ISSN 2808-3229
Journal of Biodiversity and Biotechnology. 4(2), 63–68,
2024 URL: https://jurnal.uns.ac.id/jbb/article/view/106012
doi: http://dx.doi.org/10.20961/jbb.v4i2.106012

Effect of Goat Manure and Moringa Leaf Extract on Vegetative Growth of Robusta Coffee (*Coffea canephora*)

Muhammad Farhan Alfianto[1], Pardono[2], Edi Purwanto[3], Fitria Roviqowati[1,2], Ahmad Yunus*[1,2]

[1]Department of Agrotechnology, Faculty of Agriculture, Sebelas Maret University, Surakarta
[2]Center for Research and Development of Biotechnology and Biodiversity, Sebelas Maret University, Surakarta

**Corresponding Author: yunus@staff.uns.ac.id*

Abstract
Using organic fertilizers and growth stimulants as natural plant growth regulators is the leading solution to support sustainable coffee cultivation. This research aims to determine the best treatment combination, the best dose of goat manure, and the best concentration of moringa leaf extract for vegetative growth of robusta coffee non-mature plants 1. The research was conducted in Kemuning Village, Ngargoyoso District, Karanganyar Regency, in October 2023-April 2024. The method used was a Randomized Complete Block Design (RCBD) consisting of two factors and three replications. The first factor was goat manure (0, 3, 4, and 5 kg.plant$^{-1)}$. The second factor was moringa leaf extract (0, 150, 200, and 250 g/L concentration). Data analysis used analysis of variance (ANOVA) at the 5% error level, then continued with *Duncan's Multiple Range Test* (DMRT) at the 5% error level if there were significant results. The observed variables include plant height, stem diameter, number of leaves, branches, leaf area, and total chlorophyll. The results showed that the application of goat manure and moringa leaf extract affected the vegetative growth of robusta coffee plants. The combination of goat manure 4 kg.plant^{-1}and moringa leaf extract at a concentration of 250 g.L^{-1}had an effect on increasing chlorophyll b and total chlorophyll. Goat manure did not affect all variables. The moringa leaf extract had a better impact on plant height, and the moringa leaf extract concentration of 250 g/L affected the increase in leaf area 6 weeks after application.

Keywords: antioxidant; latosol; nitrogen; *Rubiaceae*; total chlorophyll

Cite this as: Alfianto, M.F., Pardono, Purwanto, E., Roviqowati, F., Yunus, A. (2024). Effect of Goat Manure and Moringa Leaf Extract on Vegetative Growth of Robusta Coffee (*Coffea canephora*). Journal of Biodiversity and Biotechnology. 4(2), 63–68. doi: http://dx.doi.org/10.20961/jbb.v4i2.106012

Introduction

Coffee is one of the economically superior commodities in Indonesia that can generate high foreign exchange for the country. Coffee ranks fourth after palm oil, rubber, and cocoa as the highest export commodity in Indonesia. Indonesia's strength in becoming a multinational coffee exporter is less intense than that of other exporting countries, such as Vietnam and Brazil. National coffee productivity is equivalent to a quarter of the coffee productivity in these two countries. Coffee widely produced in Indonesia is divided into robusta coffee and arabica coffee. Each of these coffees has more value that attracts coffee consumers. Robusta coffee is the most popular coffee in all segments of society. The bitterness level of robusta coffee is higher than that of arabica coffee due to the high caffeine and chlorogenic acid (CGA). Caffeine is a secondary metabolic product of coffee plants classified as alkaloids. People usually consume coffee to calm their minds, improve performance, overcome depression, increase stamina and work mood, and others (1).

Coffee cultivation takes years to reach the generative phase of coffee. The vegetative phase will affect the vegetative phase of robusta coffee plants. According to (2), good vegetative growth will positively impact a plant. Using the concept of intensification in robusta coffee cultivation can speed up the cultivation process because plants can directly absorb synthetic chemicals. However, intensification using synthetic chemical fertilizers is not good in the long term because it hurts the environment and health. The continuous use of chemical fertilizers can cause a decline in soil quality,

such as soil acidification, decreased organic matter content, and damaged soil structure. Chemical fertilizer residues that plants do not absorb can pollute soil and water sources, threatening the ecosystem around coffee plantations.

