

POSITIVE INFLUENCES OF BLACK SOLDIER FLY MANURE AND LIME ON SOIL FERTILITY AND YIELD OF CHILLI PEPPER

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ABSTRACT

Nutrient deficiencies of the agricultural soil are expected to pose serious challenges for the future crop production. Therefore, it is really necessary to find organic manures, which contain high nutrients to promote the growth and yields of crops is indispensable. Black Soldier Fly manure has been an opportunity to reproduce organic nutrients for agricultural soils. The field research contributed to access the sustainable farming by BSF manure as an organic fertilizer (insect frass). The present study that was carried out in Chomoi district, Angiang province, Vietnam had five treatments and four repeats. These study results were shown that combination of BSF manure and NPK fertilizer on the growth and yield of chilli pepper were significantly affected by treatment CP4 and CP5. Application of 90N:60P:60K kg/ ha, 1.5 t CaCO₃/ ha combination with 10.0 t BSF/ ha obtained the maximum growth properties such as the plant height, number of shoots and leaves per plant. furthermore, productivity of fresh chilli pepper, which was 16,7 t/ ha, was the higher than those of other treatments from 24 to 66.0 %. From above study results, this is a optimal solution for managing the soil nutrient plant yield.

KEY WORDS: Black Soldier Fly manure, Chilli pepper, growth, lime, NPK, yield.

1. Introduction

Chilli pepper (*Capsicum annum* L.) is one of the main spices and vegetables in the global meals, which is widely grown all over the world and has a high profit value. Its nutrient properties hold many kinds of vitamin A, B1, C and a high level of potassium, calcium, protein, carbohydrates (Hayati et al, 2012; Setiadi, 2008). Furthermore, the high contents of bioflavonoids, capsaicin and capsaicin in chili pepper. In the recent trend, the amount of chili consumed in the world is remarkably increasing. The global consumption demand of chili peppers is predicted to increase approximately 14% per year, which ranges from 720.000 to 840.000 tons/year (Setiawati et al., 2019). As a result, the productive requirement of chili pepper has to raise quickly to meet the need of consumers in the community. There were many different methods to be applied for improving the growth and productivity of chili pepper. Co-application of organic and chemical fertilizer has been using, which is the best way to solve this problem (Adhikari et al., 2016). Many organic manures are produced from livestock manure, which has positive organic nutrients for crop. According to prior studies proved that animal manures raised the chilli pepper yield and improved soil fertility (Setiawati et al., 2015; Nguyen Van Chuong and Ho Xuan Nghiep, 2022). Global scientists have studied a

replaceable way to treat organic matters through disintegration by macro-fauna such as black soldier fly (BSF), earthworm... (Diener et al. 2009; 2011), in which black soldier fly made the best choice. The black soldier fly has been presented all over the world by human and natural dispersion (Marshall et al. 2015). The BSF manure has been using for the agricultural cultivation thank to its high nutrition and hygienical organic manure (Lalander et al., 2015, 2016). The decomposed process of BSF manure only needs from 35 to 40 days to perfectly decompose organic matters into a stable BSF manure. On the contrary, a normally decomposable process takes from 56 to 168 days in order to decompose into a stable organic manure (Beesigamukama et al., 2021). Co-application of BSF manure with NPK fertilizer promoted to the development, productivity, and quality of vegetable crops better than the normal organic and chemical fertilizers. The fertilization of 2.5 t BSF/ ha alone or combined with 322 kg NPK per ha improved the yield of tomatoes, kales and French beans. The organic manure acceptance of high nutrients, such as the BSF manure, could decrease the application of inorganic fertilizers and lessen the burdensome limit of environmental contamination. Application of BSF and NPK in vegetable cultivation at the optimal ratio of 1.24 tons BSF and 322 kg NPK per ha improved soil fertility, productivity and quality of vegetable plants (Anyega et al., 2021). The main goal of this research is to find out positive contributions of BSF on soil and yield of chilli pepper.

2. Materials and methods

Chilli pepper (*Capsicum frutescens* L.) is AGR1 AFRICA 207 of AgriScience company. The field research was designed at dike areas and had all five treatments, which included :CP1: NPK (N90-60P-60K kg/ ha), CP2 (1.5 tCaCO₃/ ha +10 tBSF/ ha); CP3(10 t BSF/ ha); CP4 (NPK+10 tBSF/ ha) and CP5 (NPK + 1.5 tCaCO₃/ ha +10 tBSF/ ha) with 4 replication in Chomoi district, Angiang province, Vietnam. Mekong river water watered for chilli pepper during the experimental crop. There were 120 m² [6m²]/ each repeat (1.0 m x 6.0 m) x 4 repeats x 5 treatments = 120 m². A single row was planted with 60cm in width x 30 cm in length (03 seeds per hole).

