JURNAL AGROEKOTEKNOLOGI TERAPAN
Applied Agroecotechnology Journal

Agroteknologi Universitas Sam Ratulangi **e ISSN:2797-0647**

Optimization of coconut byproducts with response surface methodology (RSM) as complete nutrients on eggplant plant.

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Manuscript received: 23 Aug. 2025.
Revision accepted: 30 Sept. 2025.

Abstract. Eggplants are good for heart health and suppress cholesterol and diabetes. Coconut waste is a widespread environmental problem because it is not utilized correctly. Coconut waste piles up and triggers the spread of disease and becomes a habitat for mosquitoes that cause dengue fever. This study aims to improve the planting media of cocopeat, manure, and coconut fibre liquid organic fertilizer (CFLF) through a systems approach. This research method uses the response surface methodology (RSM) experimental design. The output variables from FS are converted into data sets that will be formulated in RSM. The output from the c-organic, nitrogen, phosphorus, and potassium analysis parameters is closely related (Sig <0.05) to the research factors. The RSM results show that 20 experiments will be used in the study. The cocopeat, manure, and CFLF factors only produced significant results in the potassium parameter anova test (P <0.05) with a linear statistical model with a verification test. The highest content obtained was 8.684%, nitrogen 0.752%, phosphorus 35.052 ppm, and potassium 63.216 ppm. The optimum condition was produced at 50% coconut fibre, 51.14% manure, and 50% CFLF. The results of the treatment optimization were applied to plants with an average number of fruits of 4.66 (fruits), fruit length of 20.08 (cm), diameter of 4.31 (cm), and fruit weight of 138.52 g. A practical method based on the concentration of planting media and liquid organic fertilizer is needed to increase the potential for harvest yields and promote environmental sustainability

Keywords: Coconut; Feature Selection; RSM; Fertilizer; byproduct.

INTRODUCTION

Eggplant is a trendy vegetable and is widely liked by the public. Consumers are beginning to realize that eggplant is not just a vegetable that is only processed as a family meal. Eggplant contains relatively high nutrition, especially vitamin A and phosphorus content, so it has the potential to be developed as a contributor to the diversity of nutritious vegetable ingredients for the population. Eggplant fruit contains high fibre, so it is suitable for digestion; eggplant skin, especially purple eggplant, is suitable for skin health; eggplant is also known to be good for heart health, suppressing cholesterol and diabetes [1].

Research on purple eggplant (*Solanum melongena* L) has been widely conducted [2] [3], but several areas still require further exploration. Using plantation waste, such as coconut plants, as organic fertilizer for purple eggplant plants is especially limited. Previous studies have shown that coconut shells, fibres, and even coconut water contain nutrients that support plant growth [4] [5] [6]. Furthermore, the provision of liquid organic fertilizer (LOF) from various agricultural wastes has been studied in the context of purple eggplant plant growth [7] [8] [9]. However, the limitations of previous studies on the correct dose, frequency of application, and effect on harvest yields are still needed to optimize its use in purple eggplant cultivation.

Coconut waste products, also known as byproducts from coconut fruit, have enormous potential. However, the processing of these products is still minimal due to the community's lack of knowledge and technology [10]. Village communities must understand how to use environmentally friendly local raw materials to improve welfare and avoid disposal. In addition, coconut waste can function as additional nutrients for plants. The coconut fruit industry only processes the fruit's flesh, but waste such as coconut shells, fibres, and water has yet to be fully utilized. Coconut waste, including husks, shells, and coir, offers a valuable resource for nutrient recovery and sustainable farming methods. Once considered byproducts, these substances are acknowledged for improving soil fertility and promoting plant growth [11]. The shells and husks of coconuts are a great source of vital nutrients. In terms of chemistry, they consist of potassium, cellulose, lignin, gas, tar, and tannin. They make an excellent mineral fertilizer when converted into coconut husk ash, which is especially helpful for immature plants since it contains vital potassium. When used properly, these nutrients help improve the soil's fertility and structure. By improving the nutritional conditions of the soil, this plant-based fertilizer encourages the growth of healthier plants [12].

