PAPER NAME

11690_09 doi 15.1995 IJAB-22-0249 (6) 413-418 SC (10).pdf

AUTHOR

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WORD COUNT

5896 Words

CHARACTER COUNT

30730 Characters

PAGE COUNT

6 Pages

FILE SIZE

255.2KB

SUBMISSION DATE

Mar 21, 2023 9:29 AM GMT+7

REPORT DATE

Mar 21, 2023 9:29 AM GMT+7

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INTERNATIONAL JOURNAL OF AGRICULTURE & BIOLOGY
ISSN Print: 1560–8530; ISSN Online: 1814–9596
22–0249/2022/28–6–413–418
DOI: 10.17957/IJAB/15.1995
http://www.fspublishers.org

Short Communication

Agronomical Characters of Red Chili (*Capsicum annum*) in Response to Different Doses of Biofertilizer and Alkaline Based Multi Nutrient Fertilizer

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Received 13 June 2022; Accepted 14 November 2022; Published 12 December 2022

Abstract

Optimal production of red chili (*Capsicum annum* L.) var. Indrapura can be potentially achieved through culture technique intensification, alike fertilizer application. This study aimed to evaluate agronomical responses of red chili under different dose of biofertilizer and alkaline based multi nutrient fertilizer. Plant materials in form of the 28 old-days seedlings were transplanted to polybag containing a well-mixed growing media, one seedling per polybag, prior to the arrangement in randomized completely block design with two factors, *i.e.*, the dosage of biofertilizer and multi nutrient fertilizer. Both of biofertilizer and multi nutrient fertilizer were composed of 3 doses, *i.e.*, 0, 4 and 8 L/ha, and 0, 5 and 10 kg/ha, respectively. Numbers of replications involved in present study were 10, so that the size of experimental unit was 90 units. The result showed that growth performance, as indicated by plant height, stem diameter and branching level, was significantly affected only by single factor, either biofertilizer or alkaline based fertilizer solely, instead of interaction of both. The highest plant was observed in the plant treated with the highest doses of biofertilizer (8 L/ha) or alkaline fertilizer (10 kg/ha). However, the yield variables were significantly affected by interaction of both factors. The best treatment that strongly recommended was the combination of 8 L/ha biofertilizer and 10 kg/ha multi nutrient fertilizer that could improve fruit number, fruit weight, and also reduce fruit damaged by about 180, 204 and 54%, compared to control, respectively. © 2022 Friends Science Publishers

Keywords: Biofertilizer; Growth performance; Red chili; Multi nutrient fertilizer; Yield

Introduction

Chili (*Capsicum annum* L.), also known as pepper, hot pepper and chili pepper, is one of importance horticulture commodities worldwide from Solanaceae family (Knapp 2002; Peeraulle and Ranghoo-Sanmukhiya 2013; Penella *et al.* 2015). This commodity belongs to ancient crop due to the first report on its cultivation has already start at least 6000 B.C. in Mexico (Kraft *et al.* 2014). Chili is predominantly known as vegetable (Ali *et al.* 2017), specifically as a natural food flavoring spice (Bosland and Votava 2012), due to capsaicin-rich characteristic (González-Zamora *et al.* 2015; Sanati *et al.* 2018). Aside spice, chili is also used for traditional medicine by certain local households (Pawar *et al.* 2011). Chili also contains numerous beneficial phytochemicals, such as vitamin C, vitamin E, carotenoids such provitamin A, and other antioxidant compounds (Nadeem *et al.* 2011; González-Zamora *et al.* 2015; Tripodi *et al.* 2018; Farhoudi *et al.* 2019). Aside food purposes aspect, there is a high potential to set the chili as ornamental plant recently (Putra *et al.* 2017). Various beneficial things obtained from chili stimulate the growth of chili product in market, both international and local market.