Each dose of 90N:60P:60K kg/ ha (Iruthayaraj & Kulandaivelu,1973). The chemical fertilizer was applied by single fertilizer. The CaCO₃, phosphor, potassium and BSF amnure, which were fertilized 100% at 15 days before sowing (DBS). Fifty percent of nitrogen fertilizer was fertilized at DBS and 60 days after sowing (DAS). the Survey of chilli pepper plant height, number of shoots and leaves per plant were recorded at 20, 45, 65 DAS and at harvest. The yield components and yield of chilli were determined by fresh fruit tons per ha. The studied data that were collected from the growth and yield of chilli pepper, analysed by software program of statgraphics XV.

The soil pH (pH = 6.26) before the field experiment presented the suitable pH of crop soil for planting of chilli pepper (Bamidele & Eguagie, 2015). The total N content had the average result (0,193%)(Table 1). According to Table 1, the available Phosphor and exchangeable potassium (35.1 mg/100g and 0.250 meq/100g, respectively) had the average levels (Kramany et al., 2007). However, percentage of soil organic matter (2.08

%) had the low content (Habi, 2012) (Table 1).

Table 1: Soil attributes at the first of the experiment

No.	attributes	Values
1	pHH20	6.26
2	Total N (%)	0.193
3	Available P (mg/100g)	35.1
4	Exchangeble K (meq/100g)	0.250
5	OM (%)	2.08

3. Results and discussion

The results of Table 2 presented that soil attributes of all addition treatments at the end of the field experiment were significantly impacted on the pH, total N, available P, exchangeble K and organic matter at harvest. Soil pH of lime and BSF addition treatments that was higher than that of control valued from 6.06 to 6.71 and and raised to compare to soil pH of the initial experiment. Furthermore, the highest characteristic values of crop soil were at the CP5 treatment (NPK + 1.5 tCaCO₃/ ha +10 t BSF/ ha), except Exchangeble K had the highest values by the CP1, CP4 and CP5.

Table 2: Chemical attributes of soil at the end of the experiment

Treatments	pH	Total N (%)	Available P (mg/kg)	Exchangeble K (meq/100g)	OM (%)
CP1: 90N:60P:60K kg/ ha (Control)	6.06d	0.166c	6.17c	0.24a	1.31d
CP2 (1.5 t CaCO ₃ / ha +10 t BSF/ ha)	6.51b	0.142d	3.73d	0.17ab	2.63b
CP3(10 t BSF/ ha)	6.30c	0.143d	3.25e	0.12b	2.38c
CP4 (NPK+10 tons BSF/ ha)	6.31c	0.196b	7.27b	0.23a	2.37c
CP5 (NPK + 1.5 tCaCO ₃ / ha +10 t BSF/ ha)	6.71a	0.203a	8.21a	0.24a	3.03a
F	**	**	**	**	**
CV (%)	12.1	11.9	11.8	23.0	11.1

(**): significantly different at 1% level.