According to recent studies, 500 ml of coconut water contains two natural hormones, auxin and cytokinin, which can be helpful as plant growth hormones [13]. Other parts, such as coconut fibre and coconut shell, contain essential nutrients, such as potassium (K), calcium (Ca), magnesium (Mg), sodium (N), and phosphorus (P). As good nutrients, coconut shells and fibre can be processed into products that have a higher effect on plants, such as biochar and cocopeat [14] [15]. Susilawati et al. (2020) stated that coconut shells as biochar and coconut fibre as cocopeat with 500 g, can be helpful as plant media in addition to being high in potassium nutrients and the ability to bind and store water firmly, so they can moisturize the soil to prevent plants from drying out. Although some studies have been conducted on coconut waste processing, most research focuses only on producing fertilizers and organic products. Very little attention is paid to the quality and optimal dosage required to produce nutrient content. However, because there are various processes and techniques for adding plant nutrients, many research factors do not affect plant growth and yield [17]. Response surface methodology (RSM) helps identify important factors that affect the response and interactions between these factors. This method is widely applied in various fields, including engineering, chemistry, and agriculture, for process optimization, product improvement, and quality improvement [18].

Several research gaps need further exploration in developing organic fertilizers, especially those involving the Response Surface Methodology (RSM) method. For example, the fermentation process in making coconut fibre liquid organic fertilizer (CFLF) requires optimal conditions to produce quality fertilizers. Although RSM has been used to optimize this process (Yoruklu et al., 2022) [20], further research is needed to determine the most effective fermentation parameters, such as dosage, pH, temperature, and fermentation time, to improve the quality and effectiveness of CFLF. Furthermore, the raw materials used to manufacture organic fertilizers affect the nutrient composition and effectiveness of the fertilizer. Research using RSM to evaluate the effect of raw material variations on the quality of organic fertilizers is still limited [21]. This study fills the gap by using a system modelling approach using RSM to obtain an optimization model for improving the nutritional quality of the planting media mixture. Thus, this study looks at the utilization of organic waste in planting media and how they get the planting method with RSM. Further studies are needed to determine the optimal combination of raw materials in producing high-quality organic fertilizers. Currently, the problem in agricultural science cannot optimize a process from the treatment applied to agricultural cultivation. This research aims to increase the influence of cocopeat, manure, and liquid organic fertilizer growing media through a systems approach.

MATERIALS AND METHODS

This research was conducted at the Integrated Science Laboratory, Faculty of Agriculture, Madako University, Tolitoli, from July to December 2024. The materials used in this study were coconut water, chicken manure, coconut shells, coconut fibre, eggplant seeds, and EM4. Supplies include research tools such as A12 tarpaulin, plastic drums, writing tools, analytical scales, digital callipers, sieves, sacks, machetes, and graters. The raw materials of coconut shells, fibre, coconut water, and manure were obtained from farmers in Lantapan Village, Tolitoli Regency.

1 Feature Selection

This study uses feature selection to select research factors and parameters by examining the significant correlation between the two. Collecting data requires stages such as:

a. Data collection

Data retrieval using the scrapping technique involves retrieving semi-structured documents found on web pages by taking some data from the scraped website. Web scraping is also a method for extracting and storing data from the internet in a file or database for data analysis [22]. Document criteria include the latest research journals/books ranging from 2018-2023 (5 years), and the journals used are open-access. The research journal selects data from several sources, especially research factors and parameters. The data will be processed using Statistical Product and Service Solutions (SPPS) with analytical Chi-Square Test.

b. Feature Selection Formulation

The data obtained is then processed into a Dataset containing research factors and parameters. For more information, see Table 1.

Table 1. Data set of research factors and parameters

No	Research Factors	Research Parameters
1	Cocopeat	C-organic-analysis
2	CFLF dosage	NPP analysis
3	Manure dosage	Micronutrient analysis
4	Combination of planting media and manure	Water content analysis
5	Combination of planting media + manure + Liquid organic fertilizer	KTK Analysis

Operation of Response Surface Methodology

The experimental design of factors and parameters was created using the Design Expert 13 program, with data sourced from selecting selected features as factors and parameters. The data used for factor optimization came from journal data that had been collected. Data for each factor and parameter were calculated through trial and error to determine the minimum and maximum limits. Then, these minimum and maximum limits were entered into the *DX 13*® RSM CCD program to be randomized. The optimization results from RSM will be continued in the research treatment with three replications to ensure better data [23].