The main marketable plant part of chili is the fruit. The fruit become the main focus during the breeding and culture of chili plant. The chili fruit is mostly sold in a fresh raw form; however, some market requires a dried or processed one. The domestic data in Indonesia showed that there was a gap between chili actual productivity (6.88 ton per Ha) and its potential productivity (14 ton per Ha) on 2017 (BPS 2018). The chili actual productivity is still categorized as low level compared to its potential, thus opening the opportunity to boost productivity through culture practice modification.

To cite this paper: Widyastuti RAD, R Budiarto, I Listiana, H Yanfika, P Sanjaya, A Rahmat, A Mutolib (2022). Agronomical characters of red chili (*Capsicum annum*) in Response to different doses of biofertilizer and alkaline based multi nutrient fertilizer. *Intl J Agric Biol* 28:413–418

Modification of culture practice in chili is required to achieve the actual yield improvement. The most common modification to support chili fruit production is the fertilizer application. Numerous studies have reported the success of nitrogen (Aminifard *et al.* 2012; Bhuvaneswari *et al.* 2013; Ayodele *et al.* 2015), potassium (El-Bassiony *et al.* 2010; Golcz *et al.* 2012; Ortas 2013), and phosphor (Amisnaipa *et al.* 2014) application to improve chili fruit production. The nitrogen, phosphorus and potassium are well-known macro fertilizer used for agriculture. Additionally, plant growth also requires micronutrient, such as boron, zinc, manganese, iron, copper, molybdenum, chlorine. Both macro and micronutrients in both soil and leaf tissue are important to support plant yield (Efendi *et al.* 2021). Earlier study has been conducted to show the positive effect in combination of macro and micronutrient addition for chili growth and production (Baloch *et al.* 2008). Previous studies used multi nutrient fertilizer to produce ornamental chili (Putra *et al.* 2017) and to boost F1 hybrid chili yield through the improvement of growth performances (Deli *et al.* 2019; Hamdani *et al.* 2019).

Excessive application of inorganic fertilizer endangers not only the sustainability of plant yield, but also the land biodiversity and environmental quality (Mozumder and Berren 2007; García-Fraile *et al.* 2015). Additional technology to compensate the negative effect that might occur after the high rates of chemical fertilizer apply in soil is the application of biofertilizer (Mahanty *et al.* 2017). Biofertilizer is defined as the beneficial microbe-containing fertilizer product to support plant growth by providing a favor environment for plant (Hayat *et al.* 2010; Mohammadi and Sohrabi 2012; Amutha *et al.* 2014; Naveed *et al.*2015). There are various types of beneficial microbe involved in biofertilizer such as *Azospirillum*, *Azotobacter*, *Rhizobium* and phosphate solubilizing bacteria that have already known their role to ease the fixation of nutrient fixation, to solubilize less available nutrient, to accelerate organic matter decomposition and mineralization (Biswas *et al.* 2000; Prasad *et al.* 2019).

The success of biofertilizer to improve plant growth and final yield have already proofed by numerous earlier studies, such as in apple (Mosa *et al.* 2016), pomegranate (Aseri *et al.* 2008), cauliflower (Nath 2013), potato minituber (Tahmasbi *et al.* 2011), soybean (Yang *et al.* 2021), mungbean (Asad *et al.* 2004), maize (Wu *et al.* 2005; Abou-Zeid *et al.* 2021), tomato (Molla *et al.* 2012) and also chili (Gou *et al.* 2020). In addition, biofertilizer is reported to improve not only chili yield but also chili land in Bhutan (Tashi *et al.* 2023). There is a hypothesis that the application of biofertilizer, especially in combination with inorganic compound fertilizers, can increase the growth and production of local chili plants. However, there are still limited reports to proof that hypothesis. Therefore, this study aimed to evaluate agronomical characters of red chili (*Capcicum annum* L. var. Indrapura) in response to different dose of biofertilizer and alkaline based multi nutrient fertilizer.

