International Journal of Life Sciences
Available online at www.sciencescholar.us
Vol. 7 No. 3, December 2023, pages: 67-77
e-ISSN: 2550-6986, p-ISSN: 2550-6994
https://doi.org/10.53730/ijls.v7n3.14613

Solid Rabbit Fertilizer Formulation with the Addition of Manure and Dolomite Fertilizer on the Growth and Production of Chili Plants (Capsicum frutescens L.)

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MManuscript submitted: 27 August 2023, Manuscript revised:09 September 2023, Accepted for publication:18 October 2023

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Keywords

chicken fertilizer;
chili plants;
cow fertilizer;
dolomite fertilizer;
rabbit fertilizer;

Abstract

This research aims to determine the formulation of solid rabbit fertilizer with the addition of the right type of manure and dolomite fertilizer on the growth and production of chili plants. This research is a factorial experiment with a basic design of Randomized Block Design with 2 factors tested. The first factor is additional manure treatment in solid rabbit manure with 3 levels: K1 = rabbit manure (30 tons ha-1), K2 = rabbit manure + chicken manure (15 tons ha-1 + 15 tons ha-1), K3 = rabbit manure + cow manure (15 tons ha-1 + 15 tons ha-1) and the second factor is dolomite fertilizer dose with 4 levels: D0= 0 kg ha-1, D1= 240 kg ha-1, D2= 480 kg ha-1, D3= 720 kg ha-1. The interaction of solid rabbit fertilizer formulation with the addition of manure (K) and dolomite fertilizer (D) had no significant effect (P>0.05) on all observed variables. The highest production per hectare of chili plants was obtained in the rabbit fertilizer formulation with the addition of cow fertilizer at K3, namely 7.30 tons ha-1, not significantly different from K2 with a value of 6.92 tons ha-1 and significantly different from K1 with a value of 5.55 tons ha-1 and K3 experienced an increase of 5.5% and 31.53% respectively. The application of 720 kg ha-1 dolomite fertilizer gave the highest production, namely 7.33 tons and was not significantly different from the treatment without dolomite fertilizer, 240 kg ha-1 dolomite fertilizer and 480 kg ha-1 dolomite fertilizer with a value of 6.17 tons each, 6.07 tons and 6.8 tons.

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Contents

1 Introduction

Until now, chilies are a type of horticultural plant that is very important for the lives of Indonesian people. It is proven that from year to year market demand is still high during pandemic and normal conditions. The still high demand for chilies in society where their availability on the market has not been able to meet demand, both for large chilies (Capsicum annuum L.) and small chilies (Capsicum frutescens L.), provides an opportunity to meet this demand through increasing the application of plant cultivation technology, one of which is fertilization. Fertilizers generally contain the nutrients N, P and K and are needed by plants. According to Sobir & Siregar (2014) stated that the main nutrient elements that must be available for plant growth and development are the elements N, P, K. Rabbit manure is one source that can be used as solid organic fertilizer and if the fermentation process is carried out it can become a source nutrients for plants. Researchers Sajimin et al. (2005) stated that rabbit manure has great potential to be used as organic fertilizer because it contains higher nutrient elements than other livestock manure raw materials, namely C/N: (10–12%), P (2.20–2.76%) , K (1.86%), and Ca (2.08%). Providing solid rabbit fertilizer at the right dose must be effective and effective. Solid rabbit fertilizer, which contains quite high nutrient elements when compared to other manure, will be a problem if market demand is high because the fulfillment of fertilizer is very dependent on the amount of rabbit manure from rabbit cultivation which is still a small amount of raw material for fertilizer. As an alternative to overcome the limitations of raw materials, to increase the efficiency and effectiveness of fertilizer, a solution is sought to find ways to combine/add abundant sources of manure to solid rabbit manure from cow and chicken manure sources while still paying attention to the nutrient requirements needed by plants. The content of chicken manure is Nitrogen (N) 1%, Phosphorus (P) 0.8%, Potassium (K) 0.4% while cow manure is Nitrogen (N) 0.4%, Phosphorus (P) 0.2 %, Potassium (K) 0.17% (Ghani, 2021). The results of research by Polii et al. (2022) show that goat and chicken manure provide the highest plant height, as does the number of chilies. The best growth of chili plants is at a dose of 10 tons/ha of goat manure and 10 tons/ha of chicken manure. Researcher Murniati (2022), found that the application of chicken manure had a real effect on the fruit weight growth variable per plant, which resulted in the production of very good quality cayenne pepper plants with the highest value. The chicken coop dose of 20 tons ha-1 produced a plant height of 45.8 cm, total vegetative branches are 9.3 stems, the number of productive branches is 22.0 (Aria et al., 2019; Yap et al., 2021).

