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Combination of Biological Fertilizers and Inorganic Fertilizers to Increase Productivity of Red Curly Chili (*Capsicum annuum* L.)

Bayu Adirianto [1*], Endang Krisnawati [1], Dwiwanti Sulistyowati [1], Aditya Dyah Utami [2]

[1] Politeknik Pembangunan Pertanian, Bogor, Indonesia
[2]Akademi Komunitas Perkebunan, Yogyakarta, Indonesia
Corresponding author*: bayuadirianto@gmail.com

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ABSTRACT

Due to declining soil fertility as a consequence of continued land usage, the production of red curly chilies has decreased. Fertilization, both biological and inorganic, is one strategy that may be used. The goal of this research was to ascertain the effect of a fertilizer mixture on the growth and production of red curly chili. Land preparation, planting, application of biological and inorganic fertilizers, and observation of growth and production were all included in the study phases. The study was done in a factorial experiment with three replications, with factor 1 being biological fertilizer and factor 2 being the kind of micro fertilizer. At 0, 30, 60, and 90 days after planting, bio-fertilizers, NPK, and micro-fertilizers were applied four times. The height of the plant, the diameter of the crown, the number of chilies, the length of the fruit, the weight of the chilies, and the diameter of the chilies were all recorded. The collected data were examined statistically using Analysis of Variance (ANOVA) and the Duncan Multiple Range Test (DMRT) at the 5% and 10% levels. The findings indicated that micronutrient brand B treatment had an effect on plant growth. Plant production is affected by the use of biological fertilizers.

Keywords: functional microbes, micro fertilizer, nutrients, productivity, soil fertility

INTRODUCTION

Capsicum annuum L., or red curly chili, is a horticultural plant that produces high-value fruit vegetables. In 2018, Indonesia produced 1,206,768 tons of huge fresh chilies with stalks, with a large chili harvest area of 137,596 ha and an average productivity of 8.77 tons / ha. Each year, the output of red curly chili peppers varies and tends to decline. One of the methods to increase chili plant yield with fertilization [1]. To get best results, the majority of farmers use inorganic fertilizers [2]. Inorganic fertilizers are believed to be the best way to increase crop yields [3] [4]. Inorganic fertilizers are more practical in their use and contain the macro nutrients of nitrogen, phosphate and potassium (NPK) needed by plants [5]. However, excessive use of inorganic fertilizers degrades soil fertility by preventing plants from receiving nutrients and disrupting the rooting system, resulting in suboptimal root performance [6] [7].

One technology to improve the efficiency of fertilization and sustainability of agricultural production systems is biological fertilizer, inorganic fertilizer [1]. Biofertilizers include functional microorganisms that coexist with plant rizospheres and contribute to nutrient availability [8]. Bio-fertilizers are biostimulators [9]. Inorganic fertilizers that include NPK as a source of critical nutrients but have a poor degree of efficiency [1], [10]. The combination of biological fertilizers and inorganic fertilizers is the right solution in the management of plant nutrition [11].

Fertilization plays a role in the availability of nutrients so that it affects the growth and productivity of plants. Fertilization is essential for vegetative growth such as roots, stems and leaves. Nutrients contained in fertilizers play a role in increasing the availability of nutrients in the soil, especially in soils that have fertility problems, especially in Latosol soil. Latosol is one of the soils that have a sour pH so it is less supportive for the cultivation of plants, especially chili peppers. Based on this background, research uses a combination of biological, inorganic fertilizers in chili peppers without pruning in the soil of Latosol [6] The goal of this research was to determine how a mixture of biological and inorganic fertilizers affected the development and production of red curly chili peppers grown in sour soils.

MATERIALS AND METHODS

The research was conducted at the Agricultural Development Polytechnic research ground, Bogor. The study used red curly chilies used the TM-99 variety. The land used for planting is Latosol. The study was conducted in a factorial experiment arranged in a randomized group design (RGD) with 2 factors, namely factor 1 is a biological fertilizer and factor 2 is a type of inorganic fertilizer. Penenlitian obtained 6 combinations of treatment with each of 3 repeats so that a total of 18 combinations of treatment. The prepared planting medium consists of a mixture of Latosol soil with basic fertilizers of compost, dolomite and NPK fertilizer. The provision of biological fertilizers, NPK and inorganic fertilizers is given 4 times at the age of 0, 30, 60 and 90 days after planting. The dose of fertilizer used is 1 Kg / m2 dolomite and 0.15 Kg / m2 NPK. All fertilization treatment is done with a watering system where the fertilizer is dissolved first before being watered into the plant. The fertilizer is given as much as 250 mL / plant.

