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Effect of biofertilizer application on population of nitrogen fixing bacteria and yields of chili pepper at Temanggung, Central Java

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ABSTRACT

The sustainability of chili production is influenced by plant pest disturbances, for which farmers strive to suppress chili plant pests by using high chemical pesticides. The application of environmentally friendly chili cultivation such as using biofertilizer is needed to suppress negative impact for environment and chili quality. This study aims to determine the effect of Agrimeth biofertilizer application on chili yield and population of Nitrogen Fixing Bacteria. The study was conducted in April-August 2017, Temanggung, Central Java. The study used a factorial randomized two-group design with a combination treatment of three chili varieties and three frequency of agrimeth biofertilizer applications, and each treatment replicated three times. Plant parameters observed included plant height, number of fruit/plant/season, weight of fruit/plant/season, soil analysis, analysis of nitrogen fixing bacteria population at the end of the study. The results showed that the application of agrimeth was not significantly different on average of plant heigh . The treatment of the application of agrimeth 1 time a season produced the highest number of chili fruit (574 pc) and weight of chili (2.09 kg) per plant per season, significantly different from the treatment of the application of agrimeth 2 and 3 times per season. The highest population of nitrogen fixing bacteria was occurred in treatment of agrimeth applied 3 times.

***Keywords**: chili, biofertilizer, N fixation bacteria, environmentally friendly*

INTRODUCTION

Chili is a horticultural commodity favored by Indonesian people. Price fluctuations in these commodities contribute to inflation in Indonesia. Stable chili production supports the stable supply and prices of chili in the market. The plant pest disturbance is one factor that can cause crop failure of chili production. According to Hasyim et al. (2015), high chili pest attacks in high rainfall month and failure of conventional pest control leads to decreased yield and chili productivity.

Avoiding crop failure, farmers strive to control pest of chili plant by using high chemical pesticides. The use of excessive chemical insecticide will kill

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target pests and natural enemies of the pest. In addition, this has an impact that disturbs ecosystem balance, environmental sustainability and the health of the chilli produced. Therefore, it is necessary to apply environmentally friendly chili cultivation.

Crop cultivation with environmentally friendly approach promotes integrated pest control by using botanical pesticides and biological agents, reducing the use of pesticides and chemical fertilizers, addition of organic matter and use of biofertilizers to help increase nutrient supply for plants (Nurlaily and Samijan, 2017; Astuti et al., 2013) Some of benefits and advantages of the application of environmentally friendly chili cultivation are 1) chili productivity increases continuously, 2) the maintenance of ecosystem balance and biodiversity remain sustainable, 3) low pesticide residues, 4) security and safety of farmers and consumers guaranteed, 5) reduce production costs (Hasyim et al., 2015). This study aims to determine the effect of Agrimeth biofertilizer application on chili yield and population of Nitrogen Fixing Bacteria.

MATERIAL AND METHODS

The study was conducted in April-August 2017, at Campursari village, Ngadirejo, Temanggung, Central Java (7 ° 14'3 "S and 110 ° 2'17" E), the height of the location was 994 m above sea level, and soil type was Inceptisols. Chili (*Capsicum frutescens* L.) varieties tested included Sigantung, Carica, and Prima Agrihorti. Biofertilizer used was agrimeth.

The study used a factorial randomized two-group design with a combination treatment between three chili varieties and three intensity of agrimeth biofertilizer applications, each treatment replicated three times. The factors involved were cross-linked, with homogeneous environmental conditions. The intensity of the biofertilizer application tested was control (agrimeth applied once at 30 days after planting), agrimeth applied twice (at 30 and 40 days), and agrimeth applied three times (at 30, 40 and 50 days after planting).

Each plot of chili pepper replica in the form of a bed measuring 4.5 m length, 1.5 m width and 30 cm hight with the distance between beds 1 m. Each planting hole was 60 x 50 cm length, planted with one transplanted crop from

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the nursery of 14 days after spreading the seeds, with criteria for stiff seedling growth, 3-5 leaves, green leaf color and no disease pests.

Basal fertilizers used organic fertilizer were 2 tons/ha, NPK 120 kg/ha, SP36 50 kg/ha, Urea 100 kg/ha. Supplementary fertilizers using 60 kg/ha NPK Mutiara (16:16:16), KCl fertilizer was gave 3 times, once application 2 kg KCl with application time per 7 days. Fertila and ZK fertilizer were applied when the plants were 30 and 60 days after planting, at a dose of 2 kg each application. Irrigation was carried out only if necessary by observing crop conditions. Weed control was carried out mechanically every week until the age of 30 days after the plant was aged> 30 days, the control was carried out as needed.

Observed plant parameters included plant height: recorded when 50% of the first fruit plants begin to mature (92 days); number of fruits/plants/season: number of fruits harvested in each crop in 15 harvests; weight of fruit/plant/season: weighed the fruit harvested in each crop in 15 harvests. The initial and final soil analysis of the research was carried out in the Central Java BBPTP laboratory. Analysis of nitrogen fixing bacteria population at the end of the study.