Dolomite fertilizer can be used as fertilizer, pure is known to contain 45.6% MgCO3 and 54.3% CaCO3 or 30.4% CaO with the chemical formula CaMg (CO3)2. The essential elements Ca and Mg play a very important role in plant physiological processes apart from N, P, K contained in manure. According to Abay (2019) the advantage of dolomite is that it contains Calcium (Ca) and Magnesium (Mg), these elements are needed to increase land fertility. Calcium (Ca) can act as a cell wall strengthener, activate meristem cell division, help with the uptake of nitrates and activate various enzymes. Meanwhile, Magnesium (Mg) plays a very important role in the formation of chlorophyll, activates enzymes/activators, plays a role in phosphate exchange, and also influences the respiratory process. Researchers Ribeiro et al. (2017) found that the best dose of dolomite fertilizer for soil chemistry of 480 kg ha-1 had an effect on increasing (soil organic C, available P, and soil K-available Ca) and yields of green bean plants (flowering age and number of plant leaves). Researchers Setiawati et al. (2021) found that the combination of Mg and B and biological fertilizer applied twice at 30 DAP and 45 DAP was able to increase chili productivity by 21.68 tonnes/ha or an increase of 54.53% compared to the control. Until now, there are still many agricultural lands for cultivating plants that do not use dolomite

fertilizer as a very important source of nutrients because they are still oriented that dolomite only plays a role in increasing soil acidity and needs to be researched at what optimal dose can provide maximum results in the field for chili plants (Fang et al., 2006; Fridhandler, 1961).

Providing organic fertilizer is one effort that can be made to reduce soil damage. Taking into account the study above, applying additional Manure to Solid Rabbit Manure and Dolomite Fertilizer is appropriate so that the optimal dose is obtained which will be able to increase the quality and quantity of chili yields which in turn can increase farmers' income (Gil et al., 2008; Sartori et al., 2002).

2 Methodology

The experiment was carried out in Subak Buaji, Kesiman Village, East Denpasar. This research is a factorial experiment, with a basic randomized block design (RBD) with 2 factors being tried. The first factor is additional manure treatment in solid rabbit manure with 3 levels: K1 = rabbit manure (30 tons ha-1), K2 = rabbit manure + chicken manure (15 tons ha-1 + 15 tons ha-1), K3 = rabbit manure + cow manure (15 tons ha-1 + 15 tons ha-1) and the second factor is dolomite fertilizer dose with 4 levels: D0= 0 kg ha-1, D1= 240 kg ha-1, D2= 480 kg ha-1, D3= 720 kg ha-1. The planting distance used is 50 x 50 cm with a plot size of 2 m x 2.5 m, distance between plots 60 cm and within plots 50 cm. From this experiment, 12 combination treatments will be obtained and will be repeated 3 times so that there are a total of 36 combination treatments. Observations will be made on the variables: maximum plant height, maximum number of leaves, number of flowers, number of fruits, fresh and oven-dry weight of fruit, fresh and oven-dry weight of stover, production per hectare (Perkasa et al., 2016; Xiao et al., 2018).

3 Results and Discussions

The results of statistical analysis on the variables observed in this study and the results of the significance of "Solid Rabbit Fertilizer Formulation with the Addition of Manure and Dolomite Fertilizer on the Growth and Production of Chili Plants (Capsicum frutescens L.)" and its interaction (K x D) are presented in table 1.

Table 1
Significance of " Solid Rabbit Fertilizer Formulation with the Addition of Manure and Dolomite Fertilizer on the Growth and Production of Chili Plants (Capsicum frutescens L.)"

