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Application of Cow Manure and Dolomite on Mung Bean (*Vigna radiata* L.) Plants

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ABSTRACT

The plant growth and yield could be influenced by the soil ameliorants. This study was to obtain the effect of cow manure, dolomite, and their interactions on the growth and yield of mung bean plants. This study was conducted at Marindal II Village, Patumbak Subdistrict, Deli Serdang District, North Sumatra from February to May 2022. A factorial randomized block design was selected in this study with the first factor being the dosage of cow manure (0; 2.5; 5 tons ha^{-1}) and the second factor was the dolomite lime (0; 1; 2 kg $plot^{-1}$) within three replications. Data were analyzed using ANOVA and further tested by Duncan at P<0.05. The results showed an increase in dry weight, seed weight $plot^{-1}$, 100-seed weight, and yield ha^{-1} of mung bean were found in 5 tons ha^{-1} of cow manure dose by 19.06%; 103.62%; 6.48%; and 2.04 times. The plant height and dry weight of mung bean as well as soil pH also increased in 2 kg $plot^{-1}$ of dolomite dose were 24.55; 15.68; and 7.68%. Their interaction of cow manure and dolomite had a slight impact on the growth and yield of mung bean plants.

Key words: Ameliorant; Bulk density; Growth; Soil pH; Yield

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INTODUCTION

Mung bean (*Vigna radiata* L.) plants are food crops whose distribution is still relatively rare in North Sumatra. The area of mung bean planting in North Sumatra of 1,221 ha in 2021 with productivity of 10.02 tons/ha and the five largest distribution districts in order are Langkat, Serdang Bedagai, Deli Serdang, Padang Lawas, and North Padang Lawas (Statistics of Sumatera Utara, 2021). Based on the location quotient analysis, mung beans are classified as basic (more than 1) compared to other food crops such as soybeans and cassava in North Sumatra (Iyan, 2014; Sihombing, 2018). It was interpreted that the mung bean has a comparative advantage, not only does its yield fulfill the needs of the area, but it can also be exported to other areas, providing significant potential for development.

The development of mung bean yield is inseparable from agronomic, agro-climatic and soil, plant protection, and hybrid seeds (plant breeding) aspects. Based on soil aspects can be through the ameliorants-treated which aimed to improve soil quality. Soil amendments from organic matter such as crop residues, animal manures, and green manures directly affect soil organic content, soil chemical and physical characteristics, as well as microbial activity (Escobar & Hue, 2008; Roy & Kashem, 2014). Among animal manures, cow manure had higher C-organic content compared to chicken and goat manure (Maerere et al., 2001). Mokgolo, (2016) added that cow manure increased cation exchange capacity, exchangeable cations (Ca, Mg, K), total-N, and available-P compared to chicken manure at a similar dose. According to Zaman et al. (2017) that the application of cow manure can increase the content of total-N, available-P, exchangeable cations (K, Ca, Mg), available-S, Zn, and B in the soil. Adekiya et al. (2016) also found that the application of cow manure can increase the porosity, water content, and infiltration rate of the soil but decrease the bulk density, soil temperature, and soil dispersion ratio. In addition, cow manure as a soil ameliorant can increase mung bean yield. Ribeiro et al. (2017) also reported that a dose of 30 tons ha^{-1} of cow manure could be increased organic-C and improved soil fertility and have an impact on increasing the seed dry weight of mung bean.

The output of cow manure application to achieve optimal plant performance needs to be supported by the addition of agricultural lime such as dolomite. Several studies on the combination of animal manures with dolomite have been reported to improve the performance of legume crops. Herdiawan, (2016) reported that the combination of 10 tons ha^{-1} manures with 2 tons ha^{-1} dolomite significantly increased the biomass of tropical kudzu legume plants compared to other interactions. Arangote et al., (2019) found the combination of chicken manure+dolomite and goat manure+dolomite significantly improved soil chemical characteristics and peanut growth and yield compared to the use of manures without dolomite. Islam et al., (2021) added that the combination of cow manure and dolomite (5+1 tons ha^{-1}) significantly increased nutrient uptake of N, P, K, and yield ha^{-1} of mung bean plants. Ribeiro et al., (2017) also reported that the interaction of 30 tons ha^{-1} cow manure + 480 kg ha^{-1} dolomite significantly increased soil pH and total-N and the number of pods in mung bean.