Materials and Methods

This experiment was conducted from August 2020 (middle of summer) to January 2021 (middle of rainy), at Desa Sukabanjar, Gedongtataan, Pesawaran, Lampung, Indonesia. The experimental site has a relatively flat topography, with a slope of 0–4%. It is also located in the lowlands (100 m above sea level) with the characteristics of an average monthly rainfall, relative humidity and temperature for about 163 mm, 79.88% and 27°C, respectively. Plant material was seed of local red chili (*Capcisum annum* L. var. Indrapura) that obtained from local seed breeder. Seed was sowed in germination tray for 28 days prior to transplanting. Polybag, with a size of 20 cm in diameter and 30 cm in height, was prepared for growing chamber of chili seedling. Polybag was filled with a well-mixed growing media that composed of sand: soil: organic fertilizer in ratio of 1: 2: 1. There was one seedling planted in every polybag. The post-transplanted polybag was arranged in randomized completely block design to accommodate two factors, *i.e.*, biofertilizer and alkaline based micronutrient fertilizer. Three doses of biofertilizer (*Bio Max Growth*®) applied were 0, 4 and 8 L per ha that equal to 0, 25 and 50 mL per plant. *Azospirillum*, *Azotobacter*, arbuscular mycorrhizal fungi, cellulotic microbes, nutrient solubilization microbes, *Pseudomonas*, *etc.* were incorporated in biofertilizer (Gunarto 2013). Three doses of alkaline based micronutrient fertilizer (*Plant Catalyst*®) applied were 0, 5 and 10 kg per ha that equal to 0, 31.25 and 62.5 g per plant. Both biofertilizer and alkaline based micronutrient fertilizer were applied twice at 3 days after transplanting (DAT) and 33 DAT, through soil drench. In total, there were 90 experimental units in term of 90 red chili seedlings, to accommodate 9 combination treatments that replicated 10 times each.

Agronomical characters in terms of growth and yield performance were observed and measured in present experiment. Plant height, stem diameter and level of branching were measured to represent the plant growth performances, while number of fruits (per plant), fruit weight (per plant) and percentage of damaged fruit represented the yield characters. Plant height (cm) was measured by roll meter from the base of plant to the highest point of plant, *e.g.*, apical bud. Stem diameter (mm) was measured by digital caliper at the 10 cm above the soil surface. Level of branching and number fruit per plant were counted manually by hand counter. Fruit weight (g per plant) was measured in wet basis by using digital analytic. Percentage of damaged fruit was obtained by comparing the number of damaged fruits to the total of harvested fruit. All variables were measured in the harvesting day at the 23rd week after transplanting on all experimental units.

Obtained data was tabulated in Microsoft Excel, and then prepared for data analysis in Statistical Tool for Agriculture Research (STAR) software. Present study involved two kinds of analysis, *i.e.*, analysis of variance (ANOVA) and Least Significant Difference (LSD) at α 5%.

Results

Analysis of variance (ANOVA) resulted; (i) a significant effect of biofertilizer on all observed variables, except stem diameter and level of branching, (ii) a significant effect of alkaline based multi nutrient fertilizer on all variables, and (iii) a significant effect of interaction of both factors only on the number of fruits, fruit weight and percentage of damaged fruit (Table 1). The analysis of plant height in present experiment showed that local chili height was significantly affected by the single factor, either the application of biofertilizer or alkaline based multi nutrient fertilizer. The application of biofertilizer could increase the plant height ranging from 10 to 30% compared to its control (Table 2). In similar pattern, the application of alkaline based multi nutrient fertilizer could also increase the red chili height, in range of 15–21% as compared to its control.

Aside plant height, other growth variables measured were stem diameter and level of branching (Table 3). Stem diameter indicated the accumulation of assimilates in stem structure. The result showed that the red chili var. Indrapura experienced a significant increase of stem diameter as the effect of multi nutrient fertilizer only, while the biofertilizer showed no significant effect (Table 1). The application of 5 and 10 kg per ha alkaline based multi nutrient fertilizer enlarged the size of chili stem for about 22 and 32%, respectively (Table 4).

