increase of corn production. Many methods can produce good biomass growth, including adjusting plant spacing to ensure an even distribution of nutrients. Vegetation indices on sentinel-2 satellite imagery could be used to observe corn plant biomass growth. The purpose of this study was to determine the relationship between sentinel-2 image vegetation index and corn plant growth parameters at plant spacing of 70 x 40 cm, 70 x 20 cm, and irregular. This research was conducted through several stages, i.e., (1) field data collection of plant height, biomass, and leaf area, (2) downloading sentinel-2 image data for the period of December 10, 2022 - February 28, 2023, (3) atmospheric correction and image cropping, (4) transformation of NDVI and EVI vegetation indices, and (5) data analysis using simple linear regression analysis to observe the relationship of NDVI and EVI vegetation indices to corn plant growth parameters. The parameters observed were plant height, biomass, and leaf area. Based on growth parameters, plant spacing of 70 x 40 cm produced good crop growth. Furthermore, growth parameters and vegetation index values of both NDVI and EVI showed strong correlations at a plant spacing of 70 x 40 cm. Conversely, plant spacings of 70 x 20 cm and irregular patterns were considered moderate. It is found that corn plant growth parameters (plant height, biomass, and leaf area) can be monitored using sentinel-2 satellite imagery..



***Corresponding Author(s):***

Haerani
Agriculture Engineering Study program, Department of Agricultural Technology, Hasanuddin University
Jl. Perintis Kemerdekaan KM.10, 90245, Tamalanrea, Makassar, Sulawesi Selatan, Indonesia
Email: haerani@agri.unhas.ac.id

## 1. INTRODUCTION

Indonesia produces various food crops, including corn. Besides food consumption, corn can also be used as the primary raw material for the feed industry. About 57% of the total demand is used for feed and the feed industry, 34% for food, and 9% for other industries [7]. Therefore, the demand for corn continues to grow, so an increase in production is needed. One of the varieties that can increase corn productivity is hybrid varieties. These varieties have advantages such as tolerating certain pests or diseases, being responsive to fertilization, uniform cobs, and producing larger and more seeds [1]. In addition, increasing corn production is also influenced by biomass growth.

Biomass is the quantity of organic matter plant organisms produce per unit area expressed in plant weight [14]. The measurement of corn plant biomass is intended to determine the growth stages of corn plants. Several things must be considered to produce good biomass growth, such as plant spacing. Plant spacing is closely related to the production of a plant. Planting with the proper spacing can ensure that plants get the same amount of nutrients and sunlight as needed [5].

Plant population can be influenced by plant spacing. Increasing the plant population will increase yield, but if the population continues to increase, the yield of corn will decrease. Thus, an ideal population with the right spacing is needed to achieve the best results [5]. It was found that the best plant spacing specification of 70 x 40 cm will reduce the competition of corn plants for nutrients, air, and light throughout the day so plants can maximize their production and growth [10].

The estimation of biomass growth in corn plants can be done by using modern technology, such as remote sensing, which can be used to observe plant conditions and predict plant production. The technology is very useful for agricultural production management [3]. Remote sensing utilizes the electromagnetic spectrum, from the visible spectrum (450 – 750 nm) to the near and mid-infrared spectrum (850 – 1,700 nm) [16].

The vegetation index is the value of the amount of green vegetation that can be obtained by processing signal data from the digital brightness values of various satellite sensor data channels [3]. Several types or methods of vegetation indices have different levels of accuracy in determining the density of vegetation. The Normalized Difference Vegetation Index (NDVI) is one of the most widely used indices. NDVI is sensitive to green vegetation, even in areas with low vegetation cover [16]. In addition to NDVI, the EVI (Enhanced Vegetation Index) vegetation index, a refinement of the NDVI vegetation index, has better sensitivity to images of the greenest areas (dense and lush). The EVI vegetation index can reduce the effects of atmospheric disturbances and can increase biomass sensitivity [3].

Choosing the right data source is key to understanding environmental dynamics. Using satellite imagery can be an essential tool for researchers to understand this. The sentinel-2 satellite stands out as one of the most desirable platforms among the various satellite options. This is due to some of its superior features, such as its medium spatial resolution (up to 10 meters), which impacts the level of detail of the data and, consequently, the accuracy of the information in the imagery. In addition, sentinel-2 provides free and open data, so in many studies, sentinel-2 is chosen because of these advantages [3].

Research related to using sentinel imagery to predict biomass values has been conducted previously by Marshall et al [6]. The study predicted the biomass value of corn, rice, soybean, and wheat using PRISMA and sentinel-2. It used biomass modeling with Two-band hyperspectral narrowband vegetation indices (TBVI), Partial least squares regression (PLSR), and Random forest (RF). The results showed that PRISMA and Sentinel-2 images are promising data sources for predicting crop yield and biomass. RF obtained better prediction accuracy than TBVI and PLSR for all crops. Compared to Sentinel-2, PRISMA slightly underperformed for crop yield due to data anomalies in the NIR. Based on the description above, this study was conducted to determine the effect of plant spacing on biomass growth of corn plants with sentinel-2 images to determine the relationship between sentinel-2 image vegetation index and corn plant growth parameters at a spacing of 70 x 40 cm, 70 x 20 cm and irregular.

## 2. MATERIALS AND METHODS

### 2.1 Study Area

This research was conducted from December 2022 - March 2023 at corn fields at Masale Village, Tompobulu District, Maros Regency, South Sulawesi Province. The planted corn was fed corn variety of Hybrid NK7328 SUMO. Three plant spacings were observed, i.e., plant spacings of 70 x 20 cm, 70 x 40 cm, and irregular. One plot of 2 x 2 m was observed at each plant spacing.

### 2.2 Tools and Material

Tools used in this research were meters, rulers, digital scales, mobile phone cameras, and laptops containing QGIS and ArcGIS software. In addition, this research employed primary data from field surveys and secondary data from Sentinel-2 image and shapefile (shp) of Maros Regency.

### 2.3 Field Data Collection

Field data collection was conducted every 10 days at the time the Sentinel-2 satellite passed the cornfield.

a. Plant Height

Plant height was measured from the stem's lowest part to the corn flower's tip.

b. Biomass

Both above-ground and below-ground biomass were measured in this study. The above-ground biomass was in the form of stems and leaves, and the below-ground biomass was in the form of roots. Biomass was collected from four plants in each plot of the three plant spacings. The wet biomass was weighed and then dried to obtain the dry weight.

c. Leaf Area Index (LAI)

LAI measurement was done by counting the number of leaves per stem and then measuring the leaf area by multiplying the length and width of the leaves. The LAI was calculated by using the following equation.

$$\text{LAI} = \frac{Total\ Leaf\ Arean}{Total\ Area} \quad (1)$$

**2.4 Sentinel Data Processing**

Sentinel-2 image data was downloaded from https://scihub.copernicus.eu/. Eight images were downloaded, but only four could be used because clouds covered the images. Atmospheric correction was carried out using a semi-automatic classification plugin in QGIS software. This correction aimed to reduce errors in image data due to atmospheric factors.

Vegetation Index transformation of NDVI (Normalized Difference Vegetation Index) and EVI (Enhanced Vegetation Index) was carried out using Equations 2 [2] and 3 [12] in the raster calculator of QGIS software. The classification of NDVI and EVI values can be seen in Table 1.

$$NDVI = \frac{(NIR - Red)}{(NIR + Red)} \tag{2}$$

$$EVI = \frac{2{,}5 \times (NIR - Red)}{(NIR + 6 \times Red - 7{,}5 \times Blue + 1)} \tag{3}$$

Table 1. Classification of NDVI and EVI Indices [8]

| No | Index Value | Classification |
|---|---|---|
| 1 | -1 s/d -0.03 | Land without vegetation |
| 2 | -0.03 s/d 0.15 | Very low greenness |
| 3 | 0.15 s/d 0.25 | Low greenness |
| 4 | 0.25 s/d 0.35 | Medium Greenness |
| 5 | 0.35 s/d 1.00 | High Greenness |

**2.5 Regression Analysis**

Linear regression analysis was used to observe the linear model of NDVI and EVI with growth parameters of corn plants. The relationship between the dependent variable of growth parameters of corn plants and the independent variable of the vegetation index values was measured using the Coefficient of determination ($R^2$). The value of $R^2$ was categorized into three groups, namely strong, moderate, and weak, with an R2 of 0.75, 0,50, and 0,25, respectively. Regression analysis is calculated using the following equation [4]: a is constant, b is the regression coefficient, y is the dependent variable, and x is the independent variable.