3 Research Procedures

Making Cocopeat

The dried coconut fibre is cut first to facilitate the processing process. After that, use a wire brush to rub the dried coconut fibre. This technique is used to rub the coconut fibre in one direction or from two directions, according to each person's convenience. After that, the fibre and powder are separated using a sieve. After that, the fine powder is fermented to remove tannin. After soaking for 1-2 days, dry the cocopeat in the sun until dry [24].

Making Planting Media

The soil media was taken from the experimental land of the Faculty of

Agriculture, Madako University, Tolitoli. The soil taken was topsoil with a depth of ± 20 cm. The soil that had been taken was dried and then sieved to remove root residues. After that, the soil, cocopeat, and manure were mixed according to the treatment to be put into polybags.

Making Coconut Fiber liquid organic fertilizer (CFLF).

Weigh one kilogram of coconut fibre outer skin, then add 10 litres of water, 100 millilitres of local EM-4, and 100 grams of brown sugar. The method is as follows:

1. Put the cleaned coconut fibre into a container;
2. Add 10 litres of water to the brown sugar solution;
3. Add pieces of coconut fibre to the solution and
4. Close the container tightly. The container must remain closed and not be exposed to direct sunlight.
5. Wait fifteen days for soaking.
6. After fifteen days, open the lid of the container and observe the soaking water.
7. If the liquid fertilizer is blackish yellow, the fertilizer is ready to use [8].

4 Physical and chemical analysis

The nutrient content in the planting medium and coconut fibre liquid fertilizer tested in the laboratory will be based on feature selection data and RSM, which will look at which parameters have a significant correlation and value (0.05) with the research factors [25].

5 Application to Plants

After optimizing the research factors, the next step was to apply them directly to the plants [26]. Eggplant Plants (*Solanum melongena* L.) were the experimental plants. The parameters observed were the number of fruits, fruit length, fruit diameter, and fruit weight of purple eggplant.

RESULTS AND DISCUSSION

The raw materials of coconut shell, coconut fibre, coconut water, and manure are obtained from farmers in Lantapan Village, Baolan District, Tolitoli Regency. Fifty articles related to the research factors and observed parameters were obtained based on the scrapping technique or web scrapping used in this study. The source of the article was taken from 2018-2023, and the relationship between factors and responses in the study was obtained. It shows that C-organic and NPP Analysis have the most data, with 10 and 14 data relating to all the factors with feature selection using the IBM SPPS 29 application with the Chi-Square approach. Based on the results of the chi-square analysis using SPSS, it was found that the research factors and parameters were interrelated with research parameters with a significant value below 0.05. The Pearson Chi-Square number with an Asymptotic Significance value (2-sided) below 0.05. It is concluded that the research factors used are the cocopeat + manure planting media and coconut fibre liquid organic fertilizer (CFLF) factors with strongly related responses, namely c-organic (%), nitrogen (%), phosphorus (ppm), and potassium (ppm) [27]. Determining variables using SPPS can help obtain validation yields with related factors and parameters [28].

1 Optimization Response Surface Methodology

Experimental design factors and parameters were created using the *Design Expert 13* program, with data sourced from selecting features as factors and parameters [29]. The analysis determined that the combination of cocopeat, manure, and CFLF resulted in 20 experimental designs being implemented. The concentrations were processed using RSM, resulting in 20 treatments to be studied. They are shown in Table 1. Furthermore, the data was processed using Design Expert 13 software to determine the quadratic linear model formula. Validation of the prediction model was carried out using a numerical method. The numerical method used is the residual test, defined as the difference between the observation and fit values [30]. A range of 50-100% concentration was selected for each factor, derived from the evaluation of related journals and impacting plant parameters [31] [32], [33]. A total of 20 treatments (Ag1-Ag20) have been evaluated, and the results of the parameters in each treatment, both in the cocopeat, manure, and CFLF treatments. Machine learning optimization using RSM was used to determine the efficiency of the model's optimization. Following the optimization results, experiments were conducted to determine the optimized model's applicability [34]. The residual test shows that the model is usually distributed—more details in Table 2.