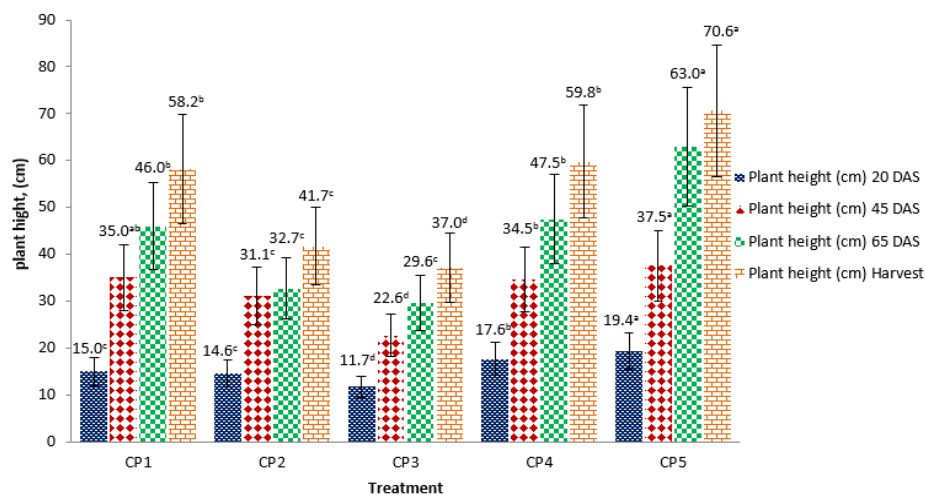


Figure 1: Effect of BSF and lime on plant height of chilli peppers

The results of Figure 1 adequately presented effects of lime, BSF manure and NPK fertilizer on the chilli pepper height of hot chilli, which raised strongly in all combined application treatments of lime and BSF. The highest height of chilli pepper was 19.4 cm, 37.5 cm, 63.0 cm and 70.6 cm in 20, 45, 65 DAS and at harvest, respectively. Contrary to CP5, lime combined with BSF in CP3 (Without NPK application), plant heights had the lowest values of 11.7, 22.6, 29.6 and 37.0 cm at 20, 45, 65 DAS and at harvest, respectively. Number of chilli pepper leaves and shoots remarkably affected on addition treatments of BSF manure and NPK fertilizer (CP4 and CP5) in Fig. 2 & Table 3. Similar to plant height, number (No.) of shoots and leaves per plant observed the maximum values in treatment CP5 compared to others during the experimental stage of 20, 45, 65 DAS and at harvest. The chilli pepper growth of treatment CP3 (10.0 t BSF/ha only) was the minimum number of shoots and leaves at stages of 20, 45, 65 DAS and at harvest comparison with other treatments (Fig. 2 & Table 3). The growth and productivity of treatment CP2 and CP3 (without NPK application) had the low values. Added treatments of BSF manure and/or lime were not a enough nutrient for the growth of Chilli peppers. There was significantly different at 5% (LSD < 0.05) among treatments.

Yield of chili pepper affected by many elements such as various kinds and rates of different fertilizers (organic and inorganic), levels, applied method and weather and agricultural soil condition, including soil nutrients and cultivator' technology (Hayati and Mahmud, 2012; Emir and Koesriharti, 2017). Organic manures have a lot of positive factors for raising crops. Furthermore, amendment of organic manures such as BSF manure could raise plant yield (Emir and Koesriharti, 2017). Produksi Tanam, (2017) proved that height and stem diameter of chili pepper increased in each week of observation. The best chilli height was the added treatment of compost tea combined with Phonska application (Emir and Koesriharti, 2017). Similarly, the best growth of chili pepper observed from combined treatments of NPK and organic manures (Hayati and

Mahmud, 2012). These studied results were the same positive effects with the discoveries of prior researchers, who found out relationship of roots, stillers, and fruit of chilli pepper and the amendment of organic manure and inorganic increased from 21.4% to 79.7% compared to the control. the best method for improving chilli pepper yield could be the application of organic, lime combined with inorganic fertilizer (Nakhro and Dkhar, 2010; Ouda and Mahadeen, 2008; Zynudheen et al., 2008; Natesh et al., 2010).

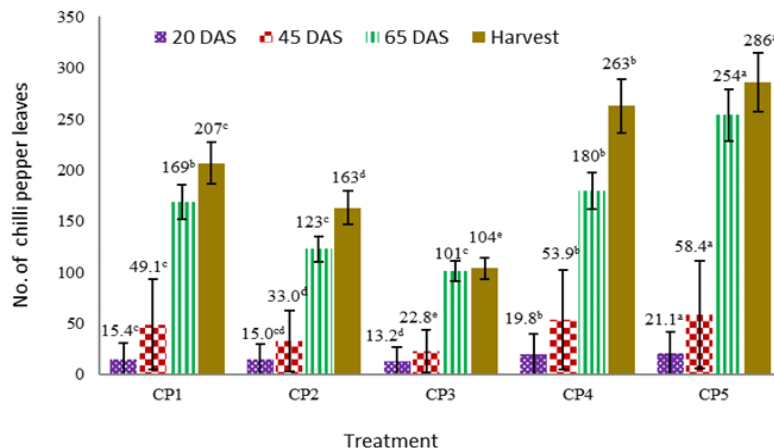


Figure 2: Effect of BSF and lime on No. of chilli pepper leaves

Amendment of BSF manure was positive impacts on growth attributes of chilli pepper such as the plant height, No. of leaves and No. of shoots (Fig. 1; 2 and Tables 3). BSF manure added at the 4 x ratios added the maximum plant was remarkably higher than that of control treatment. Moreover, the growth attributes of chilli pepper such as the plant height, No. of leaves and No. of shoots trended to be remarkably higher compared to control treatment (Fig. 1; 2 and Tables 3). The positive effects of BSF manure on chilli pepper branches were presented clearly and differed significantly at 5% among all treatment conducted in 130 DAT presented. Further, the application of BSF manure and NPK application at the different treatments significantly raised chilli shoots during the promotion stages (Table 3). Black coldier fly manure being enrichment in all key crop nutritions has excellently affected on all growth properties of crops and promoted the contribution and nutritional values to crops. Moreover, different crop hormones are analysed thank to metabolize in microorganisms existing in BSF manure therefore enriching their concent. Thereby, fast vegetative function development may be resulted in store of rich nutrient materials for the transformative progsess of chilli pepper shoots into floral branches resulting in leading to early flowering and early harvest (Pariari and Khan 2013); Jamir et al., 2017)..