$$y = a + bx \tag{4}$$

**3. Results and Discussion**

**3.1 Plant Height**

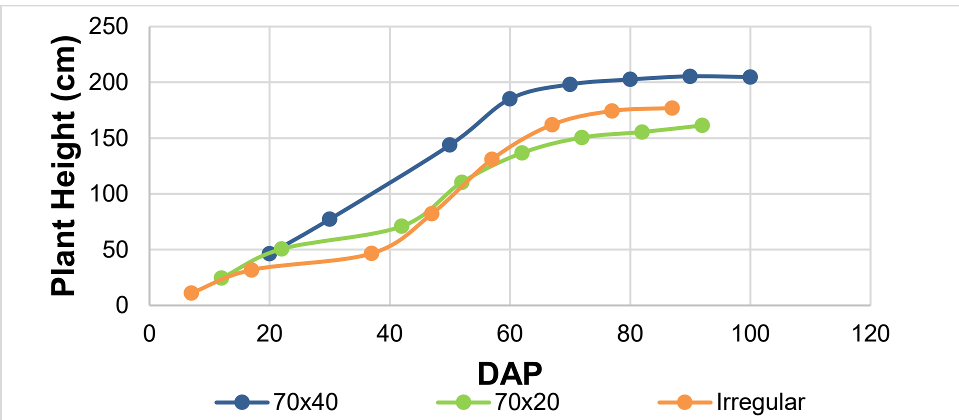


Figure 1. Corn Plant Height

It can be seen from Figure 1 that as corn plants grow, the plant height increased, especially during the vegetative period, i.e., 17 to 57 Days After Planting (DAP). Comparing all plant spacings, 70 × 40 cm experienced the highest plant height, i.e., 204.73 cm. Plant spacing 70 × 20 cm hd lower height due to the presence of weeds, which inhibit the growth of corn plants. In this case, weeds will compete with the corn plants in absorbing nutrients, water, and sunlight. In addition, competition between corn plants themselves at a tight spacing, such as a spacing of 70 x 20 cm, can also inhibit the growth of corn plants. Plant spacings determine plant population. The addition of plant population will increase yield. Still, if the population continues to increase, the yield of corn will decrease, so an optimal population with the right spacing is needed to achieve maximum yield [5].

**3.2 Biomass**

3.2.1 Plant Wet Biomass

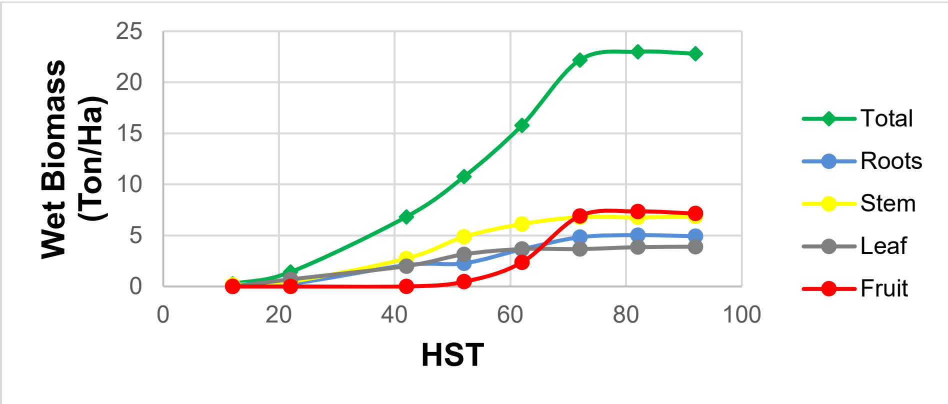


Figure 2. Graph of Wet Weight of Plants with a Plant spacing of 70 x 20 cm.

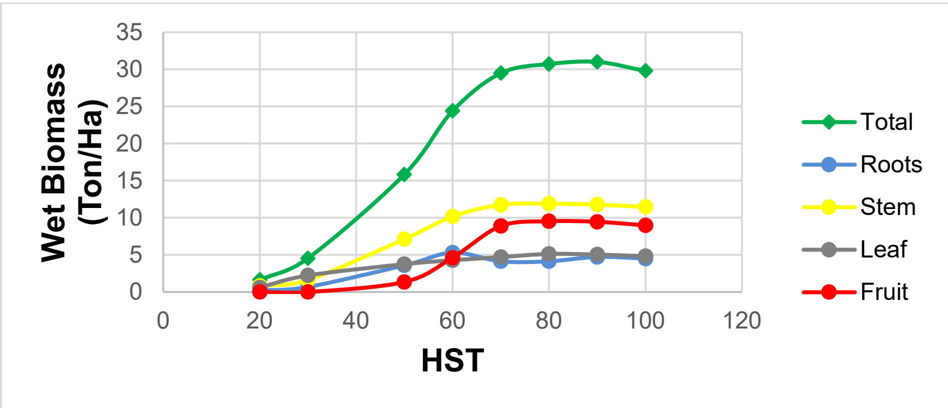


Figure 3. Graph of Wet Weight of Plants Plant spacing 70 x 40 cm.

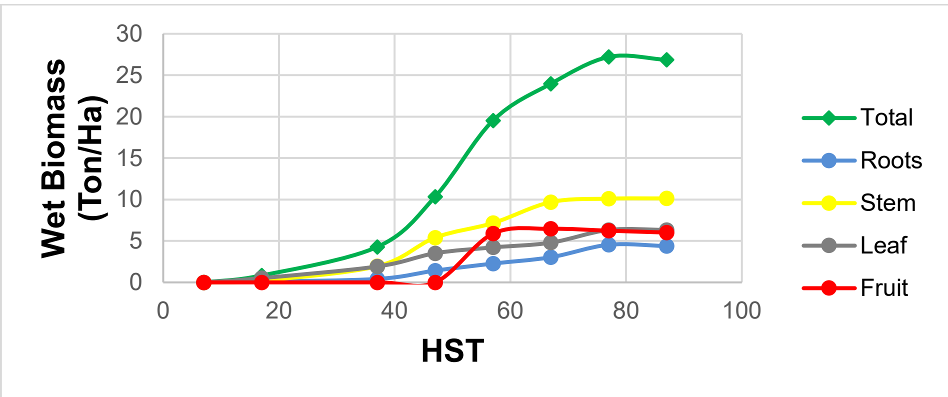


Figure 4. Graph of Wet Weight of Irregular Plant spacing Plants.

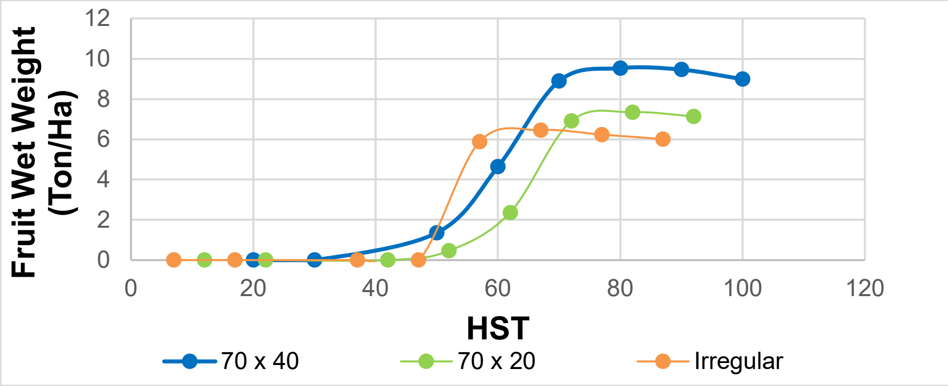


Figure 5. Graph of Fruit Wet Weight.

In Figures 2, 3 and 4, the growth of corn plants will continue to increase slowly in the early planting phase. It can be seen that the wet weight of the roots, stems and leaves of the corn plant slowly experiences growth which peaks at 40 HST to 77 HST where biomass growth is greatly increased. The new corn plant fruits will appear at 50 HST and will continue to increase until 80 HST. This is because in that phase the fruit will continue to gain weight in accordance with the adequacy of nutrients and water obtained by corn plants. Of the three plant spacing, the 70 x 40 cm spacing has a higher wet weight of 29.79 tons/ha compared to the 70 x 20 cm spacing with a weight of 22.80 tons/ha and the irregular spacing of 26.86 tons/ha because the density level is less so that plants can absorb water and nutrients well. This is in accordance with the statement of [15], which states that plant spacing can determine population density which affects the level of competition between plants related to the provision of nutrients for growth. In addition, according to [10], the best plant spacing specification is 70 x 40 cm which will reduce plant competition for nutrients, air and light so that plants can maximize production and growth.

3.2.1 Plant dry biomass

The following is the dry weight of corn plants at the three plant spacings.

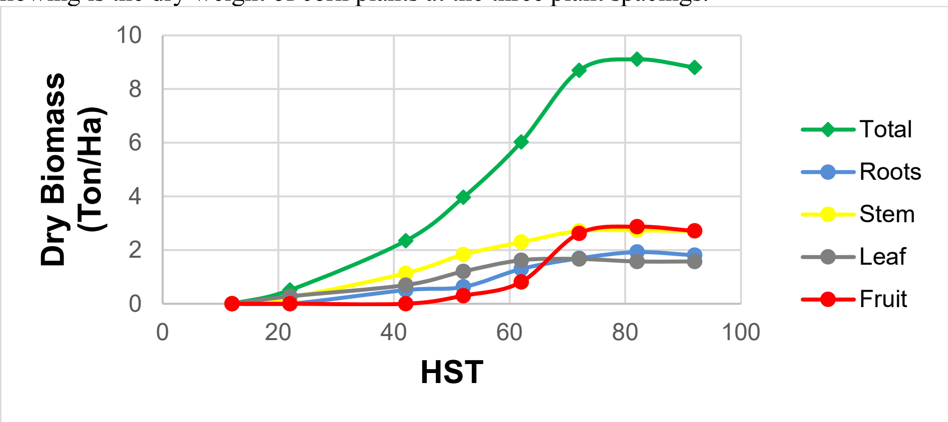


Figure 6. Graph of Dry Weight of 70 x 20 cm Plant spacing Plants.

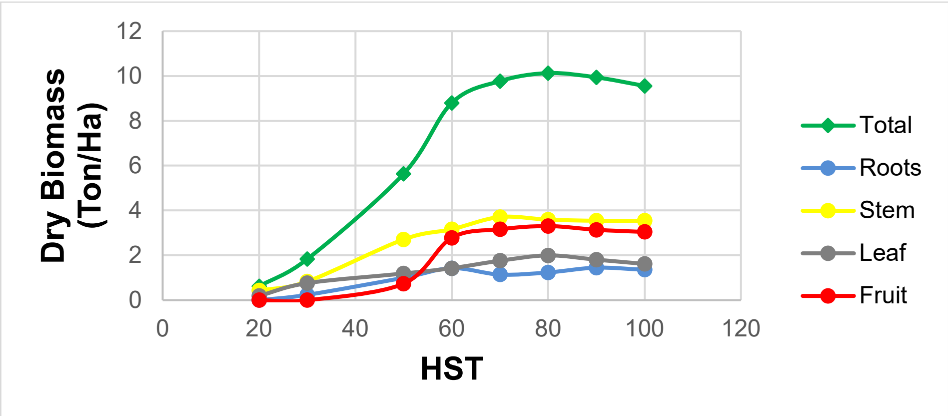


Figure 7. Graph of Dry Weight of 70 x 40 cm Plant spacing Plants.

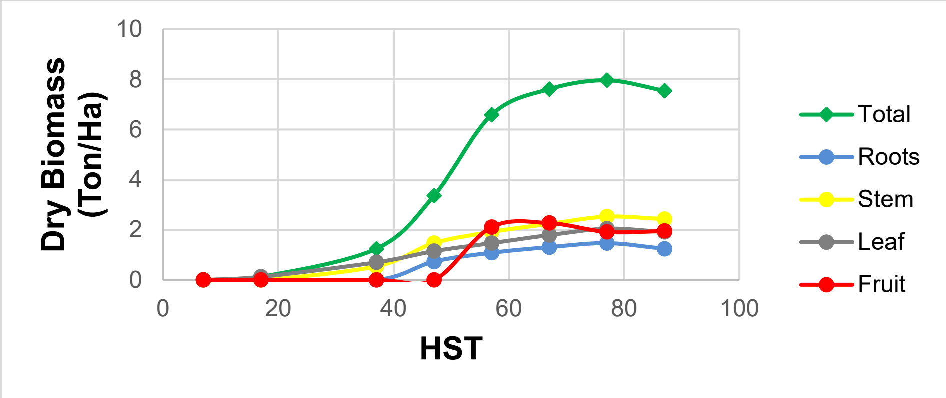


Figure 8. Graph of Dry Weight of Irregular Plant spacing Plants.

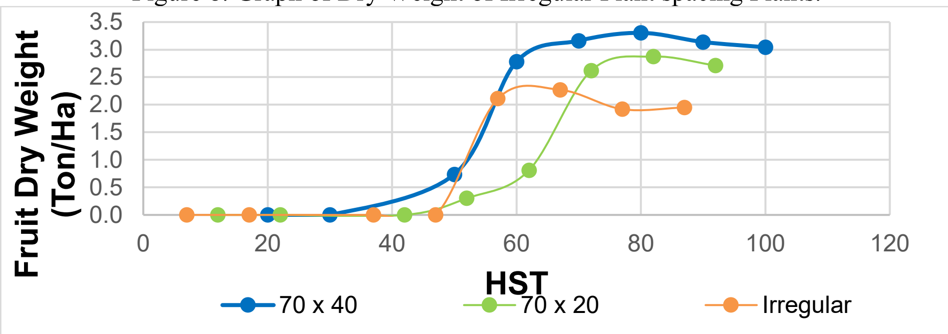


Figure 9. Graph of Fruit Dry Weight.

Figures 6, 7 and 8 show the dry weight of corn plants. Based on the graph above, it is known that the plant spacing that produces the highest dry weight is the 70 x 40 cm plant spacing with a dry weight of 9.56 tons/ha compared to the 70 x 20 cm plant spacing and irregular plant spacing. Because the tighter the spacing and the higher the population, the lower the dry weight of the plants.

Based on the graph of wet biomass and dry biomass of corn plants, it can be seen that the wet weight and dry weight of biomass have almost the same pattern for each plant spacing. However, the values are different because of the difference in the amount of water content due to the drying process. Irregular spacing has a different pattern compared to 70 x 20 cm spacing and 70 x 40 cm spacing which have almost the same pattern.

### 3.3 Leaf Area Index (LAI)

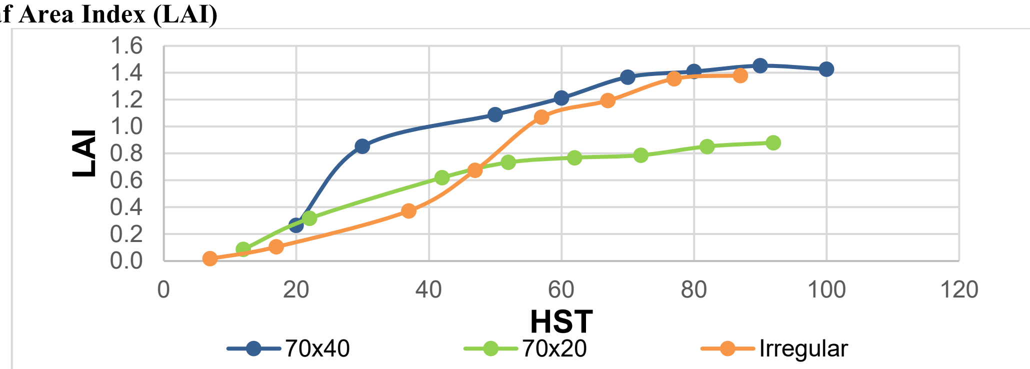


Figure 10. Graph of Leaf Area Index (LAI).

LAI based on the results of field measurements can be seen in Figure 10. It is known that the value of LAI increases with the age of corn plants during growth. It can be seen in the chart that at the time of 20 HST to 77 HST LAI experienced a high increase. The plant spacing of 70 x 40 cm has the highest LAI value of 1.43, then the irregular plant spacing has a LAI value of 1.38 and the plant spacing of 70 x 20 cm has the lowest LAI value of 0.88. This happens because since the beginning of growth, the LAI value at a plant spacing of 70 x 40 cm continues to increase very significantly so that the resulting leaf area is wider which shows a high leaf area index. This is in accordance with the statement of [9], stating that the rate of photosynthesis of plants is determined by the size of the leaf area of the plant. The greater the leaf area, the more optimal sunlight absorbed which will later be used to increase the rate of photosynthesis.

