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Growth and Production of Mustard *(Brassica chinensis* L*)* with Organic Plant Supplements Application

Zainal Arifin[1] and Elfarisna[1]

[1] Faculty of Agriculture, Jakarta Muhammadiyah University
Jl. K. H Ahmad Dahlan, Cireundeu, Ciputat, South Jakarta 15419
Email: elfa.risna@yahoo.com

ABSTRACT

Mustard (*Brassica chinensis* L) has a high economic and is sold at an expensive price than the rest mustard types. The research aims to evaluate the effect of organic plant supplement application on the growth and production of mustard and obtain the proper concentration for effective mustard cultivation. The research was arranged in Randomized Complete Block Design (RCBD) with a single factor i.e. concentration of organic plant supplement (OPS), and five replications. Five levels of organic plant supplement concentration applied consist of 0 mm^3/m^3 (control), 1 mm^3/m^3, 2 mm^3/m^3, 3 mm^3/m^3, and 4 mm^3/m^3. Organic plant supplements significantly affect vegetative growth ie. plant height, leaf length, radicle number, and yield of mustard. The significant effect on vegetative growth was obtained at 2 and 3 weeks after planting. The concentration of 3 mm^3/m^3 could be applied to obtain high vegetative growth and production in mustard cultivation.

Keywords: *Brassica chinensis* L, concentration, organic fertilizer, yield, eco-friendly farming

INTRODUCTION

Mustard (Brassica chinensis L) has a high economic and sold in expensive price than rest mustard types. This condition according to Driyani (2015) is caused by this commodity very rarely planted, although can be harvested in 40-50 day after planting. Urban farming community can cultivate mustard by composting of organic waste as the medium cultivation in polibags. Currently, demand of this commodity increase countiniously, and very potential to be broadly developed. Mustard contains high vitamin A, C, D, folate, and potassium. Potassium is one of the most important minerals in body, its regulate fluid balance, muscle contractions, nerve signals, and heart. Crispy and soft texture make this commodity very popular for consumption.

Generally, farmers use the chemical fertilizer in our practice for increasing th e production because more effective and increased the production, directly. The use of organic fertilizer is considered as old and ineffective ways, so this way began to be abandoned. The use of chemical fertilizers continuously could decrease the soil fertility as residue effect. In the massive decline soil fertility, the use of chemical fertilizer in high dose should be reduced by using organic fertilizers, and Lingga and Marsono (2003) reported this condition to increase the quality vegetables and fruit crops.

4.0^{th} Industrial revolution has changed the prespective of agricultural practice to be more efficient, technological, and eco-friendly farming. Recently, the massive land use change from agricultural to non-agricultural activity i.e. settlement, offices, factories, and industrial result the fragmentation and loss of productive agricultural land. The efficient of agricultural practice can be achieved by the use of house yards in the polybags for vegetable cultivation. Eco-friendly farming

practices in the houseyard result in free pests, and pesticides in the product (Saparinto 2013), and less chemical fertilizer (Winarni et al. 2015).

Chemical input in agricultural practice by farmers has been reported to be one of the factors of high production cost, whereas the fertilizer subsidies policy by the government is increasingly limited and tight. All this time, farmers can decrease production costs according to Suwahyono (2017) through the use of chemical fertilizer which was subsidized by government policy. The use of organic fertilizer needs to be applied in our agricultural practice, especially for horticulture crops like mustard in our houseyard. One of the organic fertilizer types that can be applied is Organic Plant Supplements (OPS).

This fertilizer reported by Azkaini (2018) could increase root and stem cell turgor, increase the flowers and fruit set, and prevent the flowers and fruit drop. A bottle organic plant supplement contains 12.98 % nitrogen (N), 5.12 % phosphate (P_2O_5), 14.20% potash(K_2O), 3.17% shulpurs (S_2O_4), 0.03% magnesium (Mg), 5.97% organic carbon, 42.02 ppm Fe, 0.61 ppm Cu, 27.80 ppm Zn, and 0.40% C/N ratio. The research aims to evaluate the effect of organic plant supplement application on the growth and production of mustard and obtain the proper concentration for effective mustard cultivation.

MATERIALS AND METHODS

Time and site

The research was carried out from March to April 2019 in Lebak Bulus Seedlings Garden, Lebak Bulus Seed Development Center and Plant Protection, Department of Maritime Agriculture and Food Security. The research site was located in 6 ° 18'1 "S and 106 ° 46'1" E, ± 25 meters above sea level (MASL), and latosol soil.