The biological fertilizer used is P brand fertilizer while inorganic fertilizer is brand B fertilizer and brand G. Nutrient content in inorganic fertilizer G includes N, P, K, Ca, Mg, B, Cu, Fe, Mn, and Zn. Inorganic fertilizer content B is N, K, Fe, Zn, Bacillus sp, yeast, amino acids and giberelin acid. The content of P brand fertilizers include: *Azospirillum lipoferum*, *Azotobacter vinelandii*, *Bacillus thuringensis*, *Lactobacillus, Saccharomyces cevisae*, *Microbacterium lactium, Lignin reshuffle*, *Paeibacillus macarans*. The observed parameters include the length of the fruit, the width of the plant header, the number of red peppers per plant, the number of chilies per plant, the diameter of the plant and the height of the plant. Observations of the height and width of plants at ages 60, 75, and 90 HST, the weight of chilies and the number of chilies at 75, 80, 90, 95 and 120 HST and the diameter and length of chili fruits at 80, 90, and 95 HST. The data obtained is statistically analyzed using ANOVA and continued with DMRT at levels of 5% and 10%.)

RESULTS AND DISCUSSION

The findings indicated that the use of biological and inorganic fertilizers has an effect on the diameter of the header, the plant's height, and the quantity of fruit produced by chili peppers (Table 1). When compared to other treatments, the P2-M therapy produced significantly different outcomes than the P0-K treatment and exhibited superior development (Table 1). This is because the nutritional content of P2-M is more complicated, including growth regulatory chemicals and functional microorganisms, such as N, K, Fe, Zn, *Bacillus* sp., yeast, amino acids, and gibberelin. Microbes contained in fertilizers after being applied to plants have benefits for both plant growth and development. Microbes in their activity will produce compounds including phytohormones, siderophores and organic acids that plants use tanaman [12] [13]. Phytohormones can spur plant growth and development. In addition, indirectly plants with good keragaan then minimize the attack of pathogens [14].

Table 1. Chili plant growth

Treatment	Header diameter (cm)	Plant height (cm)	Number of chilies per plant (fruit)
P0-K	59.5 b	47.9 b	9 c
P1-M	60.9 b	50.0 ab	11 b
P2-M	66.2 a	51.9 a	15 a

Description: Numbers followed by different letters in the same column show a real difference in the DMRT test of 5%

Microbes also produce antibiotics as antimicrobial substances that can suppress pathogenic attacks [15]. The lack of pathogenic attacks causes plants to grow well [9].Inorganic fertilizer brand B contains amino acids. Amino acids are constituents of proteins that have various functions in plants, among others as a support, carrier of other substances, coordinating the activity of organisms, cells responding to stimuli, movement, protection against disease, acceleration of selective chemical reactions [16] [17].

The findings of study demonstrating that plants treated with biological fertilizers (P0-M) are significantly different from plants not treated with biological fertilizers (P0-K) (Figure 1). P0-M produces fruits that are longer and weigh more than P0-K. (Figure 1). Optimum nutrient absorption results in optimal plant development, which produces delicious fruit [2]. Along with assisting in the availability of nutrients, functional microorganisms create organic acids. These organic acids have the potential to operate as a growth regulator [18]. Fertilizers include functional microorganisms that contribute to increased nutrient availability. [19]. Plants can take nutrients to assist their growth metabolism [20].

The P0-M treatment results in a bigger fruit diameter, which is notably different from the 5.86 mm diameter of the P0-K treatment (Figure 2). However, the use of biological and inorganic fertilizers is widespread and results in a bigger fruit diameter than P0-K. Additional nutrients that impact the development and filling of fruit are greatly affected by the nutrients utilized in photosynthesis, namely as elements of carbohydrates, lipids, proteins, minerals, and vitamins that are translocated to the fruit storage.