Table 3: Effect of BSF and lime on No.of chilli pepper shoots

Treatments	No. of tillers / plant			
	20 days	45 days	65 days	harvest
CP1(Control)	1.32 ^c	14.3 ^c	26.4 ^b	32.0 ^c
CP2	1.22 ^{cd}	12.3 ^d	16.4 ^c	20.4 ^d
CP3	1.02 ^d	8.00 ^e	12.6 ^c	15.3 ^e
CP4	1.62 ^b	18.3 ^b	30.4 ^b	40.5 ^b
CP5	2.02 ^a	25.8 ^a	36.6 ^a	46.3 ^a
F	*	*	*	*
CV (%)	19.2	17.7	13.4	16.9

* Values are significantly different at 5 % level.

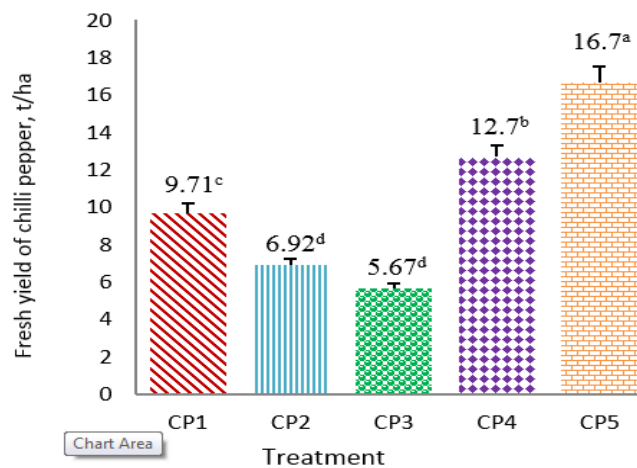


Figure 3: Fresh yield of chilli pepper

The treatment of CP5 (NPK + 1.5 tCaCO₃/ ha +10 t BSF/ ha) presented the maximum productivity of fresh (16.7 t/ ha). On the contrary, The treatment CP3 (only 10 t BSF/ ha application) had a minimum yield. Yield values of fresh chilli pepper in all treatment ranged from 5.67 to 16.7 t/ ha and significant variousness at 1% level. The treatment CP5, which applied ratios of 90N-60P-60K kg/ha + 1.5 tCaCO₃/ ha +10 t BSF/ ha, raised higher than those of CP1(90N-60P-60K kg/ha), CP2 (1.5 t CaCO₃/ ha +10 t BSF/ ha), CP3 (10 t BSF/ ha) and CP4 (NPK+10 tons BSF/ ha) from 41.8, 56.6, 66.0 and 24.0%, respectively. Optimum nutrients of BSF manure, lime combined with NPK fertilizer, which had suitable ratios, was an importance element to promote the growth and yield (Table 6). The positive impact was obtained from all combined application of BSF, lime and NPK fertilizer to be showed significantly high yields of chilli pepper (Fig.3). Productivity increased remarkably from minimum value of 5.67 t/ha at CP3 to a maximum value of 16.7 t/ ha at CP5. All growth parameters were improved when hot chilli pepper plants received advantage effects of lime and CM (Vimala et al., 2007). Moreover, the best potentiality of growth and yield enhance was perfectly combined by

amendment of BSF manure, lime with NPK. The long -term application of BSF, lime and inorganic manures may enrich the chilli yield and lessen the use of the inorganic fertilizers, pesticide, unpolluted environment and sustainably agricultural cultivation (Reddy et al., 2017). These studied results that were in agreeableness with the find of prior researchers raised significantly the chilli yield of amended treatments of lime, organic manure and inorganic fertilizer (Hasan et al., 2019). Furthermore, According to Sanjutha et al. (2008), showed the maximum number of available fruits per plant, which obtained at added treatments of high organic and inorganic fertilizers.

4. Conclusion

This research proved that application of BSF manure, lime combined with NPK fertilizer influenced on chemical properties such as soil pH, total nitrogen, available phosphorus, Exchangeable potassium, organic matter. Thus, amended treatments of BSF and NPK promoted the mature and yield of chilli pepper to compare with other treatments. Application of 90N-60P-60K kg/ha + 1.5 tCaCO₃/ ha +10 t BSF/ ha obtained the highest argonomy attributes and yield of chilli pepper. Supplementation of BSF and NPK fertilizer could help to enrich soil nutrients and promote the growth and yield of chilli pepper.

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