Based on previous studies, the use of a combination of cow manure with dolomite had a synergism in increasing soil productivity and mung bean plants. However, a similar study should be conducted to extend the understanding and could be used as a reference for farmers in increasing mung bean yield in North Sumatra. This study aimed to obtain the effect of cow manure, dolomite, and their interactions on the growth and yield of mung bean plants.

METHODS AND MATERIALS

Location and Study Methods. This study was conducted in Marindal II Village, Patumbak Subdistrict, Deli Serdang District, North Sumatra from February to May 2022. This study used a factorial randomized block design. The first factor was the dose of cow manure (0; 2.5; 5 tons ha^{-1}) and the second factor was the dose of dolomite (0; 1; 2 kg plot^{-1}) with three replications.

Study Procedures. The land was formed with a size of 60×60 cm then cleaned and inflated the soil. The soil was incubated for two days then dolomite was sown according to the treatment and uniformly stirred by a hoe, after which it was incubated for 10 days. Cow manure was sown according to the treatment and mixed thoroughly and left for a week. The mung bean seed used was the Vima-1 variety. Seeds were selected with the criteria of uniformity and filled, then soaked for an hour. A plant spacing of 40×20 cm was measured and two seeds per hole were planted at a depth of 1 cm. After 7 days, one seedling with uniform growth was selected. Plants were growing such as watering daily, manual weed control, pest and disease control by spraying chlorfenapyr insecticide at a dose of 2 ml l^{-1}. Basic fertilization of NPK 16-16-16 at a dose of 350 kg ha^{-1} or equivalent 2.8 g plant^{-1} at 10 days after planting (DAP) by immersing. Then observed growth data until harvest at the age of 60 DAP.

Data Collection and Analysis. This study collected plant growth such as plant height at 2, 4, and 6 weeks after planting (WAP), the number of leaves at 2 and 4 WAP, as well as dry weight and root length at the end of the study (60 DAP). Plant yield was measured such as the number of pods, seed weight plot^{-1}, 100 seed weight, and yield ha^{-1} at 60 DAP. The calculation of 100 seed weight was conducted by selecting 100 seeds of uniform size and weight. The calculation of yield ha^{-1} was conducted by converting the seed weight plot^{-1} using equation 1. The dry weight was determined by oven at 80°C for 48 hours (Seras, 1994). Soil samples were taken at a depth of 0-20 cm using a sampling ring and soil pH and bulk density were measured. Soil pH was measured using a pH meter with buffer solutions of pH 7 and 4. Soil bulk density was measured by oven of the soil sample+ring at 105°C for 3 hours (Soil Research Center, 2005). Then the soil was removed from the ring, then the soil weight and the ring volume (πr2t) were measured using equation 2. Data were analyzed using ANOVA and further tested by DMRT 5% using IBM SPSS. Data on soil density and pH were analyzed for Pearson correlation to mung bean growth and yield.

$$\text{Yield (kg ha}^{-1}\text{)} = \frac{Land\ area\ per\ ha}{Plot\ area}\ x\ seed\ weight\ plot^{-1} \quad [1]$$

$$\text{Bulk density (g cm}^{-3}\text{)} = \frac{Dry\ soil\ weight}{Ring\ volume} \quad [2]$$

RESULT AND DISCUSSION

Plant Growth

Dolomite significantly increased plant height growth at 4 WAP and dry weight of mung bean plants, but it was an insignificant effect on the number of leaves and root length. Application of cow manure significantly increased the dry weight of mung bean plants, but it was an insignificant effect on plant height, number of leaves, and root length. Their interactions insignificantly affect the plant height, number of leaves, root length, and dry weight of mung bean (Table 1).

Table 1. Mung bean growth due to cow manure, dolomite, and their interactions.