(3) added that excessive use of synthetic N fertilizer is the leading cause of rapid soil acidification, while manure is an effective countermeasure to reduce soil acidification. Using chemical fertilizers also has the potential to increase pesticide residues in agricultural products, which can endanger consumer health.

Using organic fertilizers followed by applying growth regulators is the leading solution for coffee cultivation towards sustainability. The role of organic fertilizer is to provide a nutrient supply for plants that contain nutrients and organic matter needed by plants. According to (4), chemical fertilizers are considered to supply nutrients only for the growth of certain parts, in contrast to organic fertilizers such as manure, which can provide a balanced supply of nutrients for plant growth. Using a growth regulator plays a role in stimulating growth acceleration, so it is expected to give the exact representation as using synthetic chemical fertilizers. (5) explained that a growth regulator plays a role in regulating the speed of plant growth and as an integrator of plant tissues until it is formed as a plant. Organic fertilizers are natural, environmentally friendly, and not easily washed away.

The characteristics of organic fertilizers are that they can change and improve the soil physically, chemically, and biologically, which will maintain soil aggregates. Using natural growth regulators is superior to sustainable agricultural practices that pay attention to external factors, not only increasing productivity. This study uses goat manure and natural growth regulator in Moringa leaf extract as a substitute for synthetic chemical fertilizers that negatively impact agricultural sustainability and robusta coffee growth.

Materials and Methods

Research activities were carried out on the robusta coffee land (*Coffea canephora) of* the Madusari III Farmer Group located in Tanen Hamlet, Kemuning Village, Ngargoyoso District, Karanganyar Regency, Central Java Province, from October 2023 to April 2024. The research site soil was analyzed at the UNS Soil Physics and Chemistry Laboratory. Data were collected once every two weeks.

The design used in this research is a Complete Randomized Group Design (CRGD) consisting of two factors and three replications. The first factor is the dose of goat manure (0, 3, 4, and 5 kg.plant$^{-1)}$. The second factor was moringa leaf extract (concentrations of 0, 150, 200, and 250 g.L$^{-1)}$. 16 combinations were formed from these two factors, resulting in 48 experimental units.

The research implementation consisted of initial soil analysis (total N, total P, total K, pH, and percentage of organic matter), land preparation and research materials, treatment, and data collection. The observed variables included plant height (cm), stem diameter (cm), number of leaves, number of branches, leaf area (cm^2), leaf size (cm^2), and chlorophyll, including chlorophyll a, b, and total.

The data obtained were analyzed using analysis of *variance* (ANOVA) with a 5% error rate. If the analysis results show significant differences, *Duncan's Multiple Range Test* (DMRT) was conducted with an error rate of 5%.

Results and Discussion

Plant height

The application of goat manure did not significantly affect the height of coffee plants 22 WAT (Week After Treatment) (Table 1). The increase in coffee plant height is due to the supply of plant nutrients, one of which comes from goat manure. Goat manure can improve soil texture and increase microbial activity in the long term. According to (6), better plant growth is caused by more bioavailable nutrients that stimulate more microbes moving towards the rhizosphere. Goat manure that does not have a significant effect can be caused by one of the following: the nature of the manure. Goat manure is classified as an organic fertilizer that is slow-release or long-decomposing because it has solid particles. The slow process of decomposing fertilizer slows plants' absorption of nutrients.