No	Variable	Treatment		
		Additional Types of Manure (K)	Dolomite Fertilizer (D)	Interaction (K x D
1	Maximum plant height (cm)	*	ns	ns
2	Maximum number of leaves per plant (pieces)	**	ns	ns
3	Maximum number of flowers per plant (florets)	**	*	ns
4	Maximum number of fruits per plant (fruit)	*	ns	ns
5	Fresh weight of leaves per plant (g)	**	ns	ns
6	Dry weight of leaves per plant (g)	**	*	ns
7	Fresh weight of stover per plant (g)	*	ns	ns
8	Dry weight of stover per plant (g)	*	ns	ns
9	Fresh weight of fruit per plant (g)	*	ns	ns
10	Dry weight of fruit per plant (g)	*	*	ns
11	Production per hectare (tons)	*	ns	ns

Note: ns = not significant effect (P≥0.05)
**= very significant effect (P<0.01)
*= significant effect (P<0.05)

Table 2
Average maximum plant height, maximum number of leaves, number of flowers maximum, maximum number of fruits, fresh weight of leaves, dry weight of leaves

Treatment	Maximum plant height (cm)	Amount maximum leaves (sheet)	Maximum interest amount (flower)	Amount maximum fruit (fruit)	Heavy Fresh leaf (g)	Heavy Dry leaf (g)
Additional Types						
Manure						
K_1	108,77 a	122,99 a	140,24 a	101,59 a	187,54 a	30,56 a
K_2	113,19 ab	128,80 ab	139,22 a	104,25 ab	231,59 b	41,27 b
K_3	119,46 b	135,11 b	157,57 b	119,04 b	230,53 b	41,86 b
LSD 5%	9,18	7,82	10,76	15,89	27,95	5,54
Dolomite Fertilizer						
D_0	118,69 a	129,59 a	144,04 a	104,91 a	203,83 a	33,39 a
D_1	114,94 a	131,52 a	155,06 b	114,69 a	210,63 a	35,50 a
D_2	109,57 a	124,95 a	139,33 a	107,76 a	224,89 a	40,68 b
D_3	112,03 a	129,76 a	144,28 a	107,83 a	227,37 a	42,02 b
LSD 5%	-	-	9,32	-	-	13,76

Table 3
Average fresh weight of stover, dry weight of stover, fresh weight of fruit per plant, dry weight of fruit per plant, production per hectare

Treatment	Fresh weight of stover (g)	Dry weight of stover (g)	Fresh weight of fruit per plant (g)	Dry weight of fruit per plant (g)	Production per Hectare (ton)
Additional ypes					
Manure					
K_1	303,63 a	55,37 a	138,67 a	22,54 a	5,55 a
K_2	383,22 b	66,64 ab	173,09 b	26,88 ab	6,92 b
K_3	384,28 b	67,63 b	182,32 b	31,64 b	7,30 b
LSD 5%	74,9	11,42	32,77	7,23	1,31
Dolomite Fertilizer					
D_0	313,08 a	59,24 a	154,04 a	21,30 a	6,17 a
D_1	347,15 a	59,51 a	151,65 a	25,72 ab	6,07 a
D_2	370,76 a	65,20 a	169,88 a	28,48 bc	6,80 a
D_3	397,18 a	68,91 a	183,21 a	32,57 c	7,33 a
LSD 5%	-	-	-	6,26	-

The results of statistical analysis showed that the interaction of solid rabbit fertilizer formulation with the addition of manure (K) and dolomite fertilizer (D) had no significant effect (P>0.05) on all observed variables. The combination of solid rabbit fertilizer with the addition of cow manure (K_3) gives the highest average variable values, namely plant height, number of leaves, number of flowers, number of fruit, dry weight of leaves, fresh weight of stover, dry weight of stover, fresh weight of fruit, dry weight of fruit and production per hectare. The highest average value of dolomite fertilizer was given at a dose of 720 kg ha^{-1} (D_3) for the number

of flowers, dry weight of leaves and dry weight of fruit. The maximum number of harvested fruit, fresh weight of fruit per plant and the highest production per hectare were obtained in the K_3 treatment, namely 119.04 fruit, 182.32 g and 7.3 tons ha^{-1} or an increase of 17.18%, 31.48% and 31 .52% compared to K_1, namely 101.59 pieces, 138.67 g and 5.55 tons $ha^{-1.}$

