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The Plant Growth Analysis of Cucumis Sativus L. Affected by Various Types of Organic Matter

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Abstract

Organic matter can be used to increase the growth and metabolism activities of Cucumis sativus L. Plant growth analysis is a simple method that can be used to determine physiological activities that support plant growth. The study aims to describe plant activities through plant growth analysis which is influenced by the use of organic matter. The research was conducted at the Experimental Garden, Faculty of Agriculture, Universitas Perjuangan Tasikmalaya. The study used a Completely Randomized Design - single factor (types of organic matters) i.e.control, rice straw compost, rice husk, leaf green compost, and cow manure. Four replications were used in this study. Based on our study, the application of organic matter significantly affects LAI 2 WAP, LAI 4 WAP, WC 2 WAP, WC 4 WAP, NAR, PGR, and HI.Cow manure, green leaf compost, and rice straw compost can increase LAI, while rice husk, rice straw, and green cow manure can increase WC. Furthermore, the application of rice husk and cow manure was able to increase in NAR, CGR, and HI. The increase NAR, CGR, and HI in this study was positively correlated with r= 0.622 and r= 0.284.

Keywords: Agronomic, horticulture, organic materials, plant growth.

1. Introduction

The use of organic matter in agricultural activities is a step in achieving sustainable agriculture (Giri and Pokhrel, 2022). The use of organic matter can improve soil properties which will increase plant growth and yield. On the other hand, the current decline in land quality requires improvements so that land resources can be used in the future (Gurmu, 2019). The impact of the continuous use of inorganic fertilizers is one of the causes of soil quality degradation. For example, a study by Sofyan and Sara (2018) stated that the use of inorganic fertilizers in the long term causes a decrease in soil quality so it is not sustainable. Therefore, the use of organic matter supplied to the soil can be a strategy for improving soil quality.

The use of organic matter is also one of the efforts that can be made to reduce production costs (Mekonen, 2023). As we know in the agronomy sector, the use of low costs is one of the goals (Biswas and Das, 2022). Therefore, the use of abundant organic matter will be a solution to reduce production costs while also being able to support improvement in plant growth and production.

Cucumis sativus L. is a horticultural plant that requires sufficient amounts of nutrients to support its growth and production (Rahman, Nasrudin and Saleh, 2022). On the other hand, soil quality will greatly influence the growth of plant organs, especially roots (Fageria and Moreira, 2011). Li *et al*., (2022) stated that the use of organic matter in the form of cow manure at the optimal dose was able to improve the root growth of cucumber plants due to the availability of nutrients and supportive physical properties. Furthermore, the use of various types of organic fertilizers such as rice straw, rice husk, and green manure can improve the physical, chemical, and biological properties of the soil (Mutammimah, Minardi and Suntoro, 2020). These conditions will be beneficial for plants because they can absorb the nutrients provided by the soil even though the amounts are low. Improvements in soil physical properties due to the use of organic matter provide opportunities for root growth optimally (Forster *et al*., 2020). This will have an impact on more efficient absorption of nutrients which will be distributed to other plant organs (Cochavi, Cohen and Rachmilevitch, 2020). According to the study of Fetus (2023) showed that the application of cow manure with the dose of 15 tonnes ha^{-1} can increase the leaf area, number of leaves, stem thickness, number of fruits, and fruit weight. The application of chicken manure to cucumber plants also influences the plant height, number of leaves, and fruit weight per plants (Aritonang, Panjaitan and Tondang, 2018).

Based on this information, it is known that the use of organic matter in agricultural activities is very important. This will improve the soil's physical, chemical, and biological properties which can support plant growth and development. On the other hand, the use of organic matter can be used as a strategy for achieving sustainable agriculture. The study aims to describe agricultural activities through plant growth analysis which is influenced by the use of organic matter.

2. Materials and Methods

The study was conducted in the Experimental Garden, Faculty of Agriculture, Universitas Perjuangan Tasikmalaya from February until May 2023. The pot method used in this study with Completely Randomized Design - single factor i.e. control, rice straw compost, rice husk, green leaf compost, and cow manure. The treatment was repeated four times.

Bandana F1 variety seeds were sown in trays using soil and organic fertilizer in a ratio of 1:1 (w/w) for 14 days. Planting media in the form of soil and organic matter (according to treatment) was prepared in a polybag measuring 40 cm x 50 cm. The dose of organic matter given is 600 g $polybag^{-1}$ and the capacity of each polybag is 5 kg. Transplanting was done in the morning and the planting media was moist using additional water. Each polybag was planted with one cucumber seed.

Plant maintenance includes controlling pests and diseases using synthetic pesticides, weeding, and watering. Weeding is done manually, while watering is done everyday to maintain water availability for the plants. The harvest was conducted after the plants had signs of yellowing of old leaves, the cucumber fruit has fine lines with a green color and is 30 - 35 days after planting (DAP).