### 3.4 Vegetation Index Processing

Table 2. NDVI Spectral Results

| Date | HST | | | NDVI Sentinel Spectral Value | | |
|---|---|---|---|---|---|---|
| | 70 x 20 cm | 70 x 40 cm | Irregular | Minimum | Maximum | Mean |
| 10/12/2022 | 12 | 20 | 7 | 0.1525 | 0.3247 | 0.2208 |
| 20/12/2022 | 22 | 30 | 17 | 0.0995 | 0.3913 | 0.2263 |
| 14/01/2023 | 47 | 55 | 42 | 0.1294 | 0.3260 | 0.2044 |
| 28/02/2023 | 92 | 100 | 87 | 0.1774 | 0.4012 | 0.2952 |

Normalized Difference Vegetation Index (NDVI) is one method which can be used to determine the greenness of vegetation from data satellites in monitoring plant conditions. NDVI has a sensitive response to green vegetation even for areas with low vegetation cover [16]. Table 2 shows the minimum, maximum and average values in the spectral values of the processing results of the NDVI vegetation index. It can be seen that the image calculation results for the NDVI vegetation index on February 28, 2023 have the highest spectral average value of 0.2952. Thus, it can be seen that the value is included in the medium greenness level based on table 1 [8].

Table 3. EVI Spectral Results

| Date | HST | | | EVI Sentinel Spectral Value | | |
|---|---|---|---|---|---|---|
| | 70 x 20 cm | 70 x 40 cm | Irregular | Minimum | Maximum | Mean |
| 10/12/2022 | 12 | 20 | 7 | 0.2618 | 0.6092 | 0.4001 |
| 20/12/2022 | 22 | 30 | 17 | 0.1980 | 0.7897 | 0.4349 |
| 14/01/2023 | 47 | 55 | 42 | 0.2975 | 0.7691 | 0.4646 |
| 28/02/2023 | 92 | 100 | 87 | 0.3215 | 0.7805 | 0.5374 |

The EVI vegetation index is a refinement of the NDVI vegetation index, where the EVI vegetation index has the ability to reduce the influence of atmospheric disturbances. Table 3 shows the minimum, maximum and average values in the spectral values of EVI vegetation index processing. It can be seen that the calculation of the EVI vegetation index image on February 28, 2023 has the highest average spectral value of 0.5374, thus based on table 1 [8], it can be seen that the value is included in the high greenness category.

The map layout resulting from the transformation of the NDVI and EVI vegetation indices can be seen in Figure 11 and Figure 12 below.

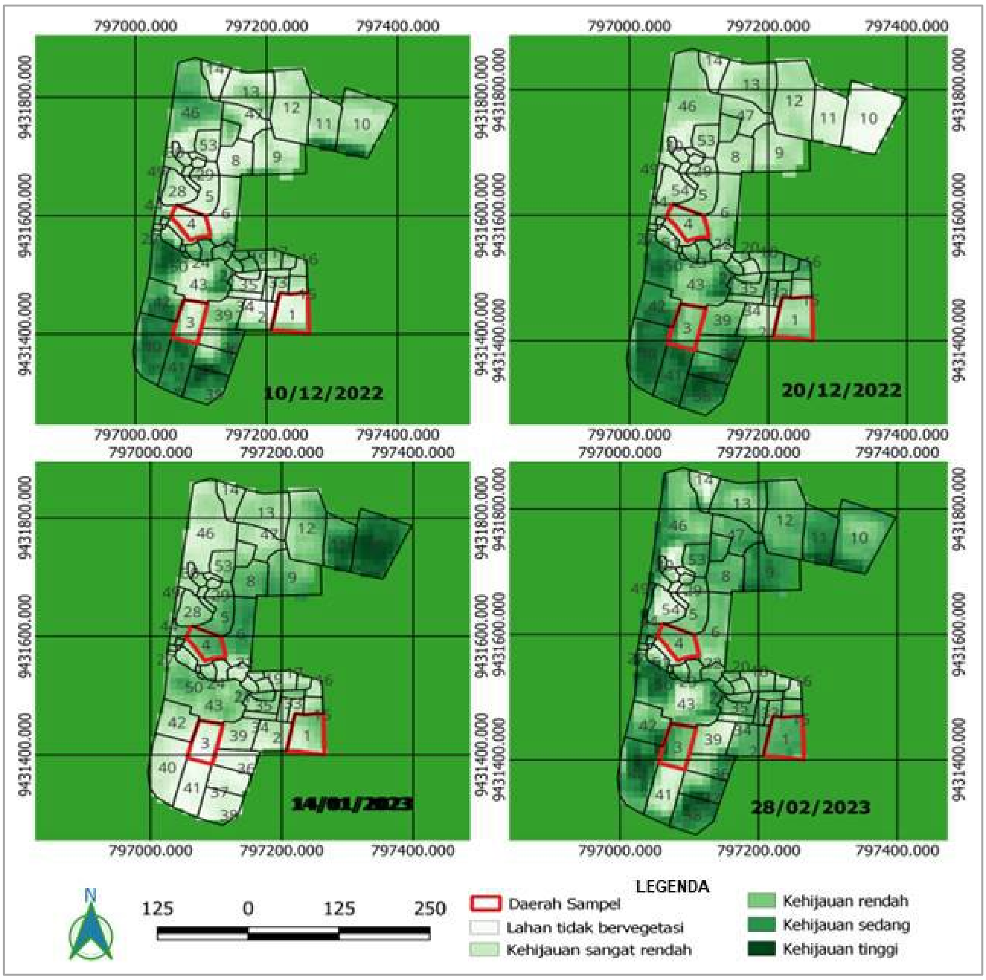


Figure 11. NDVI Vegetation Index Map.

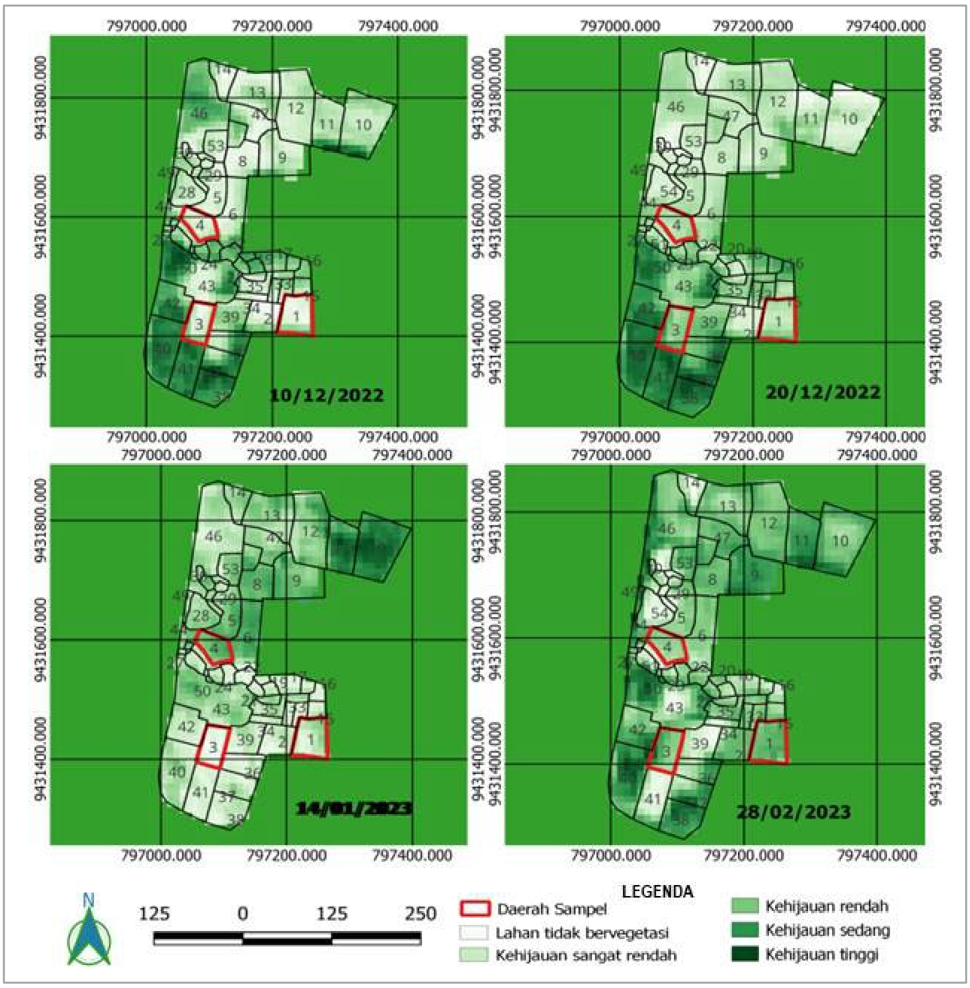

Figure 12. EVI Vegetation Index Map.