Table 1. Effect of goat manure and moringa leaf extract on vegetative growth of robusta coffee plants, non-mature plants

Treatment	Plant height 22 weeks after pruning (cm)	Diameter of stem (cm)	Number of leaves (strands)	Number of branches	Leaf area 6 weeks after pruning (cm^2)	Total chlorophyll ($mg.g^{-1}$)
Goat manure ($kg.plant^{-1}$)						
0	22.04±9.62	0.232±0.07	38.66±17.05	4.54±0.99	104.75±47.5	10.94±3.95
3	24.17±9.77	0.234±0.11	41.56±15.27	4.45±1.47	114.18±28.6	12.31±2.52
4	27.047±10.61	0.266±0.08	47.74±13.85	4.94±1.39	100.48±51	11.87±3.99
5	27.047±10.98	0.237±0.1	43.23±11.4	4.58±1.75	116.96±57.6	12.69±3.61
Moringa leaf extract ($g.L^{-1}$)						
0	28.04±9.88b	0.254±0.06	44.01±15.6	4.13±1.1	116.86±35.75ab	11.70±3.5
150	17.50±7.82a	0.202±0.08	38.11±14.82	4.21±1.42	82.98±28.82a	10.64±2.74
200	27.83±9.15b	0.252±0	49.13±11.3	5.21±1.43	98.72±53.1ab	11.80±4.09
250	26.92±10.66b	0.261±0.11	39.95±14.98	4.95±1.44	137.81±49.36b	13.66±3.33
Interaction	(-)	(-)	(-)	(-)	(-)	(+)
Sig. goat manure	0.479	0.734	0.556	0.764	0.734	0.456
Sig. of Moringa leaf extract	0.058	0.292	0.338	0.088	0.017	0.08
Sig. of interaction	0.668	0.86	0.884	0.315	0.268	0.003
CV (%)	40.1	35	36.6	26	37.66	23.1

Notes: Numbers followed by the same notation in the table indicate not significantly different according to DMRT analysis at the α = 5% level, (+): there is interaction; (-): there is no interaction, Sig: significance, CV: Coefficient of Variance

The application of moringa leaf extract showed a significantly different effect on coffee plant height at 22 weeks after pruning (Table 1). The provision of moringa leaf extract that gives a better effect is caused by the hormones contained therein. Based on (7), the continuation of cell division is caused by an increase in the rate of protein synthesis stimulated by the hormone cytokinin. In contrast, the hormone auxin spurs the elongation of cells, causing an increase in plant height. Giving a growth regulator to meet the plant's needs will have a good effect. According to (8), adding the amount of growth regulator doses adjusted to plant conditions will determine the development and growth for the better. The real effect of the moringa leaf extract treatment showed a decrease due to the use of moringa leaf extract. This is caused by poor plant conditions, causing plants to be unable to absorb and use nutrients properly.

According to (9), the addition of substances from outside the plant that are expected to have a good effect on plants will affect the physiological balance of plants and have the potential to have an adverse impact if the plants are in poor condition.

Stem diameter

The use of goat manure does not give a significant difference in the increase in stem diameter of coffee plants (Table 1). The diffusion of the coffee plant's diameter is caused by the presence of the N element, which the plant can absorb. According to (10), nitrogen is part of the protein, an essential part of enzymes, protoplasm, catalytic agents, and other nutrients that accelerate life processes that play a crucial role in which accelerates life processes that play a vital role in the formation of plant diameter.

Coffee plants are classified as C3 plants that do not require a lot of light to carry out photosynthesis. High light intensity during the study impacted the photosynthesis of coffee plants. According to (11), plant photosynthetic activity has lower and upper tolerance limits for plants to do photosynthesis; lower or higher environmental conditions will affect leaf activity in photosynthesis. (12) added that C3 plants exposed to too high light intensity will impact photosynthesis results, which is overhauled.

The application of moringa leaf extract did not significantly affect the growth of stem diameter (Table 1). This is thought to be caused by concentrations that are not yet appropriate, so plants give the exact growth representation. According to (13), more or less administration of the growth regulator can affect plant expression.

Number of leaves

The application of goat manure did not give a significant difference in the increase in coffee leaves (Table 1). The content of N, P, and K elements in manure strongly influences the formation of plant leaves. The increase in temperature from November to April hurts coffee plants. Unfavorable impact on coffee plants.

