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Application of Goat Manure and Dolomite Fertilizer Doses on Chrysanthemum Growth and Yield

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Abstract
Chrysanthemum (Dendranthema grandiflora, Tzelev) is a high-value floricultural commodity with increasing market demand. This study aims to determine the effect of the dose of goat manure and dolomite fertilizer on the growth and yield of chrysanthemum plants, as well as to determine the most effective dose. The research was carried out in Pancasari Village, Sukasada District, Buleleng Regency, Bali, using a factorial Randomized Block Design (RBD) with two factors, namely the dose of goat manure (K1 = 5 tons ha-1, K2 = 10 tons ha-1, K3 = 15 tons ha-1) and the dose of dolomite fertilizer (D1 = 2 tons ha-1, D2 = 4 tons ha-1, D3 = 6 tons ha-1). The results showed that the interaction between the two treatments had no significant effect on the observed variables. Goat manure at a dose of 15 tons ha-1 (K3) produced the highest economic fresh flower weight of 43.77 g, an increase of 18.81% compared to the dose of 5 tons ha-1 (K1). Dolomite fertilizer at a dose of 6 tons ha-1 (D3) produced the highest flower stalk weight of 52.44 g. Goat manure and dolomite fertilizer applied separately each had a significant effect on the growth and yield of chrysanthemums.

Keyword: *chrysanthemum; goat manure; dolomite fertilizer; growth; yield.*

1. Introduction

Chrysanthemum (Dendranthema grandiflora, Tzelev) is one of the high-value horticultural commodities with increasing market demand globally. In addition to serving as a decorative element on various occasions, this flower also has symbolic and aesthetic value in various cultures. According to [1], market demand for chrysanthemums is elastic and is influenced by price, seasonality, and consumer preferences for various varieties. In Indonesia, the distribution and marketing of chrysanthemums often face challenges in the form of long supply chains and price fluctuations between regions. Studies by [2] suggest that marketing efficiency can be improved through a structured approach that involves collaboration between farmers and traders. Previously, plant breeders in the United Kingdom and the Netherlands developed several types of local chrysanthemums, producing more than 500 varieties, some of which survive to this day [3].

Chrysanthemum cultivation develops through two main approaches, namely the traditional method using raised beds (guludan) and the modern method using pots, each of which exerts a different influence on water needs and financial results [4]. In addition to commercial purposes, chrysanthemums also have significant cultural and tourism value. The city of Kaifeng in China, for example, has made chrysanthemums a tourist attraction through annual festivals and the development of chrysanthemum-based products [5].

In Indonesia, the potential of chrysanthemums in supporting agro-tourism is very promising, especially in rural areas such as Pasuruan, East Java. Studies by [6] show that chrysanthemum development not only provides economic benefits for farmers, but also contributes to the

development of sustainable agricultural tourism areas. Biological control of disease using Corynebacterium-2 bacteria has shown promising results [7].

Dolomite is an effective source of calcium and magnesium that can raise the pH of acidic soils, improve soil structure, and support nutrient absorption. Dolomite application has been shown to significantly increase the stem length and fresh weight of chrysanthemums, particularly at an optimal dose of 450 kg ha-1 [8].

In addition to dolomite, goat manure is an important component in organic farming systems. Goat manure contains higher P and K than cow manure; the P and K content of goat manure is 1.14% and 2.49%, respectively, while cow manure contains 1.08% P and 0.69% K [9]. Research by [10] shows that the application of goat manure can significantly increase leaf area, flower diameter, fresh flower weight, and stalk weight. The combination of organic and inorganic fertilizers has also been shown to be effective in increasing the efficiency of nutrient absorption [11]. Goat manure has an N content of 2.10%, P2O5 0.66%, K2O 1.97%, Ca 1.64%, Mg 0.60%, Mn 2.33 ppm, and Zn 90.8 ppm, so goat manure can be used to improve the nutrient status of the soil [12]. Based on this background, this study aims to determine the effect of goat manure and dolomite fertilizer doses on the growth and yield of chrysanthemum plants, and to determine the most effective dose of each.

2. Materials and Methods

This research was conducted in Pancasari Village, Sukasada District, Buleleng Regency, Bali, at the Agro Pudak Lestari ornamental plant farmer group, located at an altitude of 1,247 meters above sea level with an average temperature of 17–20°C. The research was carried out from January to April 2025. Research materials and tools included hoes, cultivators, special scissors, stationery, goat manure, calipers, electric scales, labels, inorganic fertilizers, pesticides, and fungicides.