Treatments	Plant height (cm)			Number of leaves		Root length (cm)	Dry weight (g)
	2 WAP	4 WAP	6 WAP	2 WAP	4 WAP		
Cow manure (C)							
C0	10.78	15.55	24.52	5.04	16.41	24.18	28.75 b
C1	10.15	13.33	24.41	5.00	17.74	23.74	31.70 a
C2	10.63	13.63	26.26	5.07	18.30	23.96	34.23 a
Dolomite (D)							
D0	10.26	13.44 b	24.33	5.00	17.15	23.59	28.83 b
D1	10.26	12.33 b	25.00	4.93	17.33	24.59	32.50 a
D2	11.04	16.74 a	25.85	5.19	17.96	23.70	33.35 a
Interactions (C×D)							
C0D0	10.44	16.33	23.33	5.00	15.22	23.22	24.69
C0D1	10.56	12.45	25.11	4.78	16.89	24.55	31.68
C0D2	11.34	17.89	25.11	5.33	17.11	24.78	29.89
C1D0	10.44	12.33	24.11	5.00	16.89	23.11	30.43
C1D1	10.22	12.89	24.67	5.00	17.89	25.00	30.31
C1D2	9.78	14.78	24.44	5.00	18.45	23.11	34.35
C2D0	9.89	11.67	25.55	5.00	19.33	24.44	31.36
C2D1	10.00	11.67	25.22	5.00	17.22	24.22	35.50
C2D2	12.00	17.56	28.00	5.22	18.33	23.22	35.82
CV (%)	7.79	22.17	13.81	6.76	14.16	12.53	9.16

Note: average followed by letters in the respective columns indicated that the differences were significant by DMRT at *P*<0.05. Cow manure (C0= 0; C1= 2.5; C3= 5 tons ha^{-1}). Dolomite (D0= 0; D1= 1; D2= 2 kg plot^{-1}).

Table 1 indicated that there was an increase in plant height of mung bean at the dolomite dose of 2 kg plot^{-1} by 24.55% compared to the control at 4 WAP. Likewise, the dry weight increased along with the increase of dolomite dose up to 2 kg plot^{-1} and cow manure up to 5 tons ha^{-1} by 15.68 and 19.06%, respectively. The relationship of dolomite doses to the plant height of mung bean at 4 WAP and dry weight could be seen in Figure 1. The dolomite doses had a quadratic relationship pattern (ŷ= 2.7572x2-9.3794x+20.064) to the plant height of mung bean at 4 WAP and had a linear relationship pattern to dry weight with the equation ŷ= 2.2622x+27.034.

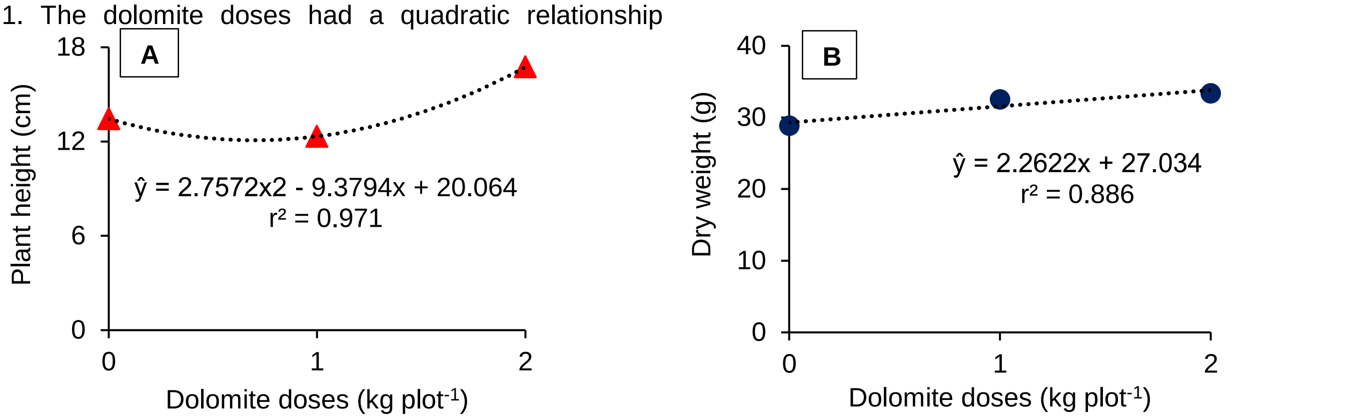

Figure 1. The relationship of dolomite doses to the plant height of mung bean (A) and dry weight (B)

Plant Yield

The application of cow manure significantly increased all mung bean yield characters except the number of pods. Dolomite application and their interactions were insignificant effects on all yield characters of mung bean (Table 2). There was a significant increase in yielding characters such as seed weight plot^{-1}, 100 seed weight, and yield ha^{-1} of mung bean along with increased the doses of cow manure up to 5 tons ha^{-1} by 103.62%; 6.48%; and 2.04 times compared to the control, respectively. Although the effect was insignificant, the number of pods also increased with 2.5 and 5 tons ha^{-1} of cow manure compared to the control.