Temperature increase, which goes hand in hand with an increase in light intensity, can stress coffee plants because of the rise in soil evaporation, which impacts the slow absorption rate of nutrients in coffee plants, especially when applying goat manure. The occurrence of soil evaporation. The occurrence of soil evaporation will make the soil drier, and the need for water will not be fulfilled. According to (14), water-stressed soil conditions harm plant metabolism, interfering with plant growth and development. The provision of moringa leaf extract is not significant; it is suspected that the content of the hormone cytokinin contained in the growth regulator is not enough to meet the needs of plants to provide a real difference (Table 1). According to (15), using a banana pseudostem growth regulator, which contains the hormone zeatin, affects the number of plantlets. Zeatin hormone affects the number of coffee leaves.

Number of Branches

The application of goat manure did not significantly increase the number of branches (Table 1). Organic fertilizers can increase soil nitrogen levels and support branch growth. Branches will determine the potential production ability of a coffee plant. (16) state that the number of branches is directly proportional to the productivity of coffee plants. This explains that if there is an increase in the number of leaves, it will increase the productivity of coffee plants in producing fruit.

The unreal difference is caused by the absorption of plant nutrients that are adjusted to the plant's needs, which are adjusted to the needs of plants. According to (17), providing a lot of fertilizer does not guarantee better plants because plants may not absorb all nutrients well; usually, plants only take enough nutrients according to their needs. Nutrients are provided in accordance with their needs. The application of moringa leaf extract did not significantly affect the number of branches (Table 1). The increase in the number of branches that was not significant on the application of growth regulator also occurred in the research of (18), where the use of growth regulator IAA had no significant effect on the increase of orthotropic branches and plagiotropic branches. Leaf extract Moringa leaf extract contains auxin and cytokinin hormones in zeatin. (6) explain that high auxin concentrations can provide significant benefits or even inhibit or interfere with plant growth.

Leaf area

The application of goat manure did not have a real effect. This growth can be caused by environmental conditions when the study took place, showing an air temperature that was not in accordance with the growing conditions of robusta coffee plants, and an increase in air temperature from the beginning to the end of the study (Table 1). According to (19), climatic conditions strongly influence plant growth and development, so that climate change will harm plant growth.

Moringa leaf extract 250g/L had a significantly different effect, among other levels, on the increase in leaf area at 6 weeks after pruning (Table 1). This is because using the right auxin hormone can accelerate cell division. (20) stated that if the auxin content is too high, leaf differentiation will be inhibited because the ability to divide by meristem cells is higher than the ability to differentiate into shoots or leaves (cellular growth overlapping). (21) added that using a growth regulator can stimulate the growth and development of leaves, including in photosynthesis and respiration.

Chlorophyll Content

The application of goat manure and Moringa leaf extract did not significantly affect the total chlorophyll in coffee leaves (Table 1). The unreal effect can be caused by high temperature and light intensity. The average air temperature at sampling reached 27.98℃ with high average light intensity. (22) state that shading coffee plants will affect the chlorophyll index. The unreal effect on moringa leaf extract is caused by giving the concentration of moringa leaf extract singly, not at the concentration of moringa leaf extract. According to (23), applying a natural growth regulator or an exogenous growth regulator that is not appropriate will provide obstacles to the growth and development of coffee plants.

Table 2. Interaction Value of Goat Manure and Moringa Leaf Extract on Total Chlorophyll Content of Non-Mature Plants

Treatment		Moringa leaf ($g.L^{-1}$)				
		0	150	200	250	Average
Goat manure ($kg.plant^{(-1)}$)	0	7.61a	10.9a-d	9.87abc	15.37de	10.94
	3	14.6cde	11.15a-d	13.97b-e	9.5abc	12.31
	4	13.58b-e	8.79ab	8.53ab	16,6e	11.87
	5	11.02a-d	11.73a-e	14.82cde	13.18b-e	12.69
		11.70	10.64	11.80	13.66	(+)

Notes: Numbers followed by the same notation in the table indicate not significantly different according to DMRT analysis at the α = 5% level, (+): there is an interaction.