Based on the transformation results map of the two indices above, it can be said that January 14, 2023 is the vegetative period of corn plants that have the lowest average spectral value characterized by low color or chlorophyll levels. The low level of chlorophyll shown on the map above is caused by the influence or condition of the atmosphere so that the resulting value can affect or change. This is in accordance with the statement of [3], which states that radiometric errors caused by atmospheric distortions, especially dust particles, water vapor, and triatomic gases make pixel values in the image inaccurate. Furthermore, based on table 1 [8], the map of the transformation of the NDVI vegetation index is included in the medium greenish category while the map of the transformation of the EVI vegetation index is included in the high greenness category.

### 3.5 Relationship of Vegetation Index with HST

3.5.1 Relationship of NDVI Vegetation Index with HST

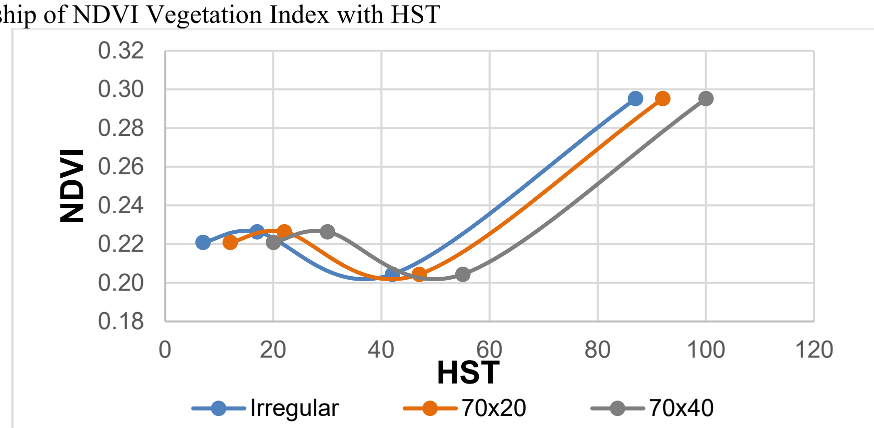

Figure 13. Relationship of NDVI Vegetation Index with HST.

Figure 13 shows the pattern of changes in vegetation index at all three plant spacings. It can be seen on the graph that the vegetation index increased at 17 HST, but at the time of entering 42 HST the vegetation index decreased then the vegetation index value again experienced a considerable increase when plants entered the age of 87 HST. The decrease in vegetation index value at 42 HST was influenced by atmospheric conditions and changes that occurred at the study site.

3.5.2 Relationship of EVI Vegetation Index with HST

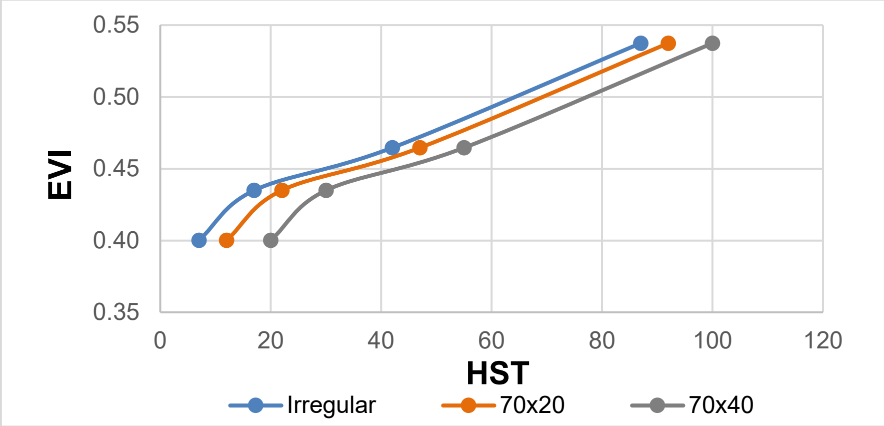


Figure 14. Relationship of EVI Vegetation Index with HST.

In Figure 14 above, we can see the pattern of changes in the EVI vegetation index at the three plant spacings. It can be seen in the graph that the EVI vegetation index has a different pattern from changes in the NDVI vegetation index, where the EVI vegetation index increases with the age of corn plants with an index value of 0.5374.

**3.6 Relationship of Vegetation Index with Plant Height**

3.6.1 Relationship of NDVI Vegetation Index with Plant Height

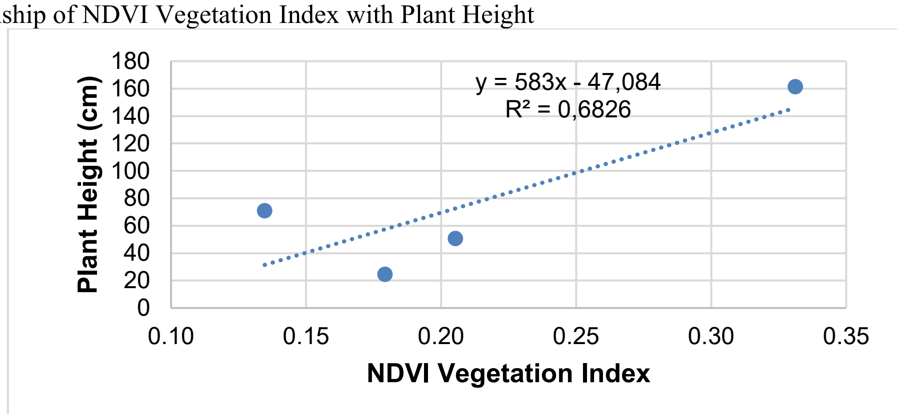


Figure 15. Relationship of NDVI Vegetation Index with Corn Plant Height (Plant spacing 70 x 20 cm).

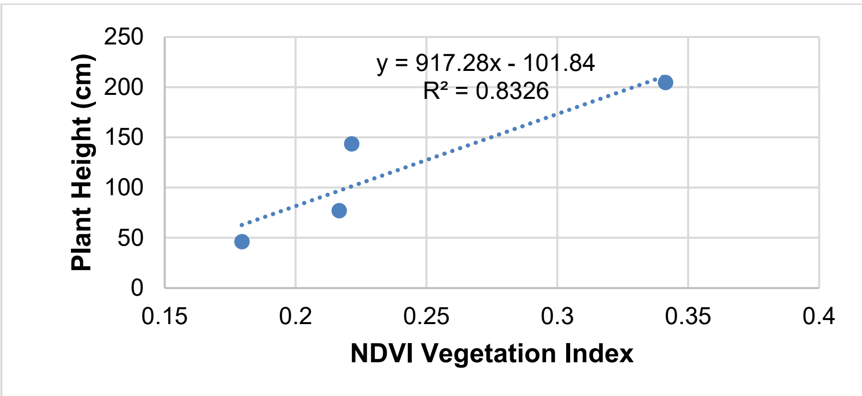


Figure 16. Relationship of NDVI Vegetation Index with Corn Plant Height (Plant spacing 70 x 40 cm).

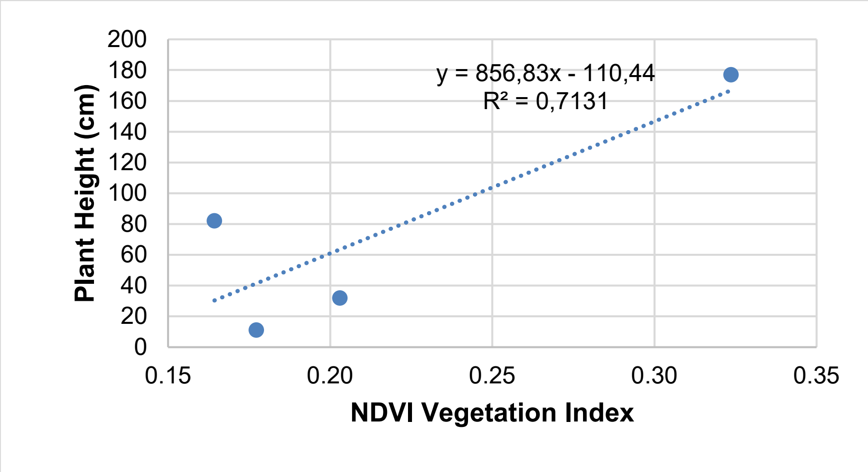

Figure 17. Relationship of NDVI Vegetation Index with Corn Plant Height (Irregular Plant Spacing).