The level of branching of red chili var. Indrapura was also affected only by multi nutrient fertilizer, while biofertilizer showed no significant effect. The result generally showed that chili plant treated with multi nutrient fertilizer displayed different levels of branching, ranging from 12–14 levels of branching. Compared to its control, the level of branching was significantly increased both at 5 kg/ha and 10 kg/ha multi nutrient fertilizer application (Table 5).

Plant production variables, such as the number of fruits per plant, the fruit weight per plant and the percentage of damaged fruit per plant were significantly affected by the interaction of biofertilizer and muti nutrient application (Table 1). The highest number of fruits per plant was observed in red chili plants treated with combination of 8 L/ha biofertilizer and 10 kg/ha multi nutrient fertilizer and this result was 180% higher compared to control (no biofertilizer and no multi nutrient fertilizer) as the lowest result obtained in present study (Table 6).

At the highest dose of biofertilizer (8 L/ha) for combination treatment, the increase of multi nutrient fertilizer dose up to 10 kg/ha was significantly produced more fruit rather than 5 kg/ha or even 0 kg/ha (Table 6). The increase of fruit number in best combination treatment (10 kg/ha multi nutrient fertilizer + 8 L/ha biofertilizer) was 113% higher than combination of 8 L/ha biofertilizer + no multi nutrient fertilizer. At the highest dose of multi nutrient fertilizer (10 kg/ha) in the combination treatment, the increase of biofertilizer dose up to 8 L/ha was significantly produced more fruit rather than both 4 L/ha and 0 L/ha (Table 6).

Fruit weight per plant also displayed similar pattern of result with number of fruit variables. General rule is the more fruit per plant, the highest fruit weight per plant.

Table 1: Analysis of variance (ANOVA) of the effect of biofertilizer (B), alkaline based multi nutrient fertilizer (A), and interaction of both factors (B*A) on growth and production of red chili

Observed variables	Significance		
	B	A	B*A
Plant height	*	*	ns
Stem diameter	ns	*	ns
Level of branching	ns	*	ns
Number of fruits	*	*	*
Fruit weight	*	*	*
Percentage of damaged fruit	*	*	*

B – biofertilizer dose, A – alkaline based multi nutrient fertilizer dose, B*A – interaction of biofertilizer and alkaline based multi nutrient fertilizer, * - significantly different based on the LSD at α 5%, ns - not significantly different

Table 2: The height of red chili (*Capsicum annum* L. var. Indrapura) in response to different doses of biofertilizer and alkaline based multi nutrient fertilizer application

Factors	Plant height (cm)
1st factor: biofertilizer dose (L/ha)	
0	72.6 c
4	79.8 b
8	94.5 a
2nd factor: Alkaline based multi nutrient fertilizer dose (kg/ha)	
0	80.2 c
5	92.4 b
10	96.8 a

Mean followed by the same alphabet in the same factor column are not significantly different based on the LSD at α 5%

Table 3: The stem diameter and branching level of red chili (*Capsicum annum* L. var. Indrapura) in response to different doses of alkaline based multi nutrient fertilizer application

Alkaline based multi nutrient fertilizer dose (kg/ha)	Stem diameter (mm)	Level of branching
0	14.6 b	12.17 c
5	17.8 a	12.92 b
10	19.2 a	13.58 a

Mean followed by the same alphabet in the same column are not significantly different based on the LSD at α 5%.

Table 4: The number of fruits per plant of red chili (*Capsicum annum* L. var. Indrapura) in response to different doses of biofertilizer and alkaline based multi nutrient fertilizer application

Alkaline based multi nutrient fertilizer (kg/ha)	Biofertilizer		
	0 L/ha	4 L/ha	8 L/ha
0	73 Bc	87 ABc	96 Ac
5	104 Cb	134 Bb	166 Ab
10	127 Ba	199 Aa	204 Aa

Mean followed by the same uppercase alphabet in the same row are not significantly different based on the LSD at α 5%. Mean followed by the same lowercase alphabet in the same column are not significantly different based on the LSD at α 5%

The highest mean of fruit weight per plant was also found in best combination treatment (8 L/ha biofertilizer + 10 kg/ha alkaline based multi nutrient fertilizer) for about 780.9 g per plant, and it was 205% higher than control treatment (no biofertilizer and multi nutrient fertilizer) for about 256.2 g per plant (Table 7). The yield variables were not only about quantity, the quality of fruit was also important variable to study. In terms of fruit/pod quality, the application of biofertilizer combined with alkaline based multi nutrient fertilizer could reduce the percentage of damaged fruit per plant up to 9.6% when best treatment applied, whereas the fruit damaged in control treatment was higher, for more than 20% (Table 8).