This study used a quantitative method with a factorial Randomized Block Design (RBD) consisting of two factors. The first factor was the dose of goat manure (K), consisting of three levels: K1 = 5 tons ha-1, K2 = 10 tons ha-1, and K3 = 15 tons ha-1. The second factor was the dose of dolomite fertilizer (D), consisting of three levels: D1 = 2 tons ha-1, D2 = 4 tons ha-1, and D3 = 6 tons ha-1. The combination of the two factors produced nine treatment combinations, each replicated to form blocks based on the Randomized Block Design.

The variables observed in this study included maximum plant height, number of leaves, stem diameter (at 30, 60, and 90 days after planting), age at first flower appearance, number of flowers, flower diameter, flower stalk length, flower stalk weight, and economical fresh flower weight. Data were analyzed using analysis of variance (ANOVA), and treatments showing significant effects were further tested using the Least Significant Difference (LSD) test at the 5% level. Correlation analysis was also conducted to examine the relationship between the economical fresh flower weight and its supporting variables.

3. Results and Discussion

3.1 Results

Based on the results of statistical analysis of all variables observed in the study, the significance of the doses of goat manure (K) and dolomite fertilizer (D) and their interaction (K x D) on the observed variables is presented in Table 1.

The interaction between goat manure and dolomite fertilizer (K x D) had no significant effect ($P \geq 0.05$) on any of the observed variables. The goat manure treatment (K) had a highly significant effect ($P < 0.01$) on all observed variables except stem diameter at 60 days after planting (DAP), which was not significant. The dolomite fertilizer treatment (D) had a highly significant effect ($P < 0.01$) on maximum plant height, number of leaves, and stem diameter at 30 DAP; a significant effect ($P < 0.05$) on stem diameter at 90 DAP, age at first flower appearance, number of flowers, and flower diameter; and no significant effect ($P \geq 0.05$) on stem diameter at 60 DAP, flower stalk length, flower stalk weight, and economical fresh flower weight.

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Table 1. Significance of the doses of goat manure (K) and dolomite fertilizer (D) and their interaction (K x D) on the variables observed in chrysanthemum plants

No.	Observed Variable	Interaction (K x D)	K	D
1	Maximum Plant Height (cm)	ns	**	**
2	Number of Leaves (strands)	ns	**	**
3a	Stem Diameter 30 DAP (mm)	ns	**	**
3b	Stem Diameter 60 DAP (mm)	ns	ns	ns
3c	Stem Diameter 90 DAP (mm)	ns	**	*
4	Age at First Flower Appearance (days)	ns	**	*
5	Number of Flowers (florets)	ns	**	*
6	Flower Diameter (mm)	ns	**	*
7	Flower Stalk Length (cm)	ns	**	ns
8	Flower Stalk Weight (g)	ns	**	ns
9	Economical Fresh Flower Weight (g)	ns	**	ns

Note: * = significant effect (P<0.05); ** = highly significant effect (P<0.01); ns = not significant (P≥0.05).

3.1.1 Maximum Plant Height

The highest average maximum plant height for the goat manure treatment was found at the K3 dose (15 tons ha-1), at 94.19 cm, while the lowest was found at the K1 dose (5 tons ha-1), at 80.50 cm (Table 2). Meanwhile, for the dolomite fertilizer treatment, the highest maximum plant height was found at the D3 dose (6 tons ha-1), at 90.51 cm, and the lowest at the D1 dose (2 tons ha-1), at 84.07 cm.

3.1.2 Maximum Number of Leaves

The highest average maximum number of leaves for the goat manure treatment was found at the K3 dose (15 tons ha-1), at 36.33 strands, while the lowest was found at the K1 dose (5 tons ha-1), at 25.78 strands. For the dolomite fertilizer treatment, the highest maximum number of leaves was found at the D3 dose (6 tons ha-1), at 32.56 strands, and the lowest at the D1 dose (2 tons ha-1), at 29.78 strands.