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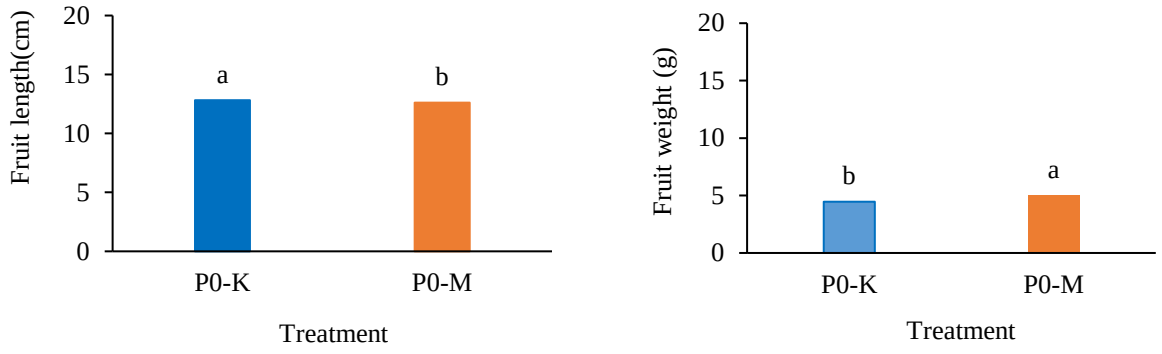


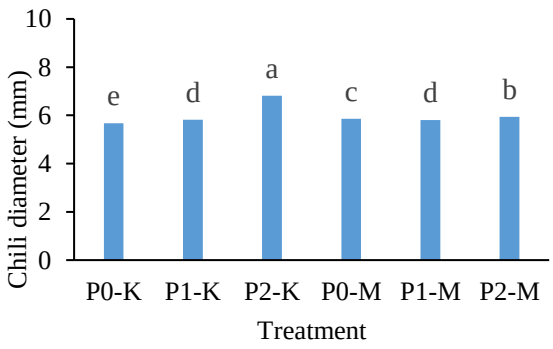
(a) (b)

Description: Numbers followed by different letters in the same column show a real difference in the DMRT test of 5%

Figure 1. Length and weight of chilli

The generative phase is a period of fruit development during which the quantity of fruits and their weight are determined by the nutrients in the soil and the supply of fertilizer. P and K are important macronutrients during this period. Element P contributes to the acceleration of blooming, seed cooking, and fruit development. Element K contributes to the strength of plant body parts such as leaves, flowers, and fruit, enhancing their resilience to drought and disease, and enhancing the quality of seeds. Additional nutrients that impact fruit shape and fullness are controlled by the nutrients utilized in photosynthesis, namely as elements of carbohydrates, lipids, proteins, minerals, and vitamins transferred into fruit storage [8].

The growth of chili peppers is also influenced by the selection of planting time. Planting time will affect the availability of water and plant-disrupting organisms (OPT). Plant drought will have an impact on the generative phase, flowering is disrupted and fruit yields decrease [21]. The availability of water depends on rainfall. The high enough intensity of rainfall causes the availability of water to be absorbed by plants is also met. Chili peppers have good growth in the rainfall range of around 600-1200 mm / year. Rainfall during the research period varied from 52.80 mm/month to 552.80 mm/month, as shown in Table 3. Sufficient rainfall has an effect on the moisture content of the soil, the aeration of the soil, and the amount of moisture required for plant development. Groundwater content affects transpiration and nitrogen assimilation. Sufficient groundwater content will cause the growth and development of plants both vegetative and generative phases will be optimal so that chili productivity is also optimal [22].



Description: Jackfruit followed by different letters in the same column is a real difference in the 10% DMRT test

Figure 2. Diamater chili

The length of the irradiation (length of the day) affects the flowering. The research site has a period of irradiation ranging from 4 to 8 hours / day. Sufficient irradiation results in the flowering of chili peppers to be optimal so that the resulting fruit is also good. When the irradiation is lacking it can interfere with the flowering and the resulting fruit can be dwarfed.

CONCLUSION

Biological fertilizers, B brand inorganic fertilizers and G brand inorganic fertilizers provide different red curly chili growth results. Plants treated with inorganic fertilizer brand B had a greater height, width, and quantity of chilies than plants treated with inorganic fertilizer brand G and biological fertilizer. However, the production of chili peppers, as measured by the number, diameter, weight, and length of chili peppers, is greater in plants treated with biological fertilizers than in plants treated with inorganic fertilizers.

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