Design

The research was arranged in Randomized Complete Block Design (RCBD) with a single factor i.e. concentration of organic plant supplement (OPS), and five replications. Five levels of organic plant supplement concentration applied consist of 0 mm3/m3 (control), 1 mm3/m3, 2 mm3/m3, 3 mm3/m3, and 4 mm3/m3.

Planting

This research used 25 experimental units, and each unit was of 3 polybags. The polybag was filled with a 5 kg growth medium; a mixture of topsoil, goat manure, and husk charcoal, and then the soil was covered by silver-black plastic mulch (MPHP) to decrease the weeds damage. 14 days seedlings of mustard (Nauly F1 variety) were planted in each polybag (20 cm x 25 cm)_one seedling for one polybag, and the maintenance was conducted daily until harvest time. 200 ml organic plant supplement was applied to each polybag/plant, every 10 days.

Plant growth and yield observation

Observation of plant growth characteristics and yield, and data recording were conducted to some parameters, i.e. plant height (cm), leaf length (cm), root length (cm), leaves number (strands), root number (strands), fresh weight (g), and consumption weight (g). The observation was performed for every week until harvest time 30 days after planting.

Data analysis

A statistical analysis was conducted using an analysis of variance for the main effects; the means of the values were compared with the Tuckey test ($p = 0.05$).

RESULTS AND DISCUSSION

The climate conditions are of paramount importance to agriculture, plant production, and food security. Considerable economic losses result from sub-optimal climate conditions, undermining plant production and food security. Plant growth and production are strongly influenced by the environmental stresses experienced by the plant in the field. Sub-optimal climate conditions will further exacerbate economic losses and decrease the predictability of yield and quality for the farmer. The climate conditions of site research are shown in Table 1.

Table 1 Climate conditions on-site research

Month	Average		Total
	Temperature (^{0}C)	Humidity (%)	rainfall (mm/month)
Maret	27,6	82,8	145,3
April	28,1	82,7	304,0

Source: BMKG Wilayah II Ciputat

These data were collected from the Meteorological, Climatological, and Geophysical Agency for Ciputat Region. The temperature and humidity during the research were suitable for the plant growth and production in the tropics, (27-6-28.1 ^{o}C) and (82.7-82.8%), respectively. This climate condition is appropriate for mustard growth and production, Sukmawati (2012) reported appropriate conditions for mustard cultivation at 15-30 ^{0}C, and >200 mm/month. There is an increase in the rainfall intensity from March to April which was shown by rainfall volume, 145.3 mm/month to 304.0 mm/month. The low rainfall intensity in March didn't affect the mustard growth and production, yet.

Vegetative growth

Fertilizer is one of the most vital inputs contributing to crop production, and fertilization will increase productivity and improve yield quantity and quality (Olaniyi et al., 2010). Roots are important organs that supply water, nutrients, hormones, and mechanical support (anchorage) to crop plants and consequently affect economic yields. In addition, roots improve soil organic matter (OM) by contributing to soil pools of organic carbon (C), nitrogen (N), and microbial biomass. Organic plant supplements showed no significant effect on radicle length (Figure 1a) and significant effect on radicle number (Figure 1b). Seedling transplanting causes the root to need time to develop, and transplanting condition leads to support the root formation. Root development will decrease water and nutrient absorption, so root formation is a strategy to increase root absorption in the transplanting phase. The highest root number was obtained at a concentration of 3 mm^3/m^3, nevertheless, it wasn't significantly different from other concentrations. The higher root number will expand the water absorption range, and according to Herumia et al. (2017); and Amir (2016) will increase the volume of water and nutrient uptake. The increased water uptake will increase the nutrient uptake. Furthermore, organic plant supplements contain nitrogen and phosphorus. Nitrogen was reported by Wahyudi (2010) to increase vegetative growth (roots, stems, and leaves), and Purwati (2013) reported P plays a role in stimulating root growth.

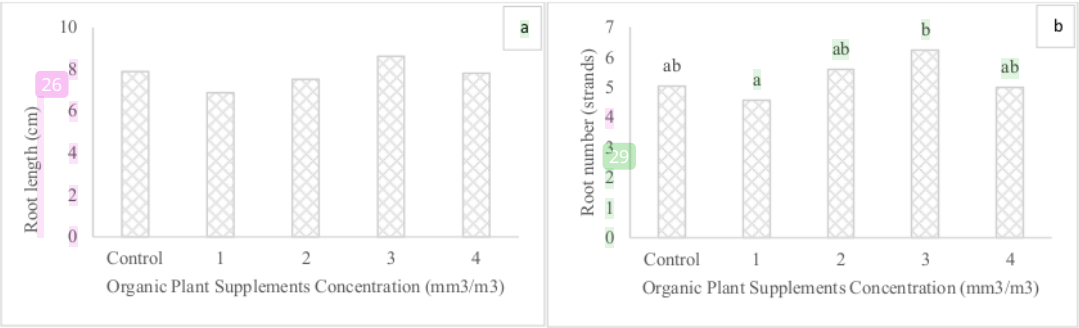

Figure 1. Mustard root length (a), and root number (b) in different concentrations of organic plant supplements. Each bar chart followed by the same letter was not significantly different at the Tuckey test ($p = 0.05$).