The increase in the maximum number of harvested fruit in the K_3 treatment was also supported by an increase in plant height (r=0.960**), maximum number of leaves (r=0.937**), maximum number of flowers (r=0.982**), dry weight of stover (r= 0.673*), fresh weight of fruit (r=0.763**), dry weight of fruit (r=0.938**), and production per hectare (r=0.767*) (Table 4). The highest maximum plant height was obtained in the K_3 treatment, namely 119.46 cm, an increase of 9.83% when compared to K_1, which was only 108.77 cm (Table 2). Researcher Mardianto (2014) stated that providing organic fertilizer containing N will encourage and accelerate growth and increase plant height. The highest maximum number of leaves was obtained in the K_3 treatment, namely 135.11, an increase of 9.85% compared to K_1, 122.99, (Table 2). Rusmana & Salim (2003) stated that the role of nitrogen, phosphorus and potassium for plants is to stimulate overall plant growth, especially stems, branches and leaves. The same thing was obtained from the results of research by Ani & Fathurrahman (2023) that overall, the application of 5 tons of cow manure ha^{-1} has significantly increased the growth and yield of red chili plants, namely plant height, more number of branches, number of fruit branches and total fruit weight per plant. increase. The highest maximum number of flowers was obtained in the K3 treatment, namely 157.57 flowers, an increase of 13.18% when compared to K_2, namely only 139.22 flowers (Table 2). It can be said that increasing production per hectare can be supported by increasing yield components such as maximum number of harvested fruit, maximum number of flowers, fresh weight of fruit and dry weight of fruit. Yusnaeni et al. (2021) from their research shows that the best treatment for the parameters of plant height, number of branches and number of fruit is a combination of 300 grams of chicken manure and 200 grams of cow manure. The increase in production per hectare cannot be separated from the function of solid rabbit fertilizer formulation plus cow manure as fertilizer which can improve soil conditions, can increase soil organic matter so that it can help it retain water better, increase absorption capacity and cation exchange capacity, the amount and metabolic activity of the soil. increases, as well as improving soil porosity which helps make the nutrients needed by plants more available (Yang et al., 2021; Wang et al., 2020).

The high variable values observed due to the formulation of cow fertilizer with rabbit fertilizer which caused the highest production per hectare in K_3 cannot be separated from the role of NPK contained in each rabbit and cow fertilizer and mutual support for the vegetative and generative growth of chili plants. According to Oga & Umekwe (2015), the results of their research stated that the application of NPK fertilizer had a significant effect on plant height, number of flowers, number of fruit, and the number of fruit that could be marketed on melons. The role of each element contained in rabbit and cow fertilizer is that it is an effective ingredient for plant growth and production. The N element is needed by plants for vegetative growth and protein formation, the P element is needed for cell division, growth and development of roots, flowers, fruit, increasing carbohydrate metabolism, increasing resistance to disease and the K element plays a role in strengthening plant tissue, improving physiological processes in plants, helping root development. Researchers Nurwanto & Sulistyaningsih (2017) found that a single application of potassium fertilizer of 2.7 g/plant got the best treatment in determining the quality of the fruit of cayenne pepper plants.

The better root development will be able to influence the plant's absorption of nutrients better so that it will support growth above ground such as chlorophyll, protein synthesis so that the assimilate produced in the photosynthesis process will be stored in the storage organ in the form of chili fruit in the form of increased production. Hendriyatno et al. (2019), stated that the function of N in plant growth is to stimulate vegetative growth, especially increasing the number of twigs, developing leaf area, root development, flower and fruit formation and is important in protein synthesis. In this research, it can be proven that the highest production per hectare was obtained in the formulation of solid rabbit fertilizer added with cow fertilizer (K_3), namely 7.30 tons ha^{-1}, which increased by 31.53% and 5.5% when compared to the provision of rabbit fertilizer, namely 5, 55 tons ha^{-1} (K_1) and the solid rabbit fertilizer formulation plus chicken fertilizer is 6.92 tons ha^{-1} (K_2) (Table 3). Research by Wirajaya et al. (2022) shows that the application of solid rabbit manure has a significant effect on the variable number of fruit per plant, fresh weight of fruit per plant and has a very significant effect on the variable production per hectare of chili plants. The treatment of giving 30 tons ha^{-1} of

