Effect Of Hormonal And Light Factors On The High Growth Of Mung Bean Sprouts

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Abstract. Green Beans (*Vigna radiata L.*) produced by Indonesia is one of the export commodities that are favored by the international market. Green beans have a high protein content and provide many health benefits. Therefore, the growth of mung beans is something that we want to observe in this study. This study aims to determine the influence of light and hormones on the growth of mung bean plants. As many as 60 mung bean seedlings were given four types of planting treatments, namely two factors (light and hormones) and two different levels (dark and light, as well as water without hormones and water with hor- mones) for 5 days. Each treatment was carried out as many as 15 replicates. Each of these factors was then analyzed in relation to sprout height using Factorial Design and processed with Minitab software. The results of this study showed that the light factor had a significant effect on the height of sprouts. Dark levels have a positive effect on sprout height, while light levels have a negative effect on sprout height.

Keywords: Green beans, sprouts, light, hormones, factorial design

1 Introduction

Sprouts according to the Great Dictionary of Indonesian (KBBI) are small plants that have just grown from the seeds of sown beans. Sprouts can be harvested after 5-14 days of age when the first true leaves begin to appear. Sprouts are widely used in the food and beverage industry to beautify dishes and are consumed in fresh salads, soups or *sandwiches*. With the increasing number of food and beverage industries, a supply of sprouts is also needed to meet the needs of the industry. To support the survival and growth of sprouts, sufficient water is needed and can also be supported by the addition of hormones. One of the hormones that is important in plant growth is cytokinin. Cytokinin is a type of hormone in plants that encourages cell division or also known as sitokenesis in meristematic tissue. In addition to being a regulator of cell growth and differentiation, cytokinins also affect the dominance of shoots, the growth of edge buds, and the *senescence* of the leaves. In addition to needing hormones from water and fertilizer, light also

V. Mardiansyah and B. A. Prasetyo (eds.), *Proceedings of the Widyatama International Conference on Engineering 2024 (WICOENG 2024)*, Advances in Engineering Research 252,
https://doi.org/10.2991/978-94-6463-618-5_13

affects sprout growth. Treatment with shading on mung bean sprout plants will affect the morphological properties of the plant. The morphology of mung bean sprout plants that are affected by shade or in dark conditions is that the stem is not sturdy, because the stem is smaller so that the plant collapses easily. This does not apply to plants that are shade-tolerant or in light conditions because they tend to be more efficient in the use of light. Cultivating mung bean sprouts is easier than other legumes, because they have high adaptability, relatively short lifespan, and are suitable for planting in land with little water. This is the basis for conducting research on the influence of light and hormonal factors on the growth of sprouts.

This study aims to determine the influence of light and hormones on the growth of mung bean plants. As many as 60 mung bean seedlings were given four types of planting treatments, namely two factors (light and nutrients) and two different levels (dark and light, as well as water and hormones) for 5 days. Each treatment was carried out as many as 15 replicates. Each of these factors was then analyzed in relation to sprout height using Factorial Design and processed with Minitab software.

2 Research Methodology

2.1 Research Flow Diagram

In this study, the factors that affect the growth of mung bean sprouts will be analyzed from the height of the plant after 5 days of germination. The research was carried out in several stages. The first stage is the formulation of the problem and research objectives. The formulation of the problem from this study is what are the factors that affect the height of mung bean sprouts after 5 days of germination. Meanwhile, the purpose of the study is to find out the factors that affect the height of mung bean sprouts after 5 days of germination. The response variables were the height of mung bean plants compared between treatments as follows: (a) Mung beans were grown in a dark place and watered with clean water, (b) Mung beans were grown in a dark place and watered with cytokinin hormone solution, (c) Mung beans were grown in a place exposed to sunlight and watered with clean water, and (d) Mung beans were grown in a place exposed to sunlight and watered with cytokinin hormone solution. The variables of response, treatment and level are found in Table 2.