Table 2. Result of design actual experimental

Run	Factor 1 A: Cocopeat (%)	Factor 2 B: Manure (%)	Factor 3 C: CFLF (%)	Parameter 1: C-organic (%)	Parameter 2: Nitrogen (%),	Parameter 3: Phosphorus (ppm)	Parameter 4: Potassium (ppm).
Ag_1	75	32.96	75	6.91	0.6	29.92	67.47
Ag_2	100	50	50	7.24	0.62	28.18	68.79
Ag_3	75	75	117.05	7.57	0.65	34.29	55.67
Ag_4	100	100	50	7.24	0.62	33.55	63.56
Ag_5	75	75	75	7.57	0.65	31.34	66.43
Ag_6	75	75	75	7.9	0.68	29.34	64.83
Ag_7	50	50	50	8.56	0.74	35.56	63.45
Ag_8	32.96	75	75	8.23	0.71	36.44	52.56
Ag_9	75	75	75	7.57	0.65	32.12	54.45
Ag_{10}	75	117.05	75	6.91	0.6	29.36	55.34
Ag_{11}	75	75	32.96	8.56	0.74	35.46	66.98
Ag_{12}	100	100	100	8.56	0.74	33.45	65.43
Ag_{13}	75	75	75	7.24	0.62	35.37	62.11
Ag_{14}	50	50	100	7.9	0.68	29.12	65.87
Ag_{15}	75	75	75	8.23	0.71	33.38	59.23
Ag_{16}	50	100	100	7.57	0.65	32.67	58.45
Ag_{17}	75	100	50	7.57	0.65	34.12	57.67
Ag_{18}	75	75	75	6.91	0.6	35.23	60.11
Ag_{19}	100	50	100	7.9	0.68	34.45	63.1
Ag_{20}	117.05	75	75	7.57	0.65	36.66	64.11

The c-organic content with the method of adding cocopeat, manure, and LOF with a concentration of 50-100% ranged from 6.91-8.56%, nitrogen content ranged from 0.60-0.74%, Phosphorus content ranged from 29.12-36.66 ppm, and potassium content ranged from 52.56-68.79 ppm (Table 2). The most considerable c-organic content was found in the treatment of 50% cocopeat, manure, and CFLF, which was 8.56%. Based on the soil research centre and stated by Sari et al. (2023), a c-organic content of more than 5% is included in the very high category for fertilizer.

Based on Table 2, the mixture of growing media with low accuracy values for c-organic and nitrogen in potting Ag1, Ag10, and Ag18 is because of the high concentration of CFLF, which causes the planting media to become too liquid and soft, making the fertilizer analysis process not optimal. Then, it continued with the lowest phosphorus content obtained by the Ag2 potting mixture at 28.18 ppm. It is thought to be caused by too much cocopeat, which is high in potassium, and manure, which is high in nitrogen, so the mixing is not balanced, resulting in a decrease in phosphorus content. Another thing is caused by too much cocopeat, which causes the texture of the fertilizer to become too dense and dry. Isa et al. (2021) stated that a balanced mixture of plant nutrients will increase the chemical content of a potting mixture. Research on Panthi et al. (2023) potting mixture with a 1:1 ratio reinforces this, as it can increase the levels of c-organic and nitrogen needed for plant growth. According to Kamaluddin et al. (2022), their research showed that the combination of cocopeat and manure only produces the most significant c-organic of 2.34%, while in this study, it produces more with the combination of cocopeat, manure, and CFLF producing 8.56%.