The parameters observed include leaf area index (LAI), water content (WC) (%), net assimilation rate (NAR) (g dm^{-2} $week^{-1}$), crop growth rate (CGR) (g m^{-2} $week^{-1}$), and harvest index (HI). LAI and water content were conducted when the plants were 2 and 4 weeks after planting (WAP) using equation 1 and equation 2, respectively.

$$LAI = \frac{1}{land\ area} \times \text{leaf area} \qquad \text{(equation 1)}$$

$$WC = \frac{(CFW - CDW)}{CFW} \times 100\% \qquad \text{(equation 2)}$$

Notes: crop fresh weight (CFW), crop dry weight (CDW)

NAR and CGR used the data of crop dry weight, leaf area, and land area, while HI used the data of crop dry weight and fruit dry weight. NAR, CGR, and HI were calculated using equation 3, equation 4, and equation 5, respectively.

$$NAR = \frac{(W2 - W1)}{T2 - T1} \times \frac{(Ln\ La2 - Ln\ La1)}{La2 - La1} \qquad \text{(equation 3)}$$

$$CGR = \frac{1}{land\ area} \times \frac{(W2 - W1)}{T2 - T1} \qquad \text{(equation 4)}$$

$$HI = \frac{fruit\ dry\ weight}{crop\ dry\ weight} \qquad \text{(equation 5)}$$

Notes: Ln (logarithm neutral); W2 (crop dry weight in 4 WAP), W1 (crop dry weight in 2 WAP), T2 (observation time in 4 WAP), T1 (observation time in 2 WAP), La 2 (leaf area in 4 WAP), and La 1 (leaf area in 2 WAP).

All the data were analyzed using the F-test followed by the Least Significant Different (LSD) test with $\alpha = 5\%$. Pearson correlation is used to determine

the relationship between parameters. All analyzes were carried out using the softwere Statistical Tools for Agricultural Research version 2.0.1.

3. Results and Discussion

Plant growth analysis is a concept that can be used to estimate physiological activities related to plant growth and development. Table 1 shows that the use of organic matter has a significant effect on LAI 2 WAP, LAI 4 WAP, WC 2 WAP, and WC 4 WAP. At 2 WAP, cow manure treatment produced the highest LAI, while rice straw compost and green leaf compost produced the lowest LAI. However, when the plants were 4 WAP, green leaf compost produced the highest LAI followed by rice straw compost and cow manure, while rice husk produced the lowest LAI.

As we know LAI is a condition of light that can be absorbed by plants in greater quantities than is transmitted (Parker, 2020). When the plants were 2 WAP tended to be influenced by plants adaptibility. A high LAI indicates that plant leaves tend to be wider and have a higher ability to absorb sunlight (Guangjian *et al*., 2019). Cow manure with a higher Nitrogen content can influence cell growth so that vegetative organs, especially leaves, become wider. The study results from Amir, Hawalid and Nurhuda, (2017) stated that the nutrient content of N, P, and K in cow manure was 0.40%, 0.02%, and 0.10%, respectively.

When the plants were 4 WAP, rice straw compost and green leaf compost influenced the increase in LAI. As we know, these two composts also contain high levels of nutrients, especially Nitrogen, namely 0.86% and 3.27% (Anggria, Rustaman and Kasno, 2014; Subaedah, Aladin and Nirwana, 2016). Plants have been able to adapt to growing media conditions which tend to increase in quality (physical, chemical, and biological properties). It is suspected that both composts can provide nutrients and improve physical properties so that plant roots can easily absorb nutrients (Japakumar, Abdullah and Rosli, 2021). This condition will help plants develop their plant organs, especially the leaf area. Wider leaves will result in increased absorption of sunlight (Fiorucci and Fankhauser, 2017).

Water in plant organs plays a very important role in making it easier for plants to carry out metabolism activities. Plants absorb water through roots, and then translocate it to all plant organs through transpiration activity (Hildebrandt, Kleidon and Bechmann, 2016). Plants with enough water could be able to carry out photosynthesis, nutrient uptake, and transpiration activities optimally (Qi *et al*., 2022). The results of this study showed that plants treated with organic matter had a high water-content and it was indicated that plants with all organic material were able to fulfil the water needs of plants through absorption from the roots (Table 1). Water absorption in plants with optimal light coverage will influence an increase in the photosynthesis rate, so that the assimilate produced will increase. This condition is proven by the results of a positive correlation between LAI and WC, namely r= 0.324. These results illustrate that an increase in LAI is followed by an increase in WC, which will affect the resulting food reserves in the form of NAR.

Table 1. Effect of organic matter on leaf area index and water content of Cucumis sativus L. aged 2 WAP and 4 WAP

Treatments	LAI 2 WAP	LAI 4 WAP	WC 2 WAP (%)	WC 4 WAP (%)
Control	0.141b	0.315d	87.370d	89.680a
Rice straw compost	0.112d	0.413b	89.130a	89.150b
Rice husk	0.121c	0.278e	89.910c	89.690a
Green leaf compost	0.112d	0.442a	87.240d	88.060c
Cow manure	0.182a	0.397c	88.930b	88.750d
CV (%)	1.730	4.390	0.120	7.250

Note: the numbers followed by different letters in the same column are significantly different in the 5% LSD-test.