solid rabbit fertilizer gave the highest value, namely 6.10 tons, an increase of 11.93% and 9.71% respectively when compared with 10 tons ha^{-1} and 20 tons ha^{-1} respectively 5, 45 tons and 5.56 tons. The high production per hectare of chilies in this study was supported by Prasetyo (2014) who found that treatment with 90 tons of cow manure gave the highest production of red chilies, namely 302.58 grams per plant, but the difference was not significant with the treatment 36 tons of chicken manure per hectare. Research by Ribeiro et al. (2017) stated that the best dose of cow manure for soil chemistry of 30 tons ha^{-1} (soil organic C) was able to improve soil fertility by increasing plant yields in the form of (dry weight of dried seeds per plant) in green bean plants. In this research, the addition of cow fertilizer to rabbit fertilizer (K_3) became a formulation that provided better binding of P elements as proven by plant height of 119.46 cm, number of flowers of 157.57 florets, fruit weight/production per hectare of 7.30 tons. Rabbit solid fertilizer as a source of organic fertilizer provided in this research contains very high levels of the macro elements N, P, K which from the analysis results can meet plant needs so that plant metabolism can run well. This is supported by Ahmad (2016) that the positive impact of rabbit compost fertilizer on soil fertility through the composition of carbon dioxide, water and minerals needed by plants such as N, P, K, thus rabbit compost fertilizer can be a source of nutrition for plants with simple processing of rabbit droppings. converted into compost which is very beneficial for increasing soil fertility and planting areas. The results of research by Amijaya et al. (2015), found that cow manure was able to increase soil pH and P uptake so that it could increase the weight of shallot bulbs. Chemically, as an organic fertilizer, cow manure can increase the cation exchange capacity so that the nutrients contained in the soil can be available, prevent nutrient loss due to the leaching process, and contains growth hormones that can stimulate plant growth. Furthermore, Wijayanti et al. (2013) stated that the combination of cow manure, goat manure and chicken manure each with a Urea dose of 200 kg ha-1 produced higher growth and yield of chilies than the combination of manure with other doses of Urea. Susilawati & Si (2019) stated that the amount of phosphorus (P) in plants is less than nitrogen and potassium. However, in reality phosphorus is considered the key to the survival of every plant. Wijayanti et al. (2013) from their research found that a combination of cow manure, goat manure and chicken manure each with a Urea dose of 200 kg ha^{-1} produced higher growth and yield of chilies than the combination of manure with other doses of Urea.

Although the application of dolomite fertilizer was not significantly different, the use of 720 kg ha^{-1} (D_3) of dolomite obtained the highest production, namely 7.33 tons, which increased 18.80% when compared to without application, namely 6.17 tons. The high production per hectare in D_3 is supported by the maximum number of fruit (r=0.767*), fresh weight of leaves (r=0.974**), dry weight of leaves (r=0.987**), fresh weight of stover (r=0.981**), dry weight of stover (r=0.991**), fresh weight of fruit (1.000) and dry weight of fruit (r=0.896**) (Table 5). Researchers Wang et al. (2020) stated that Mg-containing fertilizers alter plant performance by increasing yields or producing favorable physiological outcomes, providing great potential for integrated Mg management for higher crop yields and quality. The mechanism by which Ca and Mg are absorbed so that they can penetrate the membrane in the form of ions is greatly influenced by internal and external factors. From the research results of Pertiwi et al. (2020), it was found that there was an effect of applying dolomite fertilizer doses on plant height, stem diameter, leaf width, tomato fruit, and fresh weight of tomato fruit. The best treatment is a dolomite dose of 101.25 g. Internal factors are plant type, root tissue content, plant respiration rate. External factors include soil aeration, temperature, pH, humidity and composition and concentration of ions in the soil. Because there is still a large influence of internal and external factors determining the role of dolomite fertilizer when it is needed by plants to be able to produce well, in this study dolomite fertilizer did not show any different production between treatments. During the research, the role of dolomite fertilizer was not only to improve soil fertility, it was also seen in the field by increasing plant resistance to pests and diseases.