The root growth is very important to deliver the nutrients from the soil to plant organs. Organic plant supplements application to mustard showed a significant effect on plant height at 3 WAP and didn't significant effect at 1, 2, and 4 WAP (Figure 2a). In the 1 to 2 WAP, the mustard seedling is still in the acclimatization phase from germination seedling to the field, so this condition causes organic plant supplements uptake by roots un-optimally.

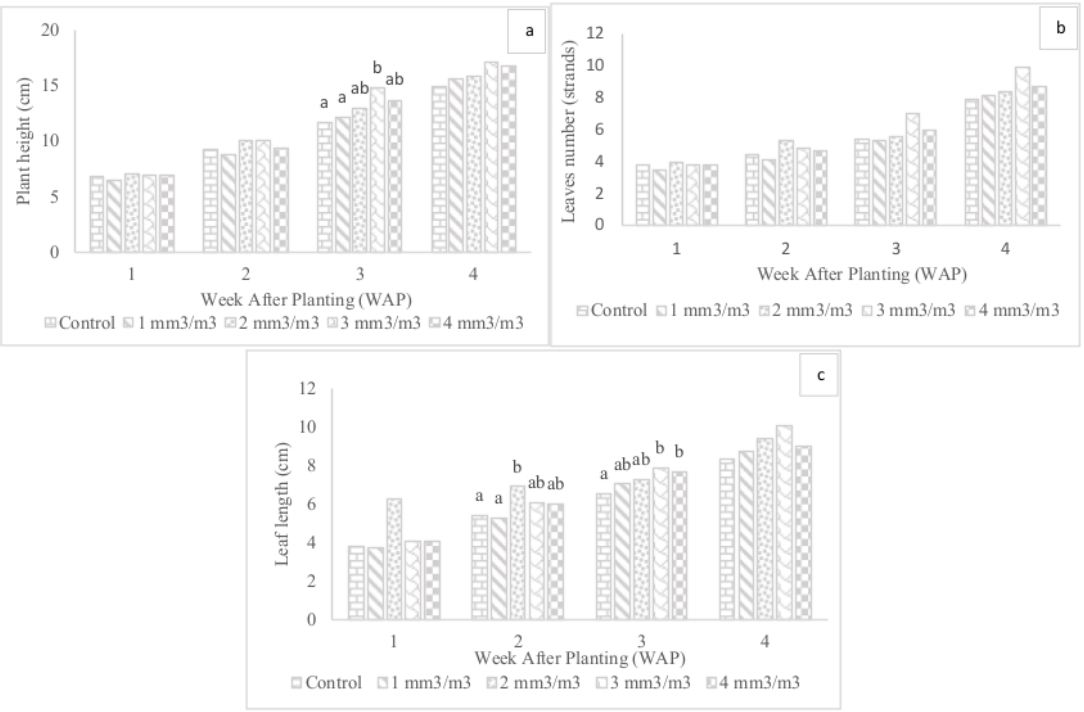

Figure 2. Mustard plant height (a), leaves number (b), and leaf length (c) on different concentration of organic plant supplements. Each bar chart followed by same letters in same week did not significant different at Tuckey test ($p = 0.05$).

In the 3 WAP, the highest plant was obtained in the concentration of 3 mm^3/m^3, nevertheless, it wasn't significantly different from the concentration of 2 mm^3/m^3 and 4 mm^3/m^3. Organic plant supplements contain high nitrogen to support mustard vegetative growth, especially plant height. Plant according to Duaja et al. (2012a) needs high nitrogen for plant height growth, and Wibowo (2017) also reported that nitrogen was needed by the plant to increase the plant height. Organic plant supplements were required by mustard to increase nitrogen uptake which was reported by Syafruddin et al. (2012) as an essential nutrient for vegetative growth. Thus, the finding agreed with that of Ojeniyi et al. (2007) who reported that application of N, P, K, and animal manure increased the plant height of the tomato compared to control. Nitrogen deficiency also reported by Sutedjo (2010) decreased the growth of plant height, and this condition was shown by mustard on control.

Organic plant supplements lates to support plant height growth cause low leaf numbers and Sritopia (2017) reported leaves grow in segments at the stem, so lower plant height will decrease the segment at the stem to leaves growing. The lower leaves number leads to the use of assimilated photosynthesis will be translocated to leaf development and result in increased leaf length. Lakitan (2012) also reported the increase in leaf length results from assimilated photosynthesis translocation. The highest leaf length was obtained at a concentration of 2 mm^3/m^3 at 2 WAP, and 3 mm^3/m^3 at 3 WAP. At 2 WAP, this concentration showed a significant difference to lower concentration, nevertheless, it wasn't significantly different to higher concentration. The concentration of 3 mm^3/m^3 resulted in the highest leaf length and was significantly different from the lower concentration, nevertheless, it wasn't significantly different from the higher concentration.

Yield Components and Production

Fresh weight is one of the characteristics that was used to measure plant growth. This character describes the photosynthesis product (Salisbury and Ross 1995), and the fresh weight of the horticulture product was affected by leaf number and leaf length (Roidi 2016; Darwin 2012). Organic plant supplements showed a significant effect on fresh weight (Figure 3a) and consumption weight (Figure 3b).

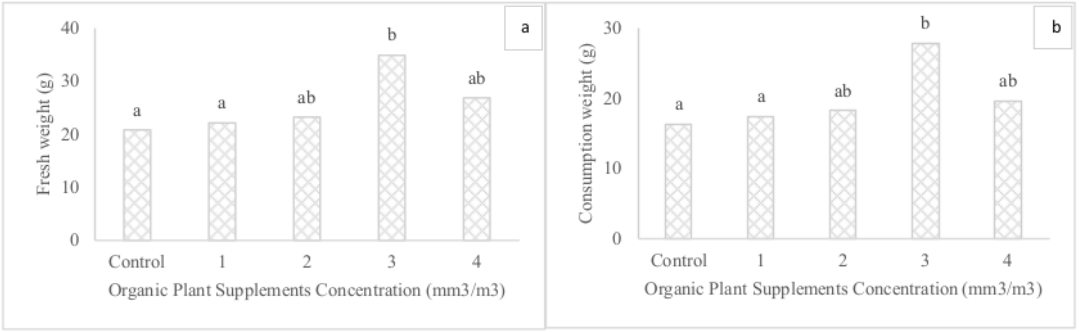

Figure 3. Mustard fresh weight (a), and consumption weight (b) in different concentrations of organic plant supplements. Each bar chart followed by the same letter was not significantly different at the Tuckey test ($p = 0.05$).

Organic fertilizer was reported by Syekfani (2002) more are quickly available for uptake by plant roots, promotes leaf length, and according to Mahdianor (2012) will increase the

photosynthesis capacity. Photosynthesis product will translocate to stem, roots, and leaf growth thus increasing the fresh weight. Tatik et al. (2014) also reported the higher leaves number will increase the fresh weight and dry weight produced. A concentration of 3 mm^3/m^3 resulted in a higher fresh and consumption weight and showed significant differences to control and 1 mm^3/m^3, nevertheless not significantly different from 2 mm^3/m^3 and 4 mm^3/m^3. Fe and Mg in organic plant supplement plays a role in the photosynthesis process, and leaf formation, as reported by Duaja et al. (2012b) increase the accumulation of carbohydrates and proteins.

Table 2. The effect of organic plant supplements to mustard yield

Organic Plant Supplements Concentration	Yield (ton/ha)	
	20 cm x 20 cm	15 cm x 15 cm
Control	5.2	9.24
1 mm3/m3	5.53	9.84
2 mm3/m3	5.8	10.32
3 mm3/m3	8.71	15.49
4 mm3/m3	6.7	11.93

Yield is the true character of the measurement of plant production, and plant spacing affects the population and will further affect yield. The effect of organic plant supplements on mustard yield is shown in Table 2. Concentration of 3 mm^3/m^3 resulted in the highest yield, 8.71t/ha in 20 cm x 20 cm and 15.49 t/ha in 15 x 15 cm spacing. Generally, mustard was planted in a spacing of 20 cm x 20 cm. A spacing of 15 x 15 cm could be applied to increase the mustard yield in houseyard cultivation.

CONCLUSIONS

1. Organic plant supplements significantly affect vegetative growth ie. plant height, leaf length, radicle length, and yield of mustard.
2. The concentration of 3 mm^3/m^3 could be applied to obtain the high vegetative growth and yield in mustard cultivation.

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