NAR describes the amount assimilated from photosynthesis that is stored in the form of food reserves in all plant organs (Qadir, Khan and Salam, 2020). Based on Table 2, showed that the use of rice husk produced the highest NAR followed by cow manure and rice straw compost, while green leaf compost and control produced a lower NAR. This condition illustrates that organic matter in the form of rice husk, rice straw, and cow manure, apart from improving soil chemistry, is also able to improve physical properties. This will influence the plant's ability to absorb nutrients in the planting medium to support various plant metabolism activities such as photosynthesis to produce food reserves. Furthermore, the high food reserves produced by plants are influenced by the chlorophyll content and leaf area to absorb more visible light (Grondelle and Boekert, 2017). In these conditions, plants through light reaction activities can produce ATP and NADPH which are used to produce carbohydrates in dark reactions (Wasilewska-Debowska, Zienkiewicz and Drozak, 2022; Johnson, 2016). Simple sugars are produced through photosynthesis activity, and then translocated into all plant organs.

Table 2. Effect of organic matter on net assimilation rate, crop growth rate, and harvest index of Cucumis sativus L.

Treatments	Net Assimilation Rate (g dm-2 week-1)	Crop Growth Rate (g m-2 week-1)	Harvest Index
Control	0.399d	8.630d	0.215a
Rice straw compost	0.469c	10.870b	0.185c
Rice husk	0.516a	10.400c	0.216a
Green leaf compost	0.323e	7.780e	0.168c
Cow manure	0.472b	13.000a	0.200b
CV (%)	4.280	5.090	10.190

Note: the numbers followed by different letters in the same column are significantly different in the 5% LSD-test.

Table 3. Pearson correlation analysis all of plant growth parameters affected by the addition of organic matter

	WC 2 WAP	WC 4 WAP	LAI 2 WAP	LAI 4 WAP	NAR	CGR	HI
WC 2 WAP	1**	0.049ns	0.324*	0.254*	0.649**	0.864**	-0.019ns
WC 4 WAP		1**	0.009ns	-0.882**	0.634**	0.136ns	0.885**
LAI 2 WAP			1**	-0.050ns	0.246ns	0.662**	0.383*
LAI 4 WAP				1**	-0.527**	-0.009ns	-0.925**
NAR					1**	0.765**	0.622**
CGR						1**	0.284*
HI							1**

*Note: * (significant a= 5%); ** (significant a= 1%); ns (not significant); WC 2 WAP (water content when plants 2 weeks after planting); WC 4 WAP (water content when plants 4 weeks after planting); LAI 2 WAP (leaf area index when the plants 2 weeks after planting); LAI 4 WAP (leaf area index when the plants 4 weeks after planting); NAR (net assimilation rate); CGR (crop growth rate); HI (harvest index).*

The food reserves produced by plants will then influence plant growth. This is shown in the crop growth rate parameters in Table 2. The results showed that the cow manure treatment produced the highest CGR followed by rice straw compost and rice husk, while green leaf compost produced the lowest CGR. This shows that there is a positive correlation between NAR and CGR, namely r= 0.765 (Table 3). Li *et al.*, (2016) stated that the higher NAR will be followed by an increase in CGR due to an increase in food reserves produced by plants

The same thing is shown by the increase in HI due to an increase in NAR and CGR. The increase in HI is influenced by an increase in NAR and CGR which is reflected through possitive correlation r= 0.622 and r= 0.284, respectively (Table 3). Food reserves produced through photosynthesis activity will influence the increase in assimilation which is translocated to the permanent sink, namely cucumber fruit (dos Santos *et al.*, 2023; Wang *et al.*, 2014). The results of this study showed that rice husk and cow manure produced higher HI compared to other organic ingredients. Apart from being able to support plant growth activities through the development of vegetative organs and can increase crop yields. This is proven by the higher HI value produced. Improving physical properties will make it easier for plant roots to absorb nutrients provided by the soil and be able to support plant metabolism activities in producing food reserve (Morales *et al.*, 2020). This increase in the HI value indicates an increase in cucumber plant production.

Based on the current study, it is known that the use of organic matter can support plant growth and development. However, not all organic matter can support plant growth optimally. The selection of organic matter to be optimal for plants needs to be done by examining their role in improving physical and biological properties as well as providing nutrients through improving chemical properties.

4. Conclusions

The application of organic matter can increase in LAI, WC, NAR, CGR, and HI to *Cucumis sativus* L. Based on our current study shows that the application of organic matter in the form of cow manure, green leaf compost, and rice straw compost can increase LAI, while rice husk, rice straw, and green cow manure can increase WC. Furthermore, the application of rice husk and cow manure was able to increase in NAR, CGR, and HI. The increase NAR, CGR, and HI in this study was positively correlated with r= 0.622 and r= 0.284.

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