Furthermore, the nitrogen content obtained is 0.14%, while in this study, it is 0.74%. Cocopeat contains a phosphorus content of 0.04% and chicken manure of 3.21% and obtained in this study 36.66 ppm, which is quite large on a ppm scale. Furthermore, cocopeat contains 0.65% K_2O, and manure contains 0.55%; this study produces 68.79 ppm. Overall, when compared, there is an increase and decrease in each nutrient content. Additionally, the low accuracy value of c-organic, nitrogen, and phosphorus is caused by the number of raw materials used in the process of making planting media, such as the amount of organic material added; in this study, only using 5 kg of coconut shells and manure and coconut fibre of 1 kg. Another problem in the field is that the processing of cocopeat, manure, and CFLF is made manually with limited tools and technology. Hence, c-organic, nitrogen, and phosphorus content is not optimal. It shows that raw materials with low nutrient content can produce organic fertilizer with nutrient levels that do not meet standards.

Hamim et al (2023) added that if this process is not carried out optimally, for example, due to inadequate fermentation time or less supportive environmental conditions, the result is fertilizer with low nutrient content. In addition, storing liquid organic fertilizer for an extended period can cause degradation of nitrogen content, thus reducing the fertilizer quality. The high C/N ratio in coconut shell and coconut fibre raw materials is relatively high, affecting the decomposition process during processing. Coconut fibre consists of coarse fibres and has a reasonably high C/N ratio. According to research, the C/N ratio of coconut fibre reaches 62.14 [40], and coconut shells have a C/N ratio that is even higher than that of coconut fibre. Studies show that the C/N ratio of coconut shells reaches 122 [41]. This high C/N ratio indicates that coconut shells and fibre contain more carbon than nitrogen, so the decomposition process is slow. According to SNI 19-7030-2004, this study did not meet the requirements since the minimum c-organic level is 9.8% and the minimum NPP content is 2% [42]. It still falls short of the quality standards for the four research parameters as stated in the Republic of Indonesia's 2019 Decree of the Minister of Agriculture about the minimum technical requirements for biological fertilizers, organic fertilizers, and soil conditioners [43].

2 Anova Test Results

The analysis of variance at a 5% error level showed that the combination treatment of cocopeat, manure, and CFLF had no significant effect ($P>0.05$) on the amount of c-organic, nitrogen, and phosphorus. Meanwhile, the analysis of variance at a 5% error level showed that the combination treatment of cocopeat, manure, and CFLF had a significant effect ($P<0.05$) on the amount of potassium. Simultaneously, from the results of the variance analysis, there are four tests to check the significance test: the parameter model test, lack of fit test, adjusted R2-predicted R2, and adequate precision. The P-values for the response model for c-organic, nitrogen, and phosphorus are 0.1481, 0.1468, and 0.1930, respectively, interpreted as insignificant ($P>0.05$). However, for the lack of a fit test for the three parameters, it is obtained respectively 0.5901, 0.5549, 0.56440 (P>0.05), which indicates that the model can describe parameter data so that it can be concluded that the model obtained is suitable for predicting process conditions that produce optimum c-organic, nitrogen, and phosphorus content. In the meantime, in the potassium content parameter, the P-value for the parameter model test obtained 0.0111 (P <0.05), which means a significant value, and the lack of fit test 0.766 P>0.05).

The ANOVA test provides many statistical and practical advantages in research involving more than two groups, such as controlling statistical errors and handling interactions between variables. Easy statistical analysis can determine interrelated independent and dependent variables [44]. So that the parameter has a linear model with a significant effect, more details can be seen in Table 3.

Table 3. ANOVA Test of C-organic, Nitrogen, Phosphorus, Potassium

Parameter	Model	Anova Test			
		Significant (P<0.05)	Lack of fit (P>0.05)	Adjusted R^2-Predicted R^2	Adequate precision
C-organic	Quadratic	0.1481	0.5901	0.3208-(-0.4964)	5.5859
Nitrogen	Quadratic	0.1468	0.5549	0.3224-(-0.5392)	5.6083
Phosphorus	Quadratic	0.1930	0.5644	0.2675-(-0.8421)	4.8701
Potassium	Linear	0.0111	0.7466	0.3954-0.2182	7.9865

Table 3 shows that the model with a significant effect is the potassium parameter with a sig-P value <0.05 linear model. According to research by Tamar et al. (2023), inadequate experimental design can lead to high variability and inaccurate parameter estimates. Furthermore, Ani et al. (2021) stated that high variation in experimental data can mask the actual effect of the independent variable on the response, resulting in a high p-value in the ANOVA test. Yılmaz and Şahan (2020) stated that if there is an interaction between unmodeled variables, the model may fail to capture the actual dynamics of the system, leading to insignificant ANOVA results. ANOVA has certain assumptions, such as residual normality, homoscedasticity, and independence. If these assumptions are violated, the ANOVA test results may be invalid [47].