Table 2. Response Variables, Factors, Levels

Variable			Description	
Response	Y	Bean plant height green setela		h 5 days (in mm)
Treatment	Factor 1	Light	Level 1	Bright
			Level 2	Dark
	Factor 2	Hormone	Level 1	Water with a 10 ppm cytokinin hormone solution
			Level 2	Clean water without hormones

The next stage is the research design, namely by factorial design method with 15 replications. Furthermore, data collection was carried out which was fully described in 3.2 to 3.4. After conducting the experiment, data on sprout height (mm) was obtained as a response variable from the study. Next, statistical analysis was carried out with variance analysis and regression models formed. Furthermore, the results were interpreted to see the factors and levels that affect the response variables. Finally, conclusions and suggestions from the research are drawn.

2.2 Research Hypothesis

There are three hypotheses in this study. Hypothesis 1 is,
H0 : Light factor does not have a significant effect on the growth of sprout height
H1 : Light factor has a significant effect on the growth of sprout height

Hypothesis 2 is,
H0 : Hormonal factors do not have a significant effect on the growth of sprout height
H1 : Hormonal factors have a significant effect on the growth of sprout height

Hypothesis 3 is,
H0 : Interaction of hormones and light factors does not have a significant effect on the growth of high sprouts
H1 : The interaction of hormones and light factors has a significant effect on the growth of high sprouts

3 Data Processing and Analysis

3.1 Experiment Result Data

Researchers conducted experiments with the factorial design method to see the relationship between the influence of light and hormones on sprout height. Researchers took samples of 15 sprouts each from the light (dark and light) conditions and the given conditions (hormones and water). The height data of 60 green sprouts is shown in Table 3.

Table 3. Response Variables, Treatment, Levels

	Water without Hormones			**Water with Hormones**		
Dark	85	202	198	188	136	154
	133	67	166	198	99	187
	105	169	178	125	132	195
	212	136	175	181	135	171
	100	118	95	155	153	75
	114	137	125	107	110	152
	161	130	169	108	136	123
Bright	103	76	120	95	97	60
	145	144	96	129	124	135
	95	113	137	141	143	99

3.2 Factorial Design Assumption Test

Assumption testing is carried out so that the conclusions drawn describe the actual situation and have accuracy in estimation, are unbiased, and consistent. The following are the results of the assumption test in this experiment.

3.2.1 Outlier Identification

Outlier identification is done to see if the collected data has unique characteristics whose values look very different from other data and appear in the form of extreme values for either a single variable or a combination. For this reason, the researcher uses outlier identification with the boxplot method. It can be concluded that no outliers were

detected, thus, it is concluded that the analyzed data is valid.

3.2.2 Residual Normality Test

The residual normality test was carried out to assess whether the distribution of data in the distributed data group was normal or not. This residual normality test is carried out by making a normal probability plot graph of the residual. It can be concluded that the assumption of error normality is fulfilled because the plot points of the residual follow and approach their diagonal lines.

3.2.3 Variance Homogeneity Test

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The homogeneity assumption requires that the residue distribution for each factor must have the same variance. For the variance homogeneity test, the researcher used Levene's test with the null hypothesis that all variants are the same and the counter hypothesis that one of the variants has different values. It can be concluded that the results of the analysis are valid because the model assumption, namely the homogeneity of residual variance, is fulfilled based on the results of the Levene's test with a p-value of 0.960 (>0.05) so that there is enough evidence to accept the null hypothesis that all variances are equal and the assumption of homogeneity of variance is fulfilled.

3.3 Statistical Analysis

3.3.1 Variance Analysis

The results of the variance analysis are in Table 4.

Table 4. Variance analysis

Source	DF	Adj SS	Adj MS	F-Value	*P-value*
Light Factor	1	10640.0	10640.0	9.08	0.004
Hormonal Factors	1	25.3	25.3	0.02	0.884
Light Factor*Hormonal Factor	1	1050.0	1050.0	0.90	0.348
Error	56	65634.8	1172.0		
Total	59	77350.2			

In Table 4, there are two factors analyzed, namely light and hormonal factors, as well as the interaction of the two factors. The light factor has a *p-value* of 0.004, which is smaller than the α significance level of 0.05. Thus, the average light factor

differed significantly, or it can be concluded that the light factor has a significant effect on the growth of sprout height. In the table, it was found that the effect of hormone factor treatment had a *p-value* greater than α of 0.05. So it can be concluded that the average hormonal factors are not significantly different. Thus, hormonal factors do not have a significant effect on the growth of sprout height. The interaction of light factor and hormones also has a p-value exceeding the significance level of α, so it can be concluded that the interaction of light factor and hormones has a value that does not differ significantly from 0. Thus, the interaction of light factor and hormonal factor did not have a significant effect on the growth of sprout height.