Table 2. Average maximum plant height and maximum number of leaves under application of goat manure and dolomite fertilizer doses

Treatment	Maximum Plant Height (cm)	Maximum Number of Leaves (strands)
Goat Manure (K)		
K1 (5 tons ha-1)	80.50 c	25.78 c
K2 (10 tons ha-1)	88.73 b	31.22 b
K3 (15 tons ha-1)	94.19 a	36.33 a
LSD 5%	3.108	1.317
Dolomite Fertilizer (D)		
D1 (2 tons ha-1)	84.07 b	29.78 b
D2 (4 tons ha-1)	88.84 a	31.00 b
D3 (6 tons ha-1)	90.51 a	32.56 a
LSD 5%	3.108	1.317

Remarks: Average values followed by the same letter within the same column show no significant difference at the 5% LSD test level.

3.1.3 Stem Diameter

Stem diameter at 30 days after planting. The highest average stem diameter at 30 DAP for the goat manure treatment was found at the K3 dose (15 tons ha-1), at 4.31 mm, while the lowest was found at the K1 dose (5 tons ha-1), at 3.52 mm. For the dolomite fertilizer treatment, the highest stem diameter at 30 DAP was found at the D3 dose (6 tons ha-1), at 4.12 mm, and the lowest at the D1 dose (2 tons ha-1), at 3.77 mm.

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Stem diameter at 60 days after planting. The highest average stem diameter at 60 DAP for the goat manure treatment was found at the K3 dose (15 tons ha-1), at 4.80 mm, while the lowest was found at the K1 dose (5 tons ha-1), at 4.62 mm. For the dolomite fertilizer treatment, the highest stem diameter at 60 DAP was found at the D3 dose (6 tons ha-1), at 4.79 mm, and the lowest at the D1 dose (2 tons ha-1), at 4.65 mm.

Stem diameter at 90 days after planting. The highest average stem diameter at 90 DAP for the goat manure treatment was found at the K3 dose (15 tons ha-1), at 5.68 mm, while the lowest was found at the K1 dose (5 tons ha-1), at 4.71 mm. For the dolomite fertilizer treatment, the highest stem diameter at 90 DAP was found at the D3 dose (6 tons ha-1), at 5.56 mm, and the lowest at the D1 dose (2 tons ha-1), at 5.13 mm.

Table 3. Average stem diameter at 30, 60, and 90 days after planting under application of goat manure and dolomite fertilizer doses

Treatment	Stem Diameter 30 DAP (mm)	Stem Diameter 60 DAP (mm)	Stem Diameter 90 DAP (mm)
Goat Manure (K)			
K1 (5 tons ha-1)	3.52 b	4.62 a	4.71 c
K2 (10 tons ha-1)	4.11 a	4.69 a	5.52 b
K3 (15 tons ha-1)	4.31 a	4.80 a	5.68 a
LSD 5%	0.191	ns	0.306
Dolomite Fertilizer (D)			
D1 (2 tons ha-1)	3.77 b	4.65 a	5.13 b
D2 (4 tons ha-1)	4.05 a	4.66 a	5.22 b
D3 (6 tons ha-1)	4.12 a	4.79 a	5.56 a
LSD 5%	0.191	ns	0.306

Remarks: Average values followed by the same letter within the same column show no significant difference at the 5% LSD test level.

3.1.4 Age at First Flower Appearance

The highest average age at first flower appearance for the goat manure treatment was found at the K1 dose (5 tons ha-1), at 84.67 days, while the lowest was found at the K3 dose (15 tons ha-1), at 78.33 days. For the dolomite fertilizer treatment, the highest age at first flower appearance was found at the D1 dose (2 tons ha-1), at 83.00 days, and the lowest at the D3 dose (6 tons ha-1), at 79.78 days.

Table 4. Average age at first flower appearance and number of flowers under application of goat manure and dolomite fertilizer doses

Treatment	Age at First Flower Appearance (days)	Number of Flowers (florets)
Goat Manure (K)		
K1 (5 tons ha-1)	84.67 a	8.67 c
K2 (10 tons ha-1)	81.89 b	11.89 b
K3 (15 tons ha-1)	78.33 c	14.89 a
LSD 5%	2.550	1.639
Dolomite Fertilizer (D)		
D1 (2 tons ha-1)	83.00 a	10.56 b
D2 (4 tons ha-1)	82.11 ab	12.00 ab
D3 (6 tons ha-1)	79.78 b	12.89 a
LSD 5%	2.550	1.639

Remarks: Average values followed by the same letter within the same column show no significant difference at the 5% LSD test level.