3 Parameter Optimization Results

It is possible to optimize the nutrients from coconut waste. The ideal circumstances for increasing plant production from coconut plant waste will be provided by Response Surface Methodology (RSM). The content of c-organic, nitrogen, phosphorus, and potassium has a different model as the output of RSM. The result is that the linear regression model of potassium content has a significant value (P<0.05). In contrast, the content of c-organic, nitrogen, and phosphorus, which are insignificant (P>0.05), produces a quadratic model More in Table 4.

Table 4. Model Parameter Result

Method	Parameter	Model
Cocopeat, manure, and liquid organic fertilizer	C-organic	$Y= 7.56 - 0.13A - 0.05B - 0.03C + 0.25AB + 0.33AC + 0.17BC + 0.16A^2 - 0.19B^2 + 0.21C^2$
	Nitrogen	$Y= 0.65 - 0.01A - 0.004B - 0.002C + 0.02AB + 0.03AC + 0.02BC + 0.01A^2 - 0.02B^2 + 0.02C^2$
	Phosphorus	$Y= 32.83 - 0.11A + 0.41B - 0.30C + 0.32AB + 1.76AC - 0.22BC + 1.09A^2 - 1.35B^2 + 0.50C^2$
	Potassium	$Y= 61.78 + 2.55 - 2.67B - 1.44C$

The Table shows that the codes Y, A, B, and C are the nutrient content of fertilizer (%), cocopeat, manure, and liquid organic fertilizer. The quadratic and linear models show that the nutrient content of nutrients obtained in fertilizer is influenced by the interaction between the concentrations of c-organic, nitrogen, phosphorus, and potassium, shown in positive constants in the model. The optimal conditions for obtaining fertilizer with the highest content of c-organic, nitrogen, phosphorus, and potassium, respectively, namely 8.684%, nitrogen 0.752%, phosphorus 35.052 ppm, and potassium 63.216 ppm, are estimated to be achieved at a concentration of 50% cocopeat, 51.14% manure, and 50% CFLF. It is supported by the Desirability value of 0.823. Figure 1 shows the contour response surface on fixed parameters plotted with three factors (cocopeat, manure, and CFLF) processed using design-expert 13 software. If there are many insignificant model terms (not counting those required to support hierarchy), model reduction may improve your model [48].

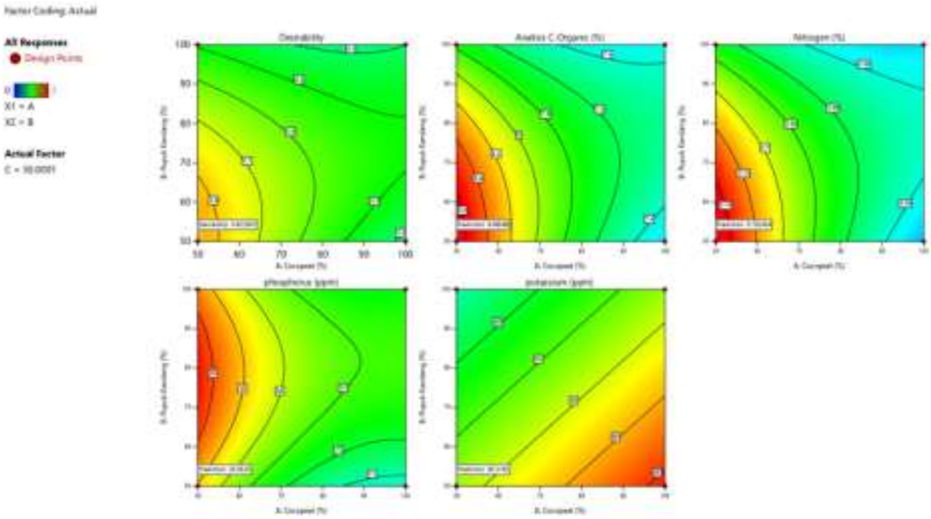

Figure 1. Response Surface shows the effect of different concentrations of fertilizer nutrients on c-organic, nitrogen, phosphorus, and potassium.