Observations related to the influence of factors and interactions between factors can be made using *the Pareto Chart* . In the diagram, there is a value of 2.003 which is the limit of effect on factors that have a significant effect on the sprout height. Hormonal factors and the interaction of light factors and hormones have a standard *effect* of less than 2.003 so that both are not significant to the height of sprouts.

3.3.2 Main effects and Interaction effects

The plot of the main effects of the Final High response is shown in Figure 6.

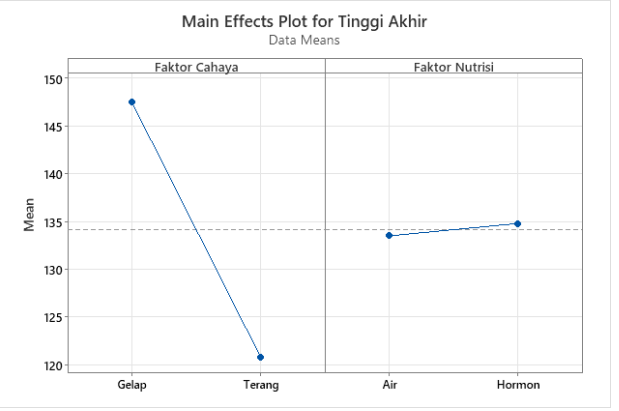

Figure 6. *Main effects*

The main effect on the light factor is 147,433-120.8 or 26,633. Meanwhile, *the main effect* on hormonal factors is 133,467 – 134,767 or -1.3. In the plot, it can be seen that there is no significant difference in the average variable of the response of clean water and water levels with hormones on hormonal factors. The interpretation of the results can also be observed by using the graph of the interaction of the two factors which shows the average response in each treatment combination. Significant interactions are indicated by non-parallel lines. The graph of factor interaction is as follows.

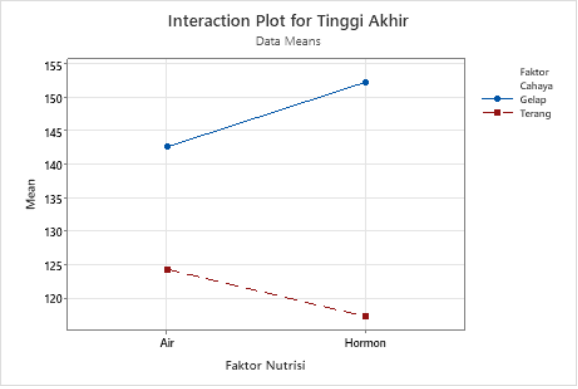

Figure 7. *Interaction effects*

In Figure 7, it can be seen that the average response to the dark treatment has a higher value than the light factor. However, in the graph, there is a difference in the effect of the interaction of hormonal factors and light factors. In dark conditions, the average response to water levels with hormones is higher than that of clean water without hormones. Meanwhile, in bright conditions, the opposite is true. This difference can be the reason why the average treatment of hormonal factors does not differ significantly. However, in the statistical tests that have been carried out, it was found that there is not enough evidence to show that there is an interaction of light factor and hormones that affect the height of sprouts.

3.4 Regression Model Equations

The factorial design model can be analyzed with a regression model by using the t-test. Each treatment at each factor and level has a coefficient found in table 5.