Data analysis was carried out with the SAS 9.1 Program to determine the value of significant differences between treatments based on DMRT advanced test level of 5% (Littell et al., 2006).

RESULTS AND DISCUSSION

The chili cultivation with environment friendly applies the minimum technology component such as organic matter, dolomite, and biofertilizers to improve soil fertility. Pest and disease control is carried out with the principles of integrated pest management (IPM) by reducing chemical insecticides use and increase of biological agents use, installation of yellow traps, and fruit fly traps. During land preparation, dolomite is given to increase soil pH. Dolomite application at a dose of 0.5-1 t/ha is to achieve neutral pH (pH 6-7). The application of organic matter (Organic fertilizer from composite of compost and manure) is spread to a depth of 20 cm on each bed at a dose of 2 t/ha (Prastuti et al., 2017).

Soil solarization is to cover the beds with transparent plastic (polyethylene/PE) for two weeks. Solarization aims to suppress pathogenic populations and weeds that will grow or dormancy in the soil. Before closing

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the plastic, the beds are flushed with water evenly, so that the solarization process can be optimal, helping to loosen soil and increase soil temperature. The effectiveness of solarization combined with the use of 10 cc/liter of PGPR (plant growth promoting rhizobacteria) biological agent is sprayed on soil surface in 1-2 days after opening plastic solarization (Prastuti et al., 2017). Solarization controls effectively a wide range of soil-borne pathogens, insects and weeds. The use of organic amendments (manure, crop residues) together with soil solarization (biofumigation) elevates the soil temperature by 1-3 ºC, and improves pest control due to a generation and accumulation of toxic volatiles (Rubin et al.; 2011).

Pest control for fruit flies using Methil Eugenol which is installed in the plant area with a height above the chili plant. Planting refugia (sunflowers, *Cosmos caudatus* and paper flowers) surrounding the plants is useful for inviting predatory insects and diverting pests from the main plants. Yellow traps are also used primarily for monitoring and controlling pests *Liriomyza chinensis*. This trap uses a clear plastic bottle that is inserted in yellow paper on the inside of the bottle and mouse glue on the outside of the bottle. Traps are installed immediately after planting with a total of 40 traps/ha (<10 ha overlay). Disease control efforts are carried out with *Trichoderma* application starting four days after planting with a dose of 2-5 ml/L of water and repeated once a week and pest control with *Beauveria* routine spraying starting seven days after planting with a dose of 2-5 ml/L and repeated once a week (Prastuti et al., 2017).

Table 1 shows the availability of N, P and K nutrients was categorized at moderate to very high levels. The excessive use of chemical fertilizers in previous planting will leave nutrients in the soil that are not absorbed by plants. This is supported by acidic soil conditions where in these conditions some nutrients are not available for plants. According to Novizan (2002), nutrients are easily absorbed by plant roots at a neutral soil pH of 6-7, because at these pHs some nutrients are easily dissolved in water. On the other hand, the soil organic matter content is low, so giving organic fertilizer will help increase soil organic matter content and can increase soil pH (Novizan, 2002). The addition of agricultural lime is needed to increase the pH of the soil close to neutral so as to achieve optimum conditions for plant growth.

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Table.1. The initial soil analysis of the environmentally friendly Chili Farming in Campursari Village, Ngadirejo District, Temanggung Regency

Parameters	Method	Value	Criteria[1)]
pH H_2O	Electrode	5.03	acid
pH KCl		4.05	
C-Organic (%)	Spectrophotometry	1.76	Low
N-Kjeldahl (%)	Titrimetry	0.24	Medium
P_2O_5 HCl 25% (mg/100g)	Spectrophotometry	191.20	Very high
K_2O HCl 25% (mg/100g)	Spectrophotometry	42.60	high
P_2O_5 Bray (ppm)	Titrimetry	38.67	Very high

[1)]Source : Laboratory analysis results

Table 2 shows that the increase in the frequency of agrimeth aplication did not affect the plant height of chili. The plant height of all chili varieties was not significantly different from the frequency of agrimeth giving once, twice and 3 times. The highest plant height was averaged in 2 times agrimeth application a season. Agrimeth biofertilizers contains *Methylobacterium* sp., *Azotobacter* sp., *Bacillus* sp., *Rhizobium* sp., and *Bradyrhizobium japonicum* (balittanah.litbang.pertanian.go.id). The biofertilezer produces phytohormones which are beneficial in the absorption of macro and micro nutrients in the soil, stimulate plant growth, flowering and maturation of seeds (balittanah.litbang.pertanian.go.id). According to Kumar et al. (2002), the maximum plant height, leaf area per plant, and dry matter production per plant of chilli (*Capsicum annuum L.*) were achieved with being to be supplied with 75% N, P plus 100% K in addition to the inoculation of *Azotobacter, azospirillum*, phosphate solubilizing bacteria (PSB) and vesicular arbuscular mycorrhiza (VAM).