Tabel 2. Plant yield due to cow manure, dolomite, and their interactions

Treatments	Number of pods	Seed weight plot^{-1} (g)	100 seed weight (g)	Yield (kg ha^{-1})
Cow manure (C)				
C0	4,89	15,48 c	3,24 b	430,03 c
C1	6,78	20,78 b	3,29 b	577,16 b
C2	6,52	31,52 a	3,45 a	875,56 a
Dolomite (D)				
D0	5,59	22,89	3,34	635,80
D1	6,74	22,85	3,27	634,78
D2	5,85	22,04	3,37	612,16
Interactions (C×D)				
C0D0	4,00	12,33	3,32	342,59
C0D1	6,11	16,67	3,20	462,96
C0D2	4,56	17,44	3,20	484,54
C1D0	5,44	21,89	3,30	607,96
C1D1	7,56	21,33	3,22	592,59
C1D2	7,33	19,11	3,34	530,93
C2D0	7,33	34,45	3,39	956,85
C2D1	6,56	30,56	3,38	848,80
C2D2	5,67	29,56	3,58	821,02
CV (%)	20,34	18,61	3,43	12,40

Note: average followed by letters in the respective columns indicated that the differences were significant by DMRT at *P*<0.05. Cow manure (C0= 0; C1= 2.5; C3= 5 tons ha^{-1}). Dolomite (D0= 0; D1= 1; D2= 2 kg plot^{-1}).

The relationship of cow manure doses had a linear pattern (ŷ= 2.7394x+26.08) to dry weight (Figure 2A). The relationship of cow manure doses also had a linear pattern (ŷ= 222.76x+182.06) to yield ha^{-1} of mung bean (Figure 2B). The higher the dose of cow manure up to 5 tons ha^{-1}, resulted the higher the dry weight and yield ha^{-1} of mung bean plants.

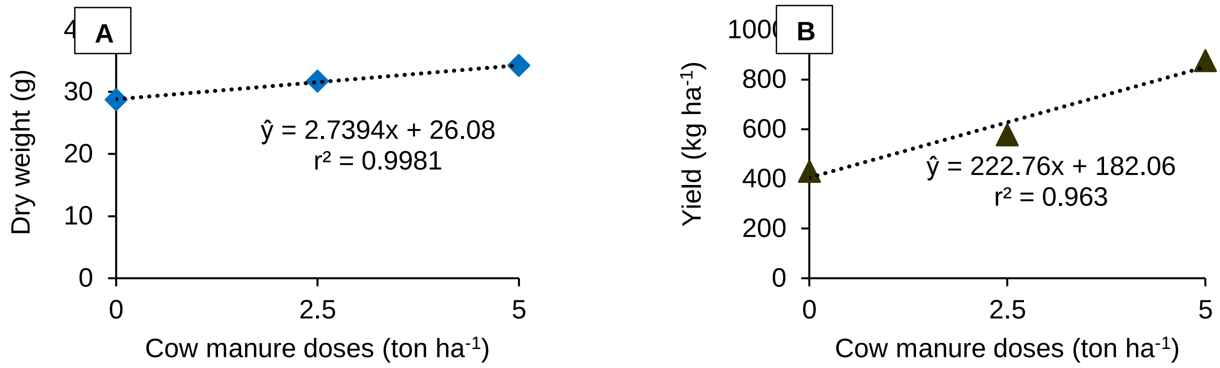

Figure 2. The relationship of cow manure doses on the dry weight (A) and yield ha^{-1} (B) of mung bean plants.

Bulk Density and Soil pH

Dolomite significantly increased soil pH, but it had an insignificant effect on bulk density. The application of cow manure and their interactions were insignificant effects on the bulk density and pH of the soil (Table 3). There was an increase in soil pH along with the increase in dolomite doses up to 2 kg plot^{-1} by 7.68% compared to the control. Although the effect was insignificant, the soil bulk density decreased with increasing doses of cow manure and dolomite. It was indicated that these treatments had a slight impact on the soil structure.

Table 3. Bulk density and pH of soil due to cow manure, dolomite, and their interactions

Cow manure (ton ha^{-1})	Dolomite (kg plot^{-1})			Average
	0	1	2	
		Bulk density (g cm^{-3})		
0	1.61	1.50	1.48	1.53
2.5	1.58	1.49	1.47	1.51
5	1.50	1.48	1.48	1.49
Average	1.56	1.49	1.48	CV= 5.54%
		Soil pH		
0	5.02	5.28	5.33	5.21
2.5	5.13	5.48	5.47	5.36
5	5.10	5.45	5.61	5.39
Average	5.08 b	5.40 a	5.47 a	CV= 4.72%

Note: average followed by letters in the respective columns and rows indicated that the differences were significant by DMRT at *P*<0.05.

Bulk Density and Soil pH

Correlation analysis between bulk density and pH of the soil on growth and yield of mung bean due to treatments could be presented in Table 4. Soil bulk density and pH were significantly and positively correlated to dry weight was 0.428* and 0.550**. Bulk density was also positively correlated and had an insignificant effect on root length, number of pods, seed weight plot^{-1}, 100 seed weight, and yield ha^{-1} of mung bean plants. Likewise, soil pH was positively correlated and had an insignificant effect on mung bean growth and yield, except root length.

Table 4. Correlation analysis between bulk density and pH of the soil on growth and yield of mung bean due to cow manure, dolomite, and their interactions.

Parameters	BD	SP	PH	NL	RL	DW	NP	SWP	1SW	Y
BD	1									
SP	-0.405*	1								
PH	-0.033	0.077	1							
NL	-0.127	0.016	0.622**	1						
RL	0.025	-0.056	0.364	0.335	1					
DW	0.428*	0.550**	0.280	0.152	-0.282	1				
NP	0.050	0.041	0.128	0.622**	0.216	0.126	1			
SWP	0.155	0.021	0.200	0.203	0.017	0.091	0.122	1		
1SW	0.129	0.254	0.311	0.309	-0.195	0.313	0.116	0.258	1	
Y	0.156	0.021	0.199	0.203	0.017	0.091	0.122	0.989**	0.258	1

Note: ** and * indicated significant correlation at 1 and 5% levels. BD= bulk density; SP= soil pH; PH= plant height; NL= number of leaves; RL= root length; DW= dry weight; NP= number of pods; SWP= seed weight plot-1; 1SW= 100 seed weight; Y= yield ha-1

Cow Manure Effect

Application of cow manure up to 5 tons ha^{-1} significantly increased dry weight, seed weight plot^{-1}, 100 seed weight, and yield ha^{-1} of mung bean plants by 19.06%; 103.62%; 6.48%; and 2.04 times compared to the control, respectively. However, it had a slight impact on plant height, number of leaves, root length, number of pods, soil bulk density, and pH. Although the effect was insignificant, the growth of plant height, number of leaves, number of pods, and soil pH also increased with the increase of cow manure doses. Vice versa, soil bulk density was lower. It was indicated that the lower the soil bulk density value, the more granular the soil condition. These findings indicated that dry weight, seed weight plot^{-1}, 100 seed weight, and yield ha^{-1} are closely related to soil physical and chemical characteristics, such as bulk density and pH (Table 3). It was supported by the correlation values of soil bulk density and pH, which are positively correlated with dry weight, seed weight plot^{-1}, 100 seed weight, and yield ha^{-1} (Table 4). Cow manure had a direct effect on improving soil physics and an indirect effect on soil chemistry. The improvement in soil physics due to the application of cow manure can have an impact on the soil structure and cause the roots to develop in uptake water and nutrients to be translocated to biomass and seeds of mung bean plants. These findings were supported by Adekiya et al. (2016) that the cow manure treated up to 10 tons ha^{-1} could be reduced bulk density by 35.03% but increased infiltration rate, porosity, and soil moisture by 162.70; 51.11; and 18.01% respectively compared to the control. Rasoulzadeh & Yaghoubi, (2010) found that the application of cow manure up to 60 tons ha^{-1} significantly decreased particle and bulk density by 9.46% and 1.91%, but increased porosity and C-organic of the soil by 10.11% and 5.1 times compared to the control. Pardo et al., (2000); Franzluebbers, (2002) reported that soil structure could be increased oxygen and water concentration, root enlargement in absorbing water and nutrients, soil strength, and water movement through porosity. Adekiya et al. (2016) also added that porosity, infiltration rate, and soil moisture were significantly positively correlated (0.969; 0.973; and 0.968) to the seed's fresh weight of plants.

Dolomite Effect

There was an increase in plant height and dry weight of mung bean and soil pH due to the application of dolomite at a dose of 2 kg plot^{-1} by 24.55; 15.68; and 7.68%, respectively. Likewise, the number of leaves increased, although the effect was insignificant. However, the longest root was found at 1 kg plot^{-1} dolomite. The results also showed that dolomite had a slight impact on mung bean-yielding characters. It can be seen from the seeds weight plot^{-1}, 100 seeds weight, and yield ha^{-1} which decreased along with an increase in dolomite doses up to 3 kg plot^{-1}, but the number of pods increased at 1 kg plot^{-1} and decreased at a dose of 2 kg plot^{-1}. The increase in plant height and dry weight of mung bean in this study could be due to the increase in soil pH along with the increase in the dolomite dose (Table 3), although the resulting soil pH was 5.47 (classified as acidic). Soil pH was also positively correlated with plant height and dry weight (Table 4). It was due to dolomite's response to neutralize soil pH, and increase root development and is closely related to the ability of roots to absorb nutrients and have a long impact on the resulting yield characters. These findings were supported by Ribeiro et al. (2017) that there was an increase in soil pH and total-N due to the application of dolomite up to 480 kg ha^{-1} by 28.39 and 118.18% compared to the control. Bergamasco et al. (2019) reported that there was an increase in nitrate in the soil along with an increase in soil pH. Changes in soil pH due to liming have an impact on nutrient availability and affect the metabolic processes of plants which are characterized by an increase in plant height. In contrast to yield plants, liming in this study had a slight effect. It was influenced by the incubation period after liming was only 10 days and it is assumed that it has not optimally responded to nutrient uptake. It could be seen that the soil pH was acidic (Table 3). In addition, the material from dolomite is classified as low in solubility and mobility. This finding was supported by Sarker et al. (2012) that dolomite liming at a dose of 0.5-3.5 tons ha^{-1} significantly increased the root volume of mung bean plants at the age of 60 days after treatment (DAT), but it had an insignificant effect at the age of 10-50 DAT, biomass, and 1000 seed weight. Yost & Ares, (2007) reported that the solubility and mobility of agricultural lime were low resulting in a long response. Kisinyo et al. (2015) added that the application of calcite lime (CaO) at a dose of 0.77-1.55 tons ha^{-1} significantly increased soil pH at the incubation period of 30 DAT and significantly also decreased aluminum saturation and increased soil nitrate, exchange-Ca, exchange-Mg, and phosphorus availability at the incubation period of 60 DAT.

Interaction Effect

The interaction of cow manure with dolomite lime was an insignificant effect on all characteristics of mung bean plants, as well as soil bulk density and pH in this study. The interaction C1D1 (cow manure 2.5 tons ha^{-1} and dolomite 1 kg plot^{-1}) gave the highest root length and number of pods in mung bean plants, as well as the interaction C2D0 (cow manure 5 tons ha^{-1} and without dolomite) on the number of leaves, seed weight plot^{-1}, and yield ha^{-1}. While the highest plant height and 100 seed weight of mung bean were found in the interaction C2D2 (5 tons ha^{-1} cow manure and 2 kg plot^{-1} dolomite). These interactions have not reached the standard recommendations that can be applied. However, the selection of C2D2 interactions could be used to improve the yield ha^{-1} of mung bean plants because it had the highest soil pH of 5.61 or was classified as slightly acidic compared to other interactions. Changes in soil pH will have an impact on the availability of nutrients needed by plants with a record of the incubation period of more than 30 days to visible differences from each treatment. These findings were supported by Li et al. (2013) that soil pH is related to the decomposition of organic matter and has an impact on increasing phosphorus, manganese, and calcium nutrients in the soil. Bradl, (2004) added that the pH value is an indicator of nutrient cycling and an increase in pH will increase nutrient adsorption. Kisinyo et al. (2015) found that there was a highly increased in soil pH from 30-60 days after lime application at a soil depth of 0-20 cm. Ribeiro et al. (2017) also added that the interaction of dolomite fertilizer and cow manure can improve soil N-total and pH as well as mung bean yields such as the number of pods, fresh weight, dry weight, seed dry weight, and 100 seed dry weight.

CONCLUSION

The dry weight, seed weight plot^{-1}, 100 seed weight, and yield ha^{-1} of mung bean plants were increased by cow manure treated at a dose of 5 tons ha^{-1} by 19.06%; 103.62%; 6.48%; and 2.04 times, respectively. Likewise, the dose of dolomite 2 kg plot^{-1} significantly increased the plant height and dry weight of mung bean and soil pH by 24.55; 15.68; and 7.68%, respectively. The interaction of cow manure and dolomite had a slight impact on the growth and yield of mung bean plants.

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