Based on the image above (Fig. 1), RSM can determine the optimal conditions for combining planting media nutrients and fertilizers, which shows that factorial and linear designs with RSM can also determine the optimal conditions. Based on the contour plot image of the response surface, the characteristics of the stationary point in the combination experiment using cocopeat, manure, and CFLF are saddle points. The graph shows that the increase in c-organic, nitrogen, phosphorus, and potassium content is not optimal. Based on Fig. 1, it can be concluded that the maximum response value, namely the content of c-organic 7.56%, nitrogen 0.65%, phosphorus 32.83 ppm, and 61.78 ppm, was obtained in the combination of cocopeat A = 50%, manure B = 51.14% C = 50%. The treatment did not respond positively to increasing the c-organic, nitrogen, phosphorus, and potassium content. According to Mehrparvar et al., (2021)., RSM is a method that can be selected to determine the optimal conditions influenced by interactions between variables

4 Verification test

Research conducted using 50% cocopeat concentration, 51.13% manure, and 50% CFLF, the potassium content test results for the linear model verification test for fertilizer nutrient concentration was 63.216 ± 3.73 ppm with an accuracy level of 80.18% in comparison to the prediction. In model verification, the results of c-organic, nitrogen, and phosphorus content using 50% cocopeat concentration, 51.13% manure, and 50% CFLF were respectively 8.68±0.44%, 0.75±0.03%, 35.05±2.25 ppm with an accuracy level of 11.14%, 0.96%, 47.57% compared to predictions. The low accuracy values of c-organic, nitrogen, and phosphorus tests (<50%) indicate that the study's model is unsuitable. Verification testing is essential in determining the validity of RSM optimization results. This process helps ensure the reliability of statistical model-based decision-making and strengthens the confidence that the experimental design and model predictions are applicable in the field [50].

5 Application to Plants

Based on the results of optimum conditions using RSM, the concentration conditions obtained were 50% cocopeat, 51.13% manure, and 50% CFLF. The plants used for the experimental test in the field were eggplant plants with a simple design and three replications. The parameters tested on the plants were plant height, number of leaves, number of fruits, and fruit weight—more in Table 5.

Table 5. Results of observations on purple eggplant plants

Factors	Parameters			
	Number of fruits (unit)	Fruits length (cm)	Fruit diameter (cm)	Fruit weight (g)
50% cocopeat, 51.13% manure, and 50% liquid organic fertilizer	4,66	20,08	4,31	138,52

Figure 2. Purple eggplant observation process

The average value of the number of fruits (fruits), fruit length (cm), fruit diameter (cm), and fruit weight (g) of purple eggplant plants were respectively 4.66 (fruit), 20.08 (cm), 4.31 (cm), and fruit weight 138.52 (g) (Table 5). According to the Ministry of Agriculture [51], the average number of fruits, fruit length, fruit diameter, and fruit weight of purple eggplant plants are, respectively, 4-6 pieces, 20-25 cm, 1.93-2.01 cm, and 264-302 grams. The study results showed that the number of fruits and the fruit length were by applicable standards. Furthermore, the fruit diameter was more significant than expected, and the fruit weight was still by expectations—more in Figure. 3.