Figures 15, 16 and 17 are the results of calculating the NDVI value with the height of the corn plant. Figure 15 yields the equation y = 583x – 47.084 where from this equation yields R2 = 0.6826. Based on the R2 value obtained, it can be seen that the resulting value is included in the moderate category. Furthermore, you can see figure 16, the resulting equation y = 917.28x – 101.84 where from this equation produces R2 = 0.8326 which means that the resulting R2 value is included in the strong category. Then figure 17 at irregular plant spacings produces the equation y = 856.83x – 110.44 where from this equation obtained R2 = 0.7131 which means that the resulting R2 value is included in the moderate category according to the statement [4].

3.6.2 Relationship of EVI Vegetation Index with Plant Height

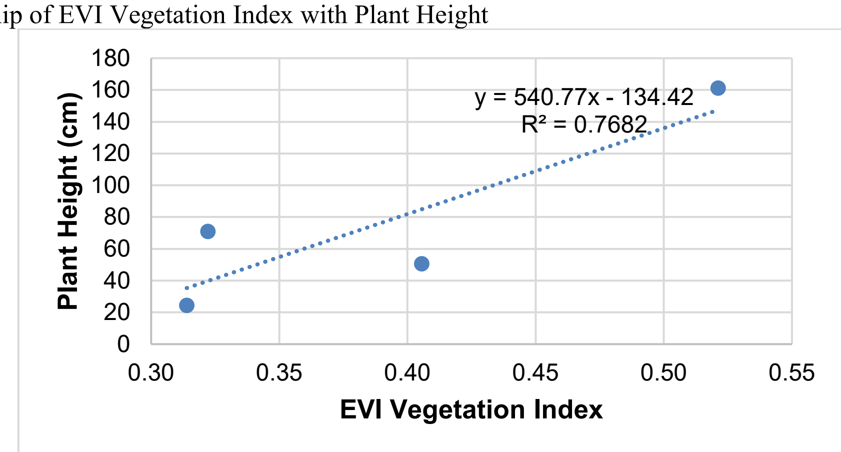

Figure 18. Relationship of EVI Vegetation Index with Corn Plant Height (Plant Spacing 70 x 20 cm).

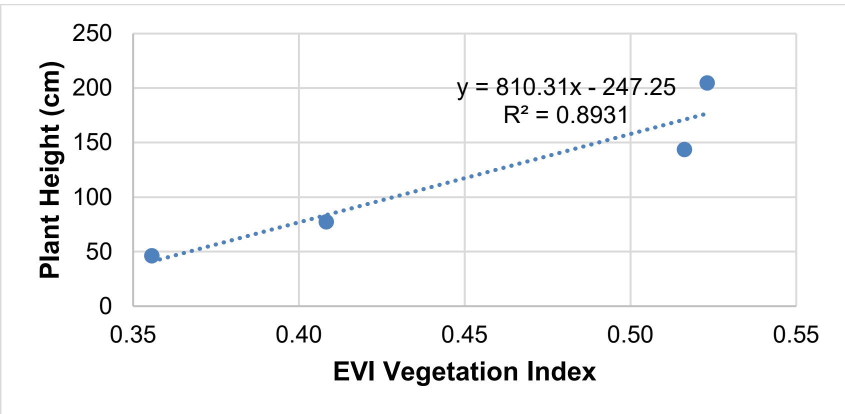

Figure 19. Relationship of EVI Vegetation Index with Corn Plant Height (Plant spacing 70 x 40 cm).

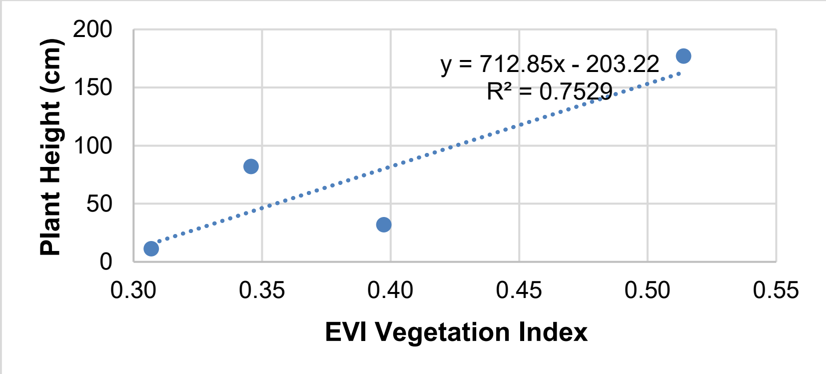


Figure 20. Relationship of EVI Vegetation Index with Corn Plant Height (Irregular Plant Spacing).

Based on the data from the calculation of the EVI value with the height of corn plants in figure 18 produces the equation y = 540.77x – 134.42 where from this equation yields R2 = 0.7682. Based on R2 value What is obtained can then be seen that the resulting value is included in the strong category. Then in figure 19 produces the equation y = 810.31x – 247.25 where from this equation yields R2 = 0.8931 which means that the resulting R2 value is included in the strong category. Based on figure 20 which is also the result of calculating the EVI value with plant height at irregular plant spacings resulting in the equation y = 712.85x – 203.22 where from this equation obtained R2 = 0.7529 which means that the resulting R2 value is included in the strong category according to the statement of [4].

Based on the results of regression of NDVI and EVI indices with plant height, a plant spacing of 70 x 40 cm is a plant spacing that has the best relationship between index value and plant height compared to irregular plant spacing and plant spacing of 70 x 20 cm.

### 3.7 Relationship of Vegetation Index with Corn Plant Biomass

3.7.1 Relationship of NDVI Vegetation Index with Biomass

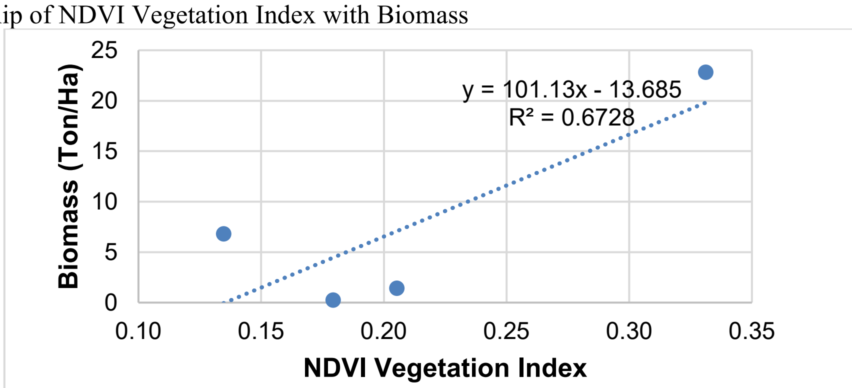


Figure 21. Relationship of NDVI Vegetation Index with Corn Plant Biomass (Plant spacing 70 x 20 cm).

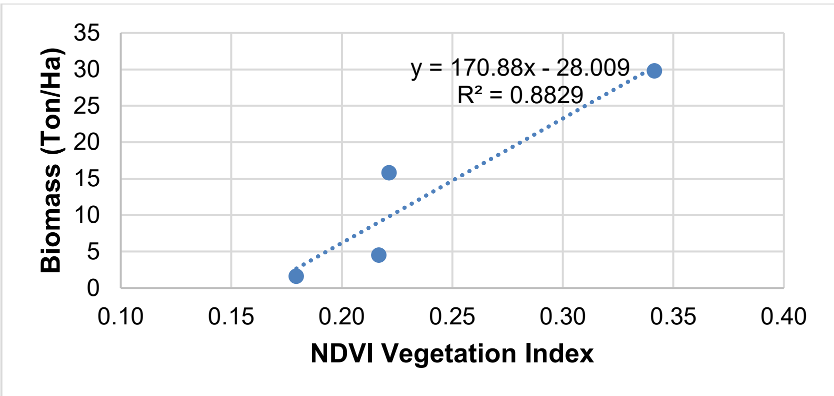


Figure 22. Relationship of NDVI Vegetation Index with Corn Plant Biomass (Plant spacing 70 x 40 cm).

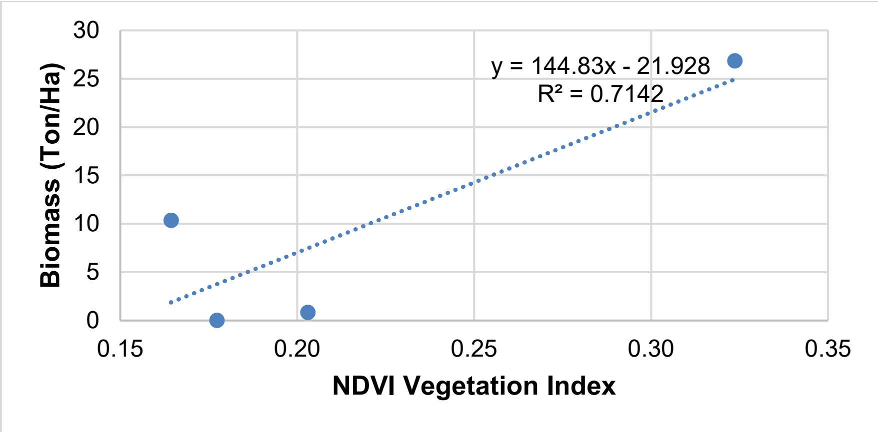

Figure 23. Relationship of NDVI Vegetation Index with Corn Plant Biomass (Irregular Plant Spacing).

The data from the calculation of NDVI values with corn biomass in Figure 21 produces the equation y = 101.13x – 13.685 where from this equation produces R2 = 0.6728. Based on the R2 value obtained, it can be seen that the resulting value is included in the moderate category. Then in figure 22 produces the equation y = 170.88x – 28.009 where from this equation produces R2 = 0.8829 which means that the resulting R2 value is included in the strong category. Based on figure 23 which is also the result of calculating the NDVI value with biomass at irregular plant spacings resulting in the equation y = 144.83x – 21.928 where from this equation obtained R2 = 0.7142 which means that the resulting R2 value is included in the moderate category according to the statement of [4].

3.7.2 Relationship of EVI Vegetation Index with Biomass

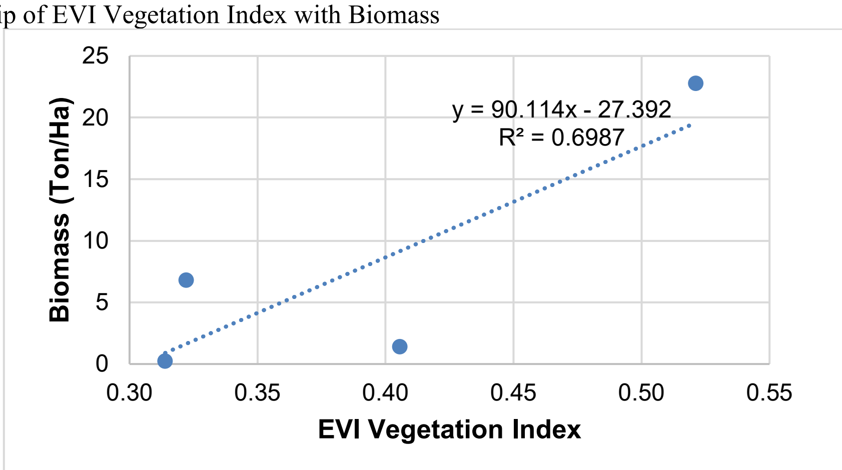

Figure 24. Relationship of EVI Vegetation Index with Maize Plant Biomass (Plant spacing 70 x 20 cm).

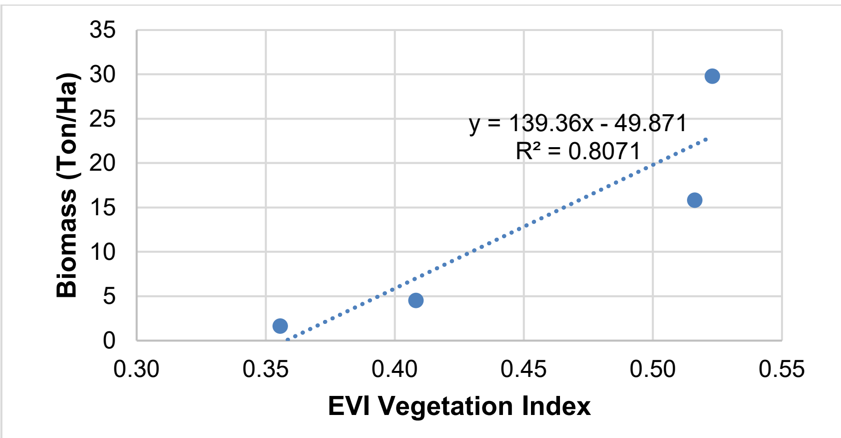

Figure 25. Relationship of EVI Vegetation Index with Maize Plant Biomass (Plant spacing 70 x 40 cm).

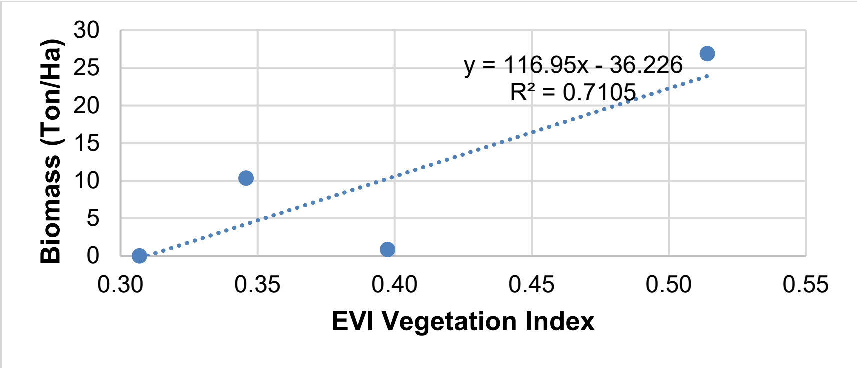


Figure 26. Relationship of EVI Vegetation Index with Maize Plant Biomass (Irregular Plant Spacing).

Based on the data from the calculation of the EVI value with corn biomass in figure 24 produces the equation y = 90.114x – 27.392 where from this equation it produces R2 = 0.6987. Based on the R2 value obtained, it can be seen that the resulting value is included in the moderate category. Then in figure 25 produces the equation y = 139.36x – 49.871 where from this equation produces R2 = 0.8071 which means that the resulting R2 value is included in the strong category. Based on figure 26 which is also the result of calculating the EVI value with biomass at irregular plant spacings resulting in the equation y = 116.95x – 36.226 where from this equation obtained R2 = 0.7105 which means that the resulting R2 value is included in the moderate category according to the statement of [4].

Based on the regression results of NDVI and EVI index values with corn plant biomass, a plant spacing of 70 x 40 cm is a plant spacing that has the best relationship between index value and biomass compared to irregular plant spacing and plant spacing of 70 x 20 cm.

### 3.8 Relationship of Vegetation Index with LAI

3.8.1 Relationship of NDVI Vegetation Index with LAI

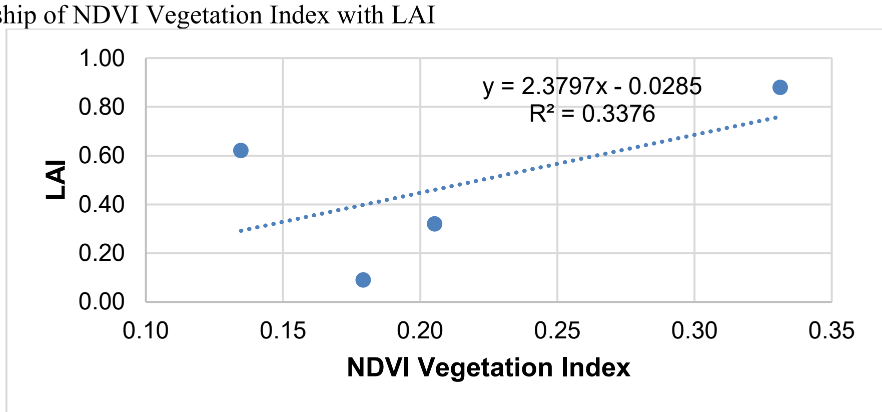


Figure 27. Relationship of NDVI Vegetation Index with LAI (Plant Spacing 70 x 20 cm).