There is an interaction in the combination of manure and Moringa leaf extract (Table 2). The best interaction was found using goat manure $4kg.plant^{-1}$and moringa leaf extract $25g.L^{-1}$. The interaction between the two treatments is caused by the two factors that have provided synergy to influence the variables. The increase in chlorophyll levels due to the interaction impacts increasing plant biomass by assimilation, directly proportional to chlorophyll levels.

Manure containing the element N plays a role in the plant growth cycle that functions during plants' vegetative growth, so an adequate supply of N will provide good plant growth, especially in chlorophyll production. According to (24), nitrogen is an integral part of chlorophyll, so nitrogen is needed to form chlorophyll. Interaction is also caused by the concentration of moringa leaf extract that meets the needs of plants to produce chlorophyll. Based on the research of (25), it is explained that the provision of moringa leaf juice significantly affects the chlorophyll content of soybean leaves.

The zeatin content in moringa leaf extract is vital in inhibiting leaf aging. According to (26), exogenous cytokinins will help inhibit chlorophyll loss. Mg content in moringa leaf extract, which also plays a micro role in chlorophyll formation, can cause the interaction. (27) added that Mg ions contained in chloroplasts are known as key components for light harvesting and as cofactors for photosynthetic enzymes.

Conclusions

The combination of goat manure at a dose of $4kg.plant^{-1}$ and moringa leaf extract at a concentration of $250g.L^{-1}$ had a better effect on the total chlorophyll content of robusta coffee non-mature plants. Goat manure does not affect the vegetative growth of robusta coffee non-mature plants 1. Moringa leaf extract can be better on coffee plant height, and moringa leaf extract 250 g/L-1 is better on the leaf area of non-mature plants of robusta coffee aged 6 weeks after pruning.

Conflicts of Interest

The author declares no conflict of interest.

References

[1] Nazariah N, Indriani Y, Kasymir E. Pola konsumsi dan sikap mahasiswa Universitas Lampung terhadap kopi robusta. J Ilmu Ilmu Agribisnis. 2021;9(3):477-84.

[2] Iswahyudi I, Garfansa MP, Khosim S, et al. Pengaruh pemotongan umbi bibit dan pemberian dosis pupuk NPK terhadap pertumbuhan dan hasil bawang merah (*Allium ascalonicum* L.). J Pertanian Presisi. 2022;6(1):50-62.

[3] Wang J, Cui W, Che Z, et al. Effects of synthetic nitrogen fertilizer and manure on fungal and bacterial contributions to N_2O production along a soil acidity gradient. Sci Total Environ. 2021;753:142011.

[4] Chemura A. The growth response of coffee (*Coffea arabica* L.) plants to organic manure, inorganic fertilizers, and integrated soil fertility management under different irrigation water supply levels. Int J Recycl Org Waste Agric. 2014;3:1-9.

[5] Febmita E, Putri SD. Uji beberapa zat pengatur tumbuh alami untuk perbanyakan vegetatif bonggol pisang (*Musa paradisiaca* L.) varietas Kepok Tanjung. J Agroplasma. 2023;10(1):216-26.

[6] Ye L, Zhao X, Bao E, et al. Bio-organic fertilizer with reduced rates of chemical fertilization improves soil fertility and enhances tomato yield and quality. Sci Rep. 2020;10(1):177.

[7] Nugroho SA, Setyoko U, Safitiri AKN, et al. Pengaruh growth regulator alami dan pupuk kandang sapi terhadap pertumbuhan bibit kopi robusta (*Coffea canephora* L.). Radikula J Ilmu Pertanian. 2023;2(1):17-24.