Table 5. Coefficients of regression models

Term	Coef	SE Coef	T-Value	*P-value*	VIF
Constant	134.12	4.42	30.34	0.000	
Light Factor					
Dark	13.32	4.42	3.01	0.004	1.00

Term	Coef	SE Coef	T-Value	*P-value*	VIF
Hormonal Factors					
Water	-0.65	4.42	-0.15	0.884	1.00
Light Factor*Hormonal Factor					
Dark Water	-4.18	4.42	-0.95	0.348	1.00

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The regression equation of the factorial experiment is as follows.

End Height = 134.12 + 13.32 Cahaya_Gelap Factor -13.32 Cahaya_Terang Factor
- 0.65 Net Hormon_Air Factor + 0.65 Hormone Factor _Air with Hormones
- 4.18 Light Factor*Clean Water Hormon_Gelap Factor
+ 4.18 Light Factor*Hormonal Factor _Gelap Water with Hormones
+ 4.18 Light Factor*Hormone Factor _Terang Clean Water
- 4.18 Light Factor*Hormonal Factor _Terang Water with Hormones

From the regression equation, it was found that the dark light factor had a positive effect on the sprout height. Sprouts placed in a dark place will increase in height by 13.32 millimeters. Meanwhile, the bright light factor has a negative influence on the sprout height. Sprouts placed in a bright place have a height reduction of 13.32 mm. So that sprouts that are treated in a dark place tend to have a greater height compared to being placed in bright light. Hormonal factors and the interaction of hormonal factors and light are not significant. Therefore, the regression equation can be rewritten as follows.

End Height = 134.12 + 13.32 Cahaya_Gelap Factor - 13.32 Cahaya_Terang Factor

4 Analysis

Based on the experiments that have been carried out, it was obtained that the light factor has a significant effect on the growth of sprout height. Then, from the regression equation, it was found that the dark light factor had a positive effect on the sprout height while the bright light factor had a negative effect on the sprout height. So that sprouts that are treated in a dark place tend to have a greater height compared to being placed in bright light. This is in accordance with the theory that sprouted seeds placed in a dark place can grow taller because there is no light that damages the hormone auxin which actively stimulates cell division [7].

In the results of the variance analysis, it was found that hormonal factors did not

have a significant effect on the growth of sprout height, or it can be concluded that the average response variables on hormonal factors were not significantly different. This, contrary to the theory that the hormone cytokinin has an effect on the growth of sprouts. In the factor interaction graph, it can be seen that in sprouts placed in a place exposed to light, the average response variable in the treatment using water is higher than the average in the treatment using hormones. However, in sprouts placed in a dark place, it can be found that the average variable response to treatment using hormones is higher than treatment using clean water. This is in accordance with the theory that cytokinins will work with auxins more optimally in dark places [7]. In bright light, the auxin hormone will be damaged so that it cannot work in tandem with the cytokinin hormone [7]. However, in the variance analysis, it was found that there was not enough evidence to show the effect of the interaction of light factors and hormones.

After conducting a two-factor factorial design of experiment and statistical analysis, it was found that: Hypothesis 1 is,
H0 : Light factor does not have a significant effect on sprout height growth (not proven)
H1 : Light factor has a significant effect on the growth of sprout height (proven)

Hypothesis 2 is,
H0 : Hormonal factors do not have a significant effect on the growth of sprout height (proven)
H1 : Hormonal factors have a significant effect on the growth of sprout height (not proven)

Hypothesis 3 is,
H0 : The interaction of hormonal factors and light did not have a significant effect on the growth of sprout height (proven)
H1 : Interaction of hormonal factors and light has a significant effect on the growth of sprout height (not proven)

5 Suggestion

Some suggestions related to the next research are as follows:

1. In terms of hormonal factors, the hormone level analyzed is only the use of cytokinin hormones of 10 ppm. In the next study, it can be considered the concentration of the use of cytokinin hormones that can maximize the high growth of mung bean sprouts

so that it is expected to see a significant difference in the treatment of hormone addition.

2. In this study, only two factors and two levels were analyzed, it is recommended for further research to be analyzed with other variation factors to see the effect on sprout growth. This can be done by adding other levels to the hormonal factor, such as the addition of the hormone auxin. The number of levels in the light factor can be increased by controlling the intensity of the light measured using a lux-meter

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