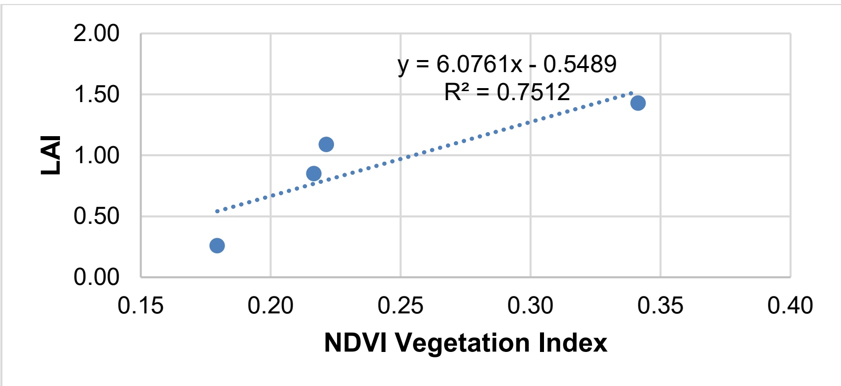


Figure 28. Relationship of NDVI Vegetation Index with LAI (Plant spacing 70 x 40 cm).

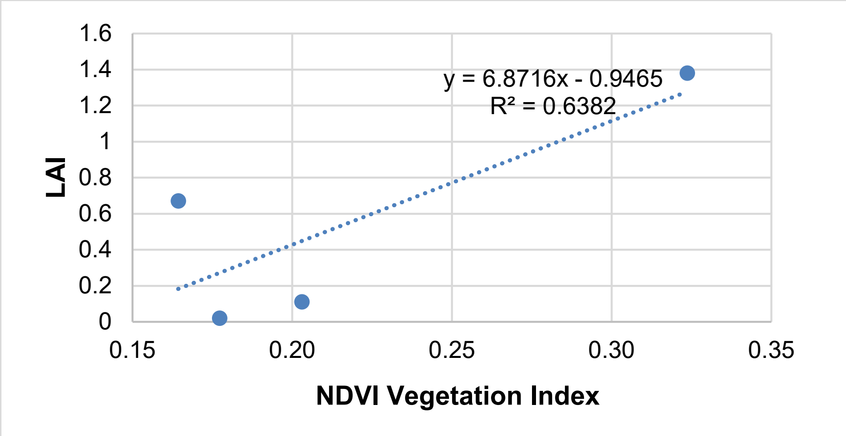


Figure 29. Relationship of NDVI Vegetation Index with LAI
(Irregular plant spacing).

Based on the data from the calculation of the NDVI value with LAI in figure 27 produces the equation y = 2.3797x – 0.0285 where from this equation produces R2 = 0.3376. Based on the R2 value obtained, it can be seen that the resulting value is included in the moderate category. Then in figure 28 produces the equation y = 6.0761x – 0.5489 where from this equation produces R2 = 0.7512 which means that the resulting R2 value is included in the strong category. Based on figure 29 which is also the result of calculating the NDVI value with LAI at irregular plant spacings resulting in the equation y = 6.8716x – 0.9465 where from this equation obtained R2 = 0.6382 which means that the resulting R2 value is included in the moderate category according to the statement of [4].

3.8.2 Relationship of EVI Vegetation Index with LAI

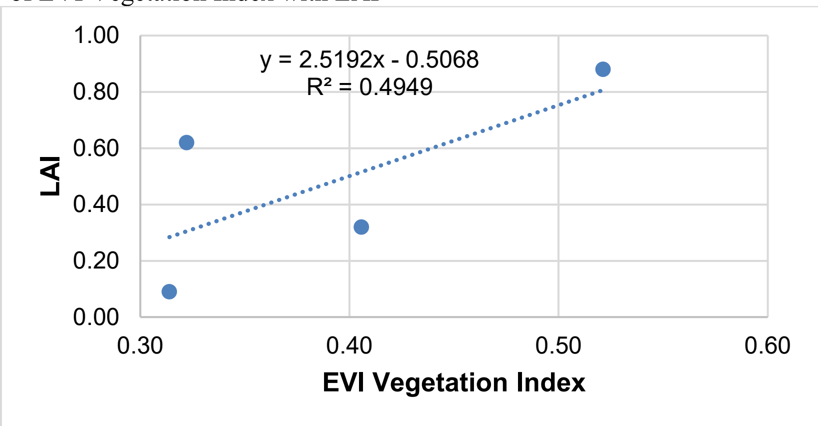


Figure 30. Relationship of EVI Vegetation Index with LAI
(Plant Spacing 70 x 20 cm).

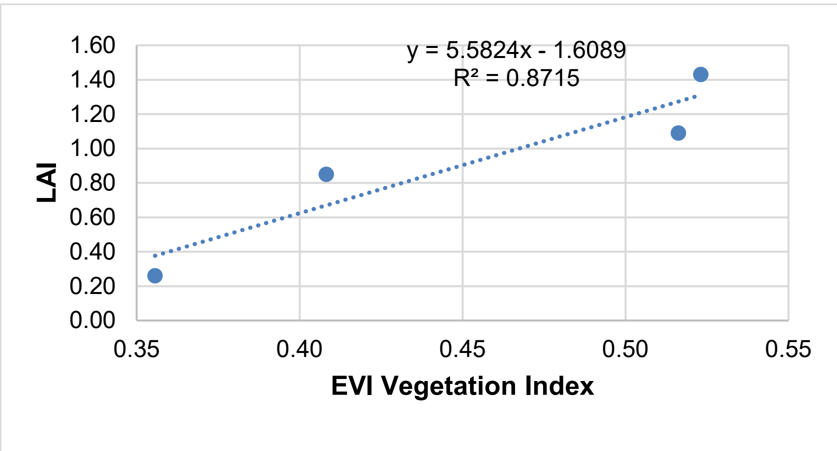


Figure 31. Relationship of EVI Vegetation Index with LAI
(Plant spacing 70 x 40 cm).

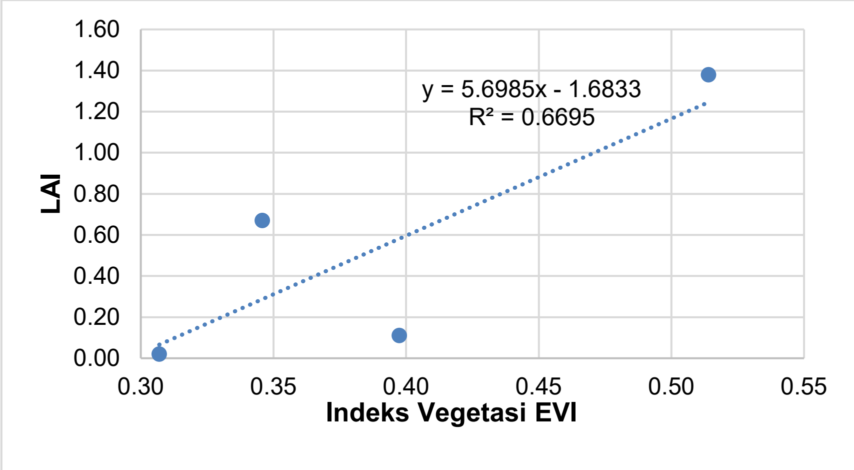


Figure 32. Relationship of EVI Vegetation Index with LAI
(Irregular plant spacing).

Based on the data from the calculation of the EVI value with LAI in figure 30 produces the equation y = 2.5192x – 0.5068 where from this equation produces R2 = 0.4949. Based on the R2 value obtained, it can be seen that the resulting value is included in the moderate category. Then in figure 31 produces the equation y = 5.5824x – 1.6089 where from this equation produces R2 = 0.8715 which means that the resulting R2 value is included in the strong category. Based on figure 32 which is also the result of calculating the EVI value with LAI at irregular plant spacings resulting in the equation y = 5.6985x – 1.6833 where from this equation obtained R2 = 0.6695 which means that the resulting R2 value is included in the moderate category according to the statement of [4].

Based on the regression results of NDVI and EVI index values with LAI, a plant spacing of 70 x 40 cm is a plant spacing that has the best relationship between index and LAI values compared to irregular plant spacings and plant spacings of 70 x 20 cm.

## 3. CONCLUSION

Based on research on the Use of Sentinel-2 Image Vegetation Index for Analysis of Maize Plant Biomass Growth at Various Plant spacing, it can be concluded that:

1. Based on the results of the analysis, the NDVI and EVI vegetation indices have a strong relationship with maize plant growth parameters at a plant spacing of 70 x 40 cm, compared to a plant spacing of 70 x 20 cm and irregular plant spacings that are still in the moderate category.
2. Maize plant growth parameters (plant height, biomass and leaf area) can be monitored using sentinel-2 satellite imagery.

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