The average comparison of purple eggplant results between research results and the Ministry of Agriculture shows that the number of fruits, fruit length, and fruit diameter per plant exceed the ministry's standards (Fig. 3). However, the fruit's weight is still not appropriate. The eggplant measurement process is waiting for shrinkage due to storage not following the procedure. Namely, it is only stored in sacks. Cahyono, (2023) agrees that the decrease in eggplant fruit weight after harvest is a common phenomenon caused by several primary factors, such as transpiration and water loss. After being harvested, eggplant fruit continues to experience transpiration and water evaporation from the fruit tissue to the surrounding environment. Transpiration causes a decrease in water content in the fruit, which directly impacts its weight loss. In addition, an environment with low relative humidity accelerates the transpiration rate, thereby accelerating the decrease in fruit weight [53].

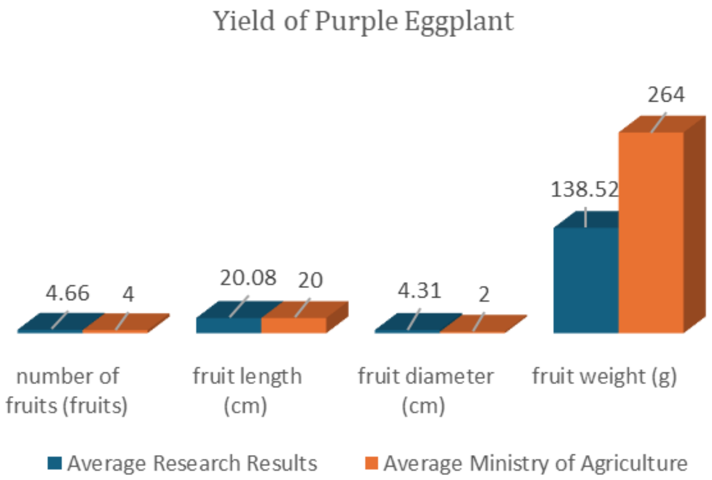

Figure. 3. Average comparison of research results and ministry standards on purple eggplant yields

According to Harleni & Maliki, (2024), cocopeat, manure, and liquid organic fertilizers tend to provide a more significant amount of nutrients, especially phosphorus and potassium contained in cocopeat and CFLF, which can increase fruit development from the size and weight of the fruit so that fruit quality also increases in general. Harahap, (2022) stated the provision of cocopeat and manure planting media because it plays a good role in soil conditions through the help of microorganisms so that soil conditions will be better. The provision of cocopeat and CFLF derived from coconut waste, which is high in potassium content, plays an important role in photosynthesis and strengthens the fruit stalk so that the fruit does not fall off [56]. Bahtiar et al. (2023) concluded that the formation and elongation of fruit are greatly influenced by the availability of phosphorus nutrients for the photosynthesis process, which produces carbohydrates, fats, proteins, vitamins, and minerals that are transferred to the fruit storage section [58]. Potassium nutrients help increase yields in the form of flowers, fruits, colors, and flavors, producing carbohydrates and proteins that are beneficial for fruit growth and can affect the enlargement of fruit size and fruit diameter [59] [60].

CONCLUSIONS

The conclusion obtained is that the nutrient content of the planting media of cocopeat, manure, and liquid organic fertilizers show a genuine effect on increasing the c-organic, nitrogen, and phosphorus, potassium of a fertilizer. As a result of Response surface methodology (RSM), factors such as cocopeat, manure, and CFLF only resulted significantly in an anova test of potassium parameters ($P<0.05$) with a linear statistical model with verification test. The highest content obtained was 8.684%, nitrogen 0.752%, phosphorus 35.052 ppm, and potassium 63.216 ppm, respectively. The optimum condition was produced at 50% cocopeat, 51.14% manure, and 50% CFLF. Optimization of plant media formulas allows for potential increases in crop yields with effective methods based on the concentration of fertilizers and plant media needed. It will impact large-scale plant cultivation; with the availability of abundant coconut waste, its use as fertilizer and plant media can be developed. According to the study, planting media should be used with optimization values for increased efficiency. The next researcher should use improved system design or new applications to boost productivity. Future studies should incorporate interdisciplinary cooperation, such as methods for boosting manufacturing capacity through tool design and construction.

ACKNOWLEDGEMENTS

Directorate General of Higher Education, Research and Technology (BIMA 2024) and Research and community service institution University of Madako Tolitoli.

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