Table 4
Correlation Coefficient Values between Plant Variables Effect of Adding Fertilizer Types

	Cage (K)										
	1	2	3	4	5	6	7	8	9	10	11
1	1										
2	0,997**	1									

3	0,890**	0,853**	1								
4	0,960**	0,937**	0,982**	1							
5	0,800**	0,843**	0,438ns	0,601ns	1						
6	0,838**	0,877**	0,498ns	0,654ns	0,998**	1					
7	0,819**	0,860**	0,467ns	0,626ns	0,999**	0,999**	1				
8	0,852**	0,889**	0,520ns	0,673*	0,996**	1,000**	0,998**	1			
9	0,913**	0,941**	0,626ns	0,763*	0,975**	0,988**	0,982**	0,992**	1		
10	0,997**	1,000**	0,854**	0,938**	0,841**	0,876**	0,858**	0,888**	0,940**	1	
11	0,915**	0,943**	0,630ns	0,767*	0,974**	0,987**	0,981**	0,991**	1,000**	0,942**	1
			r (0.05, 9, 1) = 0,666		r (0.01, 9, 1) = 0,798						

Table 5
Correlation Coefficient Values between Plant Variables Effect of Dolomite Fertilizer (D)

	1	2	3	4	5	6	7	8	9	10	11
1	1										
2	0,649ns	1									
3	0,408ns	0,847**	1								
4	0,044ns	0,648ns	0,929**	1							
5	-0,920**	-0,488ns	-0,446ns	-0,132ns	1						
6	-0,904**	-0,486ns	-0,468ns	-0,165ns	0,999**	1					
7	-0,844**	-0,252ns	-0,230ns	0,068ns	0,967**	0,965**	1				
8	-0,763*	-0,392ns	-0,521ns	-0,287ns	0,952**	0,964**	0,930**	1			
9	-0,700*	-0,374ns	-0,556ns	-0,352ns	0,916**	0,934**	0,892**	0,995**	1		
10	-0,815**	-0,210ns	-0,210ns	0,076ns	0,956**	0,955**	0,999**	0,932**	0,897**	1	
11	-0,699*	-0,376ns	-0,558ns	-0,355ns	0,915**	0,933**	0,891**	0,995**	1,000**	0,896**	1
	r (0.05, 9, 1) = 0,666				r (0.01, 9, 1) = 0,798						

Note:
1. Maximum plant height
2. Maximum number of leaves
3. Maximum number of flowers
4. Maximum number of fruits
5. Fresh weight of leaves
6. Dry weight of leaves
7. Fresh weight of stover
8. Dry weight of stover
9. Fresh weight of fruit
10. Dry weight of fruit
11. Production per hectare

ns = Not significant effect (P>0.05)
* = Significant effect (P<0,05)
** = Very significant effect (P<0.01)

4 Conclusion

The conclusions from the results of this research are as follows:

1. The interaction between the addition of manure to rabbit fertilizer and dolomite fertilizer has an insignificant effect on all observed variables.
2. The highest production per hectare of chili plants was obtained from the rabbit fertilizer formulation with the addition of cow fertilizer at K3, namely 7.30 tons ha-1, not significantly different from the rabbit fertilizer formulation with the addition of chicken fertilizer K2 with a value of 6.92 tons ha-1 and significantly different from rabbit fertilizer K1 with a value of 5.55 tons. ha-1 and K3 experienced an increase of 5.5% and 31.53% respectively.
3. 3. Giving 720 kg ha-1 dolomite fertilizer D3 gave the highest production, namely 7.33 tons and was not significantly different from the treatment without dolomite fertilizer 0 kg ha-1 D0, 240 kg ha-1

dolomite fertilizer D1 and 480 kg ha-1 dolomite fertilizer D2 with values of 6,17 tons, 6.07 tons and 6.8 tons respectively.

Acknowledgments
We would like to express our thanks to the Chancellor and Research Institute of Warmadewa University who have supported and provided funding, as well as the Dean of the Faculty of Agriculture, Warmadewa University, fellow lecturers and students for their cooperation so that this research can run smoothly.

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