Table 5: The fruit weight per plant of red chili (*Capsicum annum* L. var. Indrapura) in response to different doses of biofertilizer and alkaline based multi nutrient fertilizer application

Alkaline based multi nutrient fertilizer (kg/ha)	Biofertilizer		
	0 L/ha	4 L/ha	8 L/ha
0	256.2 Bb	319.5 Bc	442.8 Ac
5	460.0 Ba	585.4 ABb	630.6 Ab
10	527.8 Ba	673.5 Ba	780.9 Aa

Mean followed by the same uppercase alphabet in the same row are not significantly different based on the LSD at α 5%. Mean followed by the same lowercase alphabet in the same column are not significantly different based on the LSD at α 5%

Table 6: The percentage of damaged fruits per plant of red chili (*Capsicum annum* L. var. Indrapura) in response to different doses of biofertilizer and alkaline based multi nutrient fertilizer application

Alkaline based multi nutrient fertilizer (kg/ha)	Biofertilizer		
	0 L/ha	4 L/ha	8 L/ha
0	20.92 Aa	17.61 Ba	17.26 Ba
5	18.45 Aa	16.33 Aa	12.54 Bb
10	12.36 Ab	11.27 ABb	9.60 Bc

Mean followed by the same uppercase alphabet in the same row are not significantly different based on the LSD at α 5%. Mean followed by the same lowercase alphabet in the same column are not significantly different based on the LSD at α 5%

Table 7: The fruit weight per plant of red chili (*Capsicum annum* L. var. Indrapura) in response to different doses of biofertilizer and alkaline based multi nutrient fertilizer application

Alkaline based multi nutrient fertilizer (kg/ha)	Biofertilizer		
	0 L/ha	4 L/ha	8 L/ha
0	256.2 Bb	319.5 Bc	442.8 Ac
5	460.0 Ba	585.4 ABb	630.6 Ab
10	527.8 Ba	673.5 Ba	780.9 Aa

Mean followed by the same uppercase alphabet in the same row are not significantly different based on the LSD at α 5%. Mean followed by the same lowercase alphabet in the same column are not significantly different based on the LSD at α 5%

Table 8: The percentage of damaged fruits per plant of red chili (*Capsicum annum* L. var. Indrapura) in response to different doses of biofertilizer and alkaline based multi nutrient fertilizer application

Alkaline based multi nutrient fertilizer (kg/ha)	Biofertilizer		
	0 L/ha	4 L/ha	8 L/ha
0	20.92 Aa	17.61 Ba	17.26 Ba
5	18.45 Aa	16.33 Aa	12.54 Bb
10	12.36 Ab	11.27 ABb	9.60 Bc

Mean followed by the same uppercase alphabet in the same row are not significantly different based on the LSD at α 5%. Mean followed by the same lowercase alphabet in the same column are not significantly different based on the LSD at α 5%

Discussion

Red chili production should be improved in order to meet the increasing demand on the market. In general, the improvement of the number of harvested area and intensification of agricultural input could accomplish that challenge (Foley *et al.* 2011). Fertilizer is one of important agricultural inputs that influenced not only the plant yield but also farmer's income and environmental sustainability. The use of a balanced fertilizer between chemical and biofertilizer play a key role in obtaining good and sustainable yield at the same time with maintaining agroecosystem.

Present study revealed the increase of growth performance, as indicated by plant height, stem diameter, and branching levels, as the impact of applied biofertilizer or multi nutrient fