

Effect of dolomite, horse manure and NPK application on plant growth and yield of Cauliflower and its residue effect on Snap bean cultivation

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Abstract. Liming and fertilizers were reported to affect significantly the plant growth. The goal of this experiment was to study effect of dolomite, horse manure and NPK fertilizer on cauliflower and its residue on snap bean yield. Research activities had been carried out at Experimental Garden of Indonesian Vegetable Research Institute (IVEGRI) in Lembang - Bandung, West Java. A Split-split Plot Design with three replications was set up in the field. The main plots were dosage of dolomite, viz. 0 and 3 t/ha, the sub plots were dosage of horse manure, viz. 0, 15 and 30 t/ha, and the sub-sub plots were dosage of NPK fertilizer, viz. 600 and 1200 kg/ha. The results showed that horse manure and dolomite significantly affect plant diameter and yield of cauliflower, but not NPK. The best yield without dolomite could be reach by 30 t/ha horse manure plus 600 kg/ha NPK fertilizer, but with dolomite 3 t/ha the best yield could be reach by 15 t/ha horse manure plus 600 kg/ha NPK fertilizer. Dolomite could reduce a half of horse manure application. Dolomite residue also gave good effect on snap bean yield.

Key Words: Dolomite, horse manure, NPK fertilizer, cauliflower.

Introduction. Cauliflower (*Brassica oleracea* L.) and snap beans (*Phaseolus vulgaris*) are highland vegetables which are commonly planted by the Lembang West Java farmers. Cauliflower is sensitive with soil pH and will give good growth and yield on 6.0 - 6.8 pH (Knott 1962), but Lembang soil is Andisol which commonly have low pH (<5) so it needed liming to increase pH. Snap bean is a leguminosae which can fix the nitrogen directly (Gutierrez et al 1994) and give good response on acid soil liming (Thompson & Throeh 1975). Dolomite is one of the commercial limes and could increase pH level. pH level impacts recent nutrients and nutrients uptake. Recent nutrients are present for the plant on 5.5 - 6.5 pH (NeSmith & Geraldton 1969).

Horse manure and NPK application could supply plant nutrients. Planting snap bean after cauliflower would increase R/C ratio and application of dolomite, horse manure and NPK would increase yield of both of them. Found on maize that mineral and organic fertilizer combined with lime was the optimal solution of increasing the yield of maize (Kisic et al 2004a), and liming also increase P, Ca, Mg and Mo concentration on adequate range (Kovacevic & Rastija 2010). The research objective is to find out the effect of application of dolomite, horse manure and NPK on cauliflower growth and yield and also to find out the effect of residue on snap bean cultivation. It is assumed that dolomite, horse manure and NPK application can give good effect on plant growth and yield of cauliflower and snap bean.

Material and Method. The experiment was conducted at Indonesian Vegetable Research Institute's (IVEGRI) Experimental Field (Lembang, Jawa Barat, Indonesia, 1200 m abs) in rainy season. Type of soil is Andisol with low pH (5.1), very low total N 0.67 %, medium P₂O₅ concentration (7.0 ppm), and very high K content (134.8 ppm). Split-split Plot Design with main plots were dolomite dosages (0 and 3 t/ha⁻¹), sub plots were horse

manure dosages (0, 15, and 30 t/ha⁻¹) and sub-sub plot were NPK (15-15-15) fertilizer dosages (600 and 1200 kg/ha⁻¹), and three replications were performed.

Dolomite (CaO = 28 % and MgO = 18 %) applied one month before planting with spread method on the top of the soil and than mix with the soil depth 25 cm. Horse manure was applied 2 days before planting, and NPK (15-15-15) fertilizer applied at planting time. Seedlings of cauliflower at the age of 30 days was planted on a plot size of 3 x 5 m with plant spacing of 60 x 50 cm. Cauliflower was harvested 70 – 90 days after planting. Snap bean was planted on the same plot of cauliflower.

Results and Discussion. There interaction was observed between dolomite and horse manure upon plant growth (Table 1). Without dolomite, horse manure application increase plant growth on all levels. But with dolomite 3 t/ha⁻¹, application of horse manure do not increase plant growth on all levels. Dolomite application could increase soil pH from 4.9 to 5.4 and also increase Ca and Mg stock in soil. The condition made cauliflower to show good vegetative growth because cauliflower is sensitive on pH level and need high dosage of Mg (Thompson & Kelly 1957). Dolomite application also could increase root growth and led to the concentrations increase of Ca and Mg in the soil (Oliveira et al 2003).

Table 1

Interaction between dolomite and horse manure on plant growth

Dolomite (t/ha ⁻¹)	Plant diameter (cm)			Plant height (cm)		
	Horse manure (t/ha ⁻¹)			Horse manure (t/ha ⁻¹)		
	0	15	30	0	15	30
0	75.50 b	126.57 a	123.27 a	55.74 b	96.30 a	99.05 a
	B	A	A	B	A	A
3	109.03 a	126.73 a	127.40 a	76.88 a	97.21 a	98.77 a
	B	A	A	B	A	A

Without dolomite, horse manure application increase vegetative growth of cauliflower. Diameter and height of plants are significantly affected by horse manure application. Horse manure application treatments got significantly vegetative growth higher than without horse manure application, but level of dosage not gives significantly differences.

The biggest diameter got on 3 t dolomite and 30 t/ha horse manure treatment, and the highest plant got on 30 t/ha horse manure and without dolomite treatment. But all of them not significantly different with other treatments except without dolomite and horse manure treatment. This is proving that dolomite application without horse manure could increase plant growth, but in general the best plant growth is given by horse manure and dolomite application.

NeSmith & Geraldton (1969) shows that dolomite could increase pH of soil and increase Ca and Mg supplies for the plant, and also could boost other essential elements via organic decomposition by soil microorganisms. Activity of soil microorganisms will be increased by liming. Application of horse manure also makes essential unsure content higher because leaching could decrease. Liming and application of fertilizer also increased soil pH and enhanced P release (Anetor & Akinrinde 2006). So, dolomite application with horse manure will provide better effect than dolomite or horse manure application alone.

Increasing NPK fertilizer dosage from 600 to 1200 kg/ha not increase vegetative growth at all (Table 2).

It was assumed that application of horse manure and dolomite could supply essential unshures for the plant, so application of 600 kg/ha NPK is enough for vegetative growth and to increase yield of cauliflower. Especially on P unsure, reported by Dechassa et al (2003) that cauliflower is very efficient on P uptake. But, NPK application is still needed as de Fonseca et al (2002) reported that Nitrogen could increase fresh yield of cabbage.

Table 2

Effect of NPK fertilizer on vegetative growth and yield of cauliflower

<i>NPK 15-15-15 (kg/ha)</i>	<i>Plant diameter (cm)</i>	<i>Plant height (cm)</i>	<i>Yield (kg/plant)</i>	<i>Net yield (kg/plant)</i>	<i>Weight of curd (kg/plant)</i>
600	57.82 a	43.69 a	0.72 a	0.51 a	0.20 a
1200	56.93 a	43.61 a	0.72 a	0.58 a	0.19 a

Regarding crop yield, as resulted, level of horse manure dosage increase yield parameters. Horse manure application could maintain and increase yield of cabbage (Wardjito & Suwahyo 1994) and curd weight of cabbage with horse manure higher than cabbage without horse manure (Winarto & Samin 1995). Horse manure as an organic material could supply essential unsure for the plant such as increase P-potential content (Hartatik et al 1993) and increase total C-organic content (Pujiyanto et al 2003), and also could maintain chemical and physical soil aspect such as decrease dissolved aluminum (Yusuf et al 2004), increase cation exchange capacity (Arbiwati 2000), control iron toxicity (Hakim et al 2012), and not at least decrease soil weight volume (Dharmawati 2003) for good root growth and development. Beside that, horse manure decrease essential unsure from leaching on rainy season.

Dolomite increase the yield, but the response will show its effect with horse manure and NPK fertilizer together (Table 3). Dolomite application increases the yield, and the net yield was affected by dolomite and horse manure. Dolomite application could reduce horse manure dosage at half than without dolomite. Without dolomite it was needed 30 t/ha but with dolomite just 15 t/ha was sufficient. Dosage of NPK fertilizer of 600 kg/ha assumed was enough to get the best yield. The net yield could increase by application of 3 t/ha dolomite, 15 t/ha horse manure and 600 kg/ha NPK fertilizer. Meanwhile, weight of curd would get maximal by 30 t/ha horse manure. Generally, the best yield of cauliflower without dolomite could be reach by 30 t/ha horse manure and 600 kg/ha NPK. But, if there's dolomite application at the dosage of 3 t/ha, only 15 t/ha horse manure and 600 kg/ha NPK fertilizer is needed.

Table 3

Effect of dolomite, horse manure and NPK fertilizer on yield of cauliflower

<i>Treatments</i>	<i>Yield (kg/plant)</i>	<i>Net yield (kg/plant)</i>	<i>Weight of curd (kg/plant)</i>
A	0.337 d	0.227 c	0.053 e
B	0.407 d	0.280 c	0.067 de
C	0.843 ab	0.630 bc	0.220 abc
D	0.603 cd	0.577 bc	0.143 abc
E	0.857 ab	0.667 a	0.237 abc
F	0.870 ab	0.667 a	0.237 abc
G	0.460 cd	0.240 c	0.080 de
H	0.660 bc	0.500 b	0.157 bcd
I	0.913 a	0.697 a	0.253 abc
J	0.883 ab	0.677 a	0.223 abc
K	0.887 ab	0.683 a	0.330 a
L	0.913 a	0.703 a	0.297 a

A - 0 kg/ha dolomite + 0 t/ha horse manure + 600 kg/ha NPK, B - 0 kg/ha dolomite + 0 t/ha horse manure + 1200 kg/ha NPK, C - 0 kg/ha dolomite + 15 t/ha horse manure + 600 kg/ha NPK, D - 0 kg/ha dolomite + 15 t/ha horse manure + 1200 kg/ha NPK, E - 0 kg/ha dolomite + 30 t/ha horse manure + 600 kg/ha NPK, F - 0 kg /ha dolomite + 30 t/ha horse manure + 1200 kg/ha NPK, G - 3 kg/ha dolomite + 0 t/ha horse manure + 600 kg/ha NPK, H - 3 kg/ha dolomite + 0 t/ha horse manure + 1200 kg/ha NPK, I - 3 kg/ha dolomite + 15 t/ha horse manure + 600 kg/ha NPK, J - 3 kg/ha dolomite + 15 t/ha horse manure + 1200 kg/ha NPK, K - 3 kg/ha dolomite + 30 t/ha horse manure + 600 kg/ha NPK, L - 3 kg/ha dolomite + 30 t/ha horse manure + 1200 kg/ha NPK.

Residue of dolomite significantly increase yield of snap bean (Table 4), because soil with dolomite residue had pH, Ca and Mg content (pH = 5.4; Ca = 4.1 me/100 g soil and Mg = 1.84 me/100 g soil) higher than soil without dolomite residue (pH = 4.9; Ca = 2.5 me/100 g soil and Mg = 0.5 me/100 g soil). Snap bean as a leguminosae need high level of Ca and Mg (Thompson & Throeh 1975), and increasing of pH value is assumed that will increase Rhizobium activity on nitrogen fixation, but if Nitrogen content in the soil is high, the rhizobium activity will decrease. Application of P also increase number of nodule and seed yield (Giller et al 1998) and plant made good nodule formation on balances of soil substances situation (Amijee & Giller 1998). Application of liming material will increase base saturation of the cation exchange capacity and also nutrient content such as P and K (Kisic et al 2004b), and also increase pH (CaCl²), KCl-exchangeable, Ca and Mg and residual CO₃ in the top surface layers but not effect the subsoil composition (Meda et al 2002).

Dolomite significantly affect yield of snap bean, but adding of horse manure and NPK fertilization not give significantly yield increase. There was a trend which at increasing horse manure application increases weight of pods but decrease number of pods and weight of seed (Table 4). Nitrogen concentration pushes pods growth, but could inhibit seed formation because there were no balances between N and other unures (McCollum 1975). There was an interaction between horse manure and NPK fertilizer on number of pods and seed yield. To get highest number of pods and seed yield, without horse manure it was need 1200 kg/ha NPK fertilizer, but if there was 15 t/ha horse manure it was need only 600 kg/ha NPK fertilizer (Table 5).

Table 4

Effect of dolomite, horse manure and NPK residue on yield of snap bean

<i>Treatments</i>		<i>Weight of pods (kg/15 m²)</i>	<i>Number of pods (kg/15 m²)</i>	<i>Weight of seed (kg/15 m²)</i>
Dolomite	With residue	3.75 b	143.44 b	0.35 b
	Without residue	5.65 a	180.39 a	0.46 a
Horse manure	0 t/ha	3.66 a	182.67 a	0.45 a
	15 t/ha	4.86 a	163.92 a	0.42 a
	30 t/ha	5.58 a	139.17 a	0.35 a
NPK fertilizer	600 kg/ha	4.40 a	160.67 a	0.40 a
	1200 kg/ha	5.00 a	163.17 a	0.41 a

Table 5

Interaction effect of horse manure and NPK fertilizer on number of pods and seed yield of snap bean

<i>Horse manure</i>	<i>Number of pods (/15 m²)</i>		<i>Seed yield (kg/15 m²)</i>	
	<i>NPK fertilizer 600 kg/ha</i>	<i>NPK fertilizer 1200 kg/ha</i>	<i>NPK fertilizer 600 kg/ha</i>	<i>NPK fertilizer 1200 kg/ha</i>
0 t/ha	152.50 a	212.83 b	0.36 a	0.53 b
15 t/ha	175.83 a	152.00 a	0.46 a	0.37 a
30 t/ha	153.67 a	124.67 a	0.39 a	0.31 a

Conclusions. Dolomite and horse manure significantly effect plant growth but NPK fertilizer did not. Application of dolomite and horse manure increase yield of cauliflower, and dolomite application could reduce a half of horse manure dosage. Without dolomite the best yield could be achieved by 30 t/ha horse manure + 600 kg/ha NPK fertilizer, but with 3 ton per ha dolomite it was need 15 ton per ha horse manure + 600 kg/ha NPK. Dolomite residue increase yield of snap bean.

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Received: 30 June 2013. Accepted: 31 July 2013. Published online: 14 September 2013.

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How to cite this article:

Sopha G. A., Sumarni N., 2013 Effect of dolomite, horse manure and NPK application on plant growth and yield of Cauliflower and its residue effect on Snap bean cultivation. *AAB Bioflux* 5(2):60-65.