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Table 2. Height and yield of chili plants with biological fertilizer applications

	Frequency of agrimeth application	Chili variety			Average
		Sigantung	Carica	Prima Agrihorti	
Plant height (cm)	Once	124.97 a(A)	126.97 a(A)	117.58 a(A)	123.17 a
	Twice	137.21 a(A)	121.49 a(AB)	116.70 a(B)	125.13 a
	Three times	130.70 a(A)	119.21 a(B)	117.18 a(B)	122.36 a
	Average	130.96 A	122.56 B	117.15 B	
		Varieties			Average
		Sigantung	Carica	Prima Agrihorti	
Number of fruit/plants/season (pc)	Once	497.27 b(B)	308.27 a(B)	918.82 a(A)	574.79 a
	Twice	670.64 ab(A)	265.82 ab(B)	384.82 b(B)	440.42 b
	Three times	739.55 a(A)	204.36 b(C)	365.09 b(B)	436.33 b
	Average	635.82 A	259.48 B	556.24 A	
		Varieties			Average
		Sigantung	Carica	Prima Agrihorti	
Weight of fruit/plant/season (kg)	Once	1.96 a(B)	1.18 a(B)	3.14 a(A)	2.09 a
	Twice	2.53 a(A)	0.90 ab(B)	1.21 b(B)	1.55 b
	Three times	2.38 a(A)	0.78 b(C)	1.36 b(B)	1.51 b
	Average	2.29 A	0.95 C	1.90 B	

*)Values in the same column followed by letter same are not significantly different according to DMRT 0.05

The highest number and weight of fruit per plant in Prima Agrihorti variety with agrimeth applied once was 918.82 fruits and 3.14 kg which was significantly different with agrimeth applied twice or three times. In Sigantung variety, the highest number of fruits per plant per season at 3 times agrimeth application was not significantly different with 2 times the application of agrimeth and was significantly different from thagrimeth applied three times. The Carica variety, agrimeth is given once a season, yiele treatment of ding highest amount and weight of chilli, while it was not significantly different from the treatment of twice agrimeth application and significantly different from the treatment of 3 times agrimeth application. The highest number and weight of fruit per plant per season was averaged of 574.79 pieces and 2.09 kg at the frequency of 1 time agrimeth application was significantly different from the treatment of 2 times and 3 times agrimeth application for a season. Research results from Khan and Pariari (2012) showed that the inoculation of *Azospirillum* +75% N along with P & K gave maximum fruit yield (10.25 t/ha), number of fruits/plant (80.20), fruit length (6.72 cm) and oleoresin content (19.80 %) of

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Chilli. All growth parameters such as plant height (62.75 cm) and number of branches/plant (25.15) of Chilli (*Capsicum, Annuum L.*) was found highest with *Azospirillum* +100% N + PK, which were at par with Azotobacter + 100% N + PK. According Jaipaul *et al.* (2011) the highest fruit yield (9.27 tonnes/ha) of *Capsicum annuum* was recorded in plots receiving recommended NPK + farmyard manure + biofertilizers.

Table 3. Population of Nitrogen-fixing bacteria with the addition of biofertilizers

Frequency of biofertilizers	Population of BPN (cfu/g soil) in each variety			Average
	Sigantung	Carica	Prima Agrihorti	
1 x Agrimeth	nd	1.12×10^5	4.31×10^4	5.17×10^4
2 x Agrimeth	3.01×10^7	nd	nd	1.00×10^7
3 x Agrimeth	8.75×10^7	4.79×10^5	3.12×10^6	3.03×10^7
Average	3.92×10^7	1.97×10^5	1.05×10^6	

Note: nd = not detected; cfu = colony forming unit

Table 3 shows that the frequency of agrimeth applied 3 times favored development of BPN population. The highest population was 3.03×10^7 cfu / g soil. Agrimeth biofertilizer contains nitrogen fixing bacteria including *Azotobacter* sp., *Rhizobium* sp., *Bradyrhizobium japonicum*, which also enhances the microbial population of N-fixing in soil. This bacteria is able to fix free nitrogen so that it increases N element in the soil. High soil microbial populations stimulate biochemical activity in the soil and improve soil quality index. The use of N_2 fixing bacteria is a part of environmental friendly agriculture that reduce potentially the need for synthetic N fertilizer (Saraswati and Sumarno, 2008).

CONCLUSIONS

There is not interaction between chili variety and biofertilizer application. The intensity of agrimeth application did not significantly influence plant height of chili. The agrimeth applied once each season gave significantly the highest amount of chili (574.79 pc) and chili yield (2.09 kg) per plant compared with application twice and three times. The highest population of nitrogen fixing bacteria was obtained on treatment of agrimeth applied 3 times per season.

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