[8] Rahma. Efektivitas pupuk MKM dan ekstrak tauge terhadap pertumbuhan dan produksi tanaman tomat (*Lycopersicum esculentum* Mill.) [Skripsi]. 2020.
[9] Suherman C, Dewi IR, Wulansari R. Pengaruh metode aplikasi dan dosis stimulan cair terhadap produksi lateks pada tanaman karet Klon PR 300 umur 25 tahun. J Kultivasi. 2020;19(1):1023-9.
[10] Setiono S, Azwarta A. Pengaruh pemberian pupuk kandang sapi terhadap pertumbuhan dan hasil tanaman jagung manis (*Zea mays* L.). J Sains Agro. 2020;5(2):1-8.
[11] Tkemaladze GS, Makhashvili KA. Climate change and photosynthesis. Ann Agrar Sci. 2016;14(2):119-26.
[12] Effendy I, Utami D. Growth and yield of three varieties of soybeans in inter-row with cutting on palm oil fronds tips. J Agrotek Tropika. 2020;8(2):207-16.
[13] Thamrin NT, Hairuddin R, Hasrianti A. Uji beberapa konsentrasi ekstrak bawang merah sebagai zat pengatur tumbuh terhadap keberhasilan sambung pucuk tanaman kakao (*Theobroma cacao* L.). Perbal J Pertanian Berkelanjutan. 2019;7(3):219-24.
[14] Matondang CO, Nurhayati N. Pengaruh cekaman air terhadap pertumbuhan dan produksi tanaman kopi. BEST J Biol Edu Sains Tech. 2022;5(1):249-54.
[15] Vonnisye, Tonglo F. Pengaruh bokashi jerami padi dan growth regulator bonggol pisang terhadap pertumbuhan tanaman kopi arabika. AgroSainT. 2020;11(2):85-91.
[16] Covre AM, Partelli FL, Bonomo R, Braun H, et al. Vegetative growth of Conilon coffee plants under two water conditions in the Atlantic region of Bahia State, Brazil. Acta Sci Agron. 2016;38(4):535-45.
[17] Farhanah A, Tandi I, Musfira RM, et al. Pemanfaatan rumput laut Kendal sebagai POC untuk meningkatkan produksi tanaman bayam (*Amaranthus tricolor* L.). J Ilm Pertanian Kehutanan. 2022;9(2):138-46.
[18] Erlacher WA, Amaral JFTD, Amaral JATD, et al. Effect of indole-3-acetic acid on growth, physiology, and nutritional status of young arabica coffee plants. Coffee Sci. 2023;e172050.
[19] Altieri MA, Nicholls CI. The adaptation and mitigation potential of traditional agriculture in a changing climate. Clim Change. 2017;140:33-45.
[20] Pamungkas SST, Nopiyanto R. Pengaruh zat pengatur tumbuh alami dari ekstrak tauge terhadap pertumbuhan pembibitan budchip tebu (*Saccharum officinarum* L.) varietas Bululawang. Mediagro. 2020;16(1):68-80.
[21] Surya MI, Ismaini L, Normasiwi S, Putri DM, et al. Plant growth regulators affecting leaf traits of loquat seedlings. Annu Res Rev Biol. 2020;35(11):73-85.
[22] Maxiselly Y, Nafy FR, Sarsan GS, et al. Pengaruh naungan dan dosis fungi mikoriza arbuskular terhadap pertumbuhan kopi arabika (*Coffea arabica*) fase non-mature plants. Paspalum J Ilm Pertanian. 2023;11(2):283-93.
[23] Inekeputri, Miftakhurrohmat A. Pengaruh macam dan konsentrasi growth regulator sintetik terhadap fase vegetatif tanaman kedelai (*Glycine max* L.). J Agric. 2022;17(1):1-16.
[24] Wasaya A, Tahir M, Ali H, Hussain M. Influence of varying tillage systems and nitrogen application on crop allometry, chlorophyll contents, biomass production, and net returns of maize (*Zea mays* L.). Soil Tillage Res. 2017;170:18-26.
[25] Amriyanti FL, Ajiningrum PS. Aplikasi sari daun kelor sebagai zat pengatur tumbuh organik terhadap pertumbuhan dan kadar klorofil tanaman kedelai (*Glycine max* (L.) Merr.). Stigma J MIPA Unipa. 2019;12(2):82-8.
[26] Sosnowski J, Truba M, Vasileva V. The impact of auxin and cytokinin on the growth and development of selected crops. Agriculture. 2023;13(3):724.
[27] Guo W, Nazim H, Liang Z, et al. Magnesium deficiency in plants: an urgent problem. Crop J. 2016;4:83-91.