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3.1.5 Number of Flowers

The highest average number of flowers for the goat manure treatment was found at the K3 dose (15 tons ha-1), at 14.89 florets, while the lowest was found at the K1 dose (5 tons ha-1), at 8.67 florets. For the dolomite fertilizer treatment, the highest number of flowers was found at the D3 dose (6 tons ha-1), at 12.89 florets, which was not significantly different from the D2 dose (4 tons ha-1), while the lowest was found at the D1 dose (2 tons ha-1), at 10.56 florets.

Table 5. Average flower diameter and flower stalk length under application of goat manure and dolomite fertilizer doses

Treatment	Flower Diameter (cm)	Flower Stalk Length (cm)
Goat Manure (K)		
K1 (5 tons ha-1)	7.81 b	115.52 c
K2 (10 tons ha-1)	8.60 a	129.00 b
K3 (15 tons ha-1)	8.72 a	139.57 a
LSD 5%	0.233	8.106
Dolomite Fertilizer (D)		
D1 (2 tons ha-1)	8.23 b	124.58 a
D2 (4 tons ha-1)	8.33 b	127.29 a
D3 (6 tons ha-1)	8.57 a	132.22 a
LSD 5%	0.233	ns

Remarks: Average values followed by the same letter within the same column show no significant difference at the 5% LSD test level.

3.1.6 Flower Diameter

The highest average flower diameter for the goat manure treatment was found at the K3 dose (15 tons ha-1), at 8.72 cm, while the lowest was found at the K1 dose (5 tons ha-1), at 7.81 cm. For the dolomite fertilizer treatment, the highest flower diameter was found at the D3 dose (6 tons ha-1), at 8.57 cm, and the lowest at the D1 dose (2 tons ha-1), at 8.23 cm.

3.1.7 Flower Stalk Length

The highest average flower stalk length for the goat manure treatment was found at the K3 dose (15 tons ha-1), at 139.57 cm, while the lowest was found at the K1 dose (5 tons ha-1), at 115.52 cm.

Table 6. Average flower stalk weight and economical fresh flower weight under application of goat manure and dolomite fertilizer doses

Treatment	Flower Stalk Weight (g)	Economical Fresh Flower Weight (g)
Goat Manure (K)		
K1 (5 tons ha-1)	43.33 b	36.84 b
K2 (10 tons ha-1)	51.55 a	40.55 a
K3 (15 tons ha-1)	55.00 a	43.77 a
LSD 5%	4.02	3.32
Dolomite Fertilizer (D)		
D1 (2 tons ha-1)	48.11 a	38.84 a
D2 (4 tons ha-1)	51.33 a	40.66 a
D3 (6 tons ha-1)	52.44 a	41.66 a
LSD 5%	ns	ns

Remarks: Average values followed by the same letter within the same column show no significant difference at the 5% LSD test level.

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3.1.8 Flower Stalk Weight

The highest average flower stalk weight for the goat manure treatment was found at the K3 dose (15 tons ha-1), at 55.00 g, while the lowest was found at the K1 dose (5 tons ha-1), at 43.33 g. For the dolomite fertilizer treatment, the highest flower stalk weight was found at the D3 dose (6 tons ha-1), at 52.44 g, and the lowest at the D1 dose (2 tons ha-1), at 48.11 g.

3.1.9 Economical Fresh Flower Weight

The highest average economical fresh flower weight for the goat manure treatment was found at the K3 dose (15 tons ha-1), at 43.77 g, while the lowest was found at the K1 dose (5 tons ha-1), at 36.84 g. For the dolomite fertilizer treatment, the highest economical fresh flower weight was found at the D3 dose (6 tons ha-1), at 41.66 g, and the lowest at the D1 dose (2 tons ha-1), at 38.84 g.

3.2 Discussion

The highest economical fresh flower weight was obtained at the goat manure dose of 15 tons ha-1 (K3), at 43.77 g, an increase of 18.81% from the lowest economical fresh flower weight obtained at the dose of 5 tons ha-1 (K1), at 36.84 g. This increase in economical fresh flower weight was supported by the number of flowers (r = 1.000**), flower diameter (r = 0.935**), and flower stalk length (r = 1.000**). The highest number of flowers was obtained at the goat manure dose of 15 tons ha-1 (K3), at 14.89 florets, an increase of 71.74% from the lowest number of flowers obtained at the dose of 5 tons ha-1 (K1), at 8.67 florets. The highest flower diameter was obtained at the goat manure dose of 15 tons ha-1 (K3), at 8.72 cm, an increase of 11.65% from the lowest flower diameter obtained at the dose of 5 tons ha-1 (K1), at 7.81 cm. The highest flower stalk length was obtained at the goat manure dose of 15 tons ha-1 (K3), at 139.57 cm, an increase of 20.81% from the lowest flower stalk length obtained at the dose of 5 tons ha-1 (K1), at 115.52 cm.

Goat manure has an N content of 2.10%, P2O5 0.66%, K2O 1.97%, Ca 1.64%, Mg 0.60%, Mn 2.33 ppm, and Zn 90.8 ppm [13]. As an organic material, goat manure increases soil infiltration capacity, improves the soil's ability to hold groundwater, and increases microbial activity. The potential of goat manure as an organic fertilizer is considerable because it contains the nutrients needed by plants and does not disturb soil microorganism habitats [14]. With increased microbial activity, the decomposition of soil organic matter is accelerated, so that the nutrients contained in the soil can be released and become available to plants [15].

Dolomite fertilizer treatment produced the highest flower stalk weight at the dose of 6 tons ha-1 (D3), at 52.44 g, an increase of 9.00% from the lowest flower stalk weight obtained at the dose of 2 tons ha-1 (D1), at 48.11 g. This increase in flower stalk weight was supported by maximum plant height (r = 1.000**), maximum number of leaves (r = 0.941**), number of flowers (r = 0.990**), and flower stalk length (r = 0.905**). The highest maximum plant height was obtained at the dolomite fertilizer dose of 6 tons ha-1 (D3), at 90.51 cm, an increase of 7.66% from the lowest maximum plant height obtained at the dose of 2 tons ha-1 (D1), at 84.07 cm. The highest maximum number of leaves was obtained at the dolomite fertilizer dose of 6 tons ha-1 (D3), at 32.56 strands, an increase of 9.33% from the lowest maximum number of leaves obtained at the dose of 2 tons ha-1 (D1), at 29.78 strands. The highest number of flowers was obtained at the dolomite fertilizer dose of 6 tons ha-1 (D3), at 12.89 florets, an increase of 22.06% from the lowest number of flowers obtained at the dose of 2 tons ha-1 (D1), at 10.56 florets. The highest flower stalk length was obtained at the dolomite fertilizer dose of 6 tons ha-1 (D3), at 132.22 cm, an increase of 6.13% from the lowest flower stalk length obtained at the dose of 2 tons ha-1 (D1), at 124.58 cm.

Dolomite is able to supply nutrients to the soil and contains other micronutrients, so it can support plant growth and development [16]. Improper liming dosage can affect the availability of phosphorus in the soil; in acidic soils, phosphorus is unavailable because it is bound by Al to form Al-P, while soils with high lime content do not necessarily have high fertility either, since excessive application can be toxic because lime will bind soil P to form Ca-P, even though this

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nutrient is needed for plant growth. A study showed that applying 1 kg of dolomite to a single oil palm tree was able to increase soil phosphate levels by 47%, potassium by 16%, and magnesium by 32%, thereby promoting root development [17]. Dolomite ($CaMg(CO_3)_2$) is a type of lime containing the nutrients calcium carbonate ($CaCO_3$) and magnesium carbonate ($MgCO_3$). Dolomite lime contains 30.4% CaO, 47.7% CO_2, 21.9% MgO, and small amounts of iron, manganese, silica, and other compounds (0.05%) [18]. According to [19], the application of lime as an ameliorant material can increase soil pH due to the conversion of several H+ ions into water. In addition to neutralizing soil pH, other advantages of dolomite include increasing root growth, improving soil structure, improving plant quality, and increasing soil fertility because it can suppress several types of fungi or bacteria in the soil [20].

4. Conclusion

The interaction between the type of goat manure and dolomite fertilizer had no significant effect on any of the observed variables. Goat manure treatment produced the highest economical fresh flower weight at a dose of 15 tons ha-1, at 43.77 g, an increase of 18.81% from the lowest economical fresh flower weight obtained at a dose of 5 tons ha-1, at 36.84 g. Dolomite fertilizer treatment produced the highest economical fresh flower weight at a dose of 6 tons ha-1, at 41.66 g, an increase of 9.00% from the lowest economical fresh flower weight obtained at a dose of 2 tons ha-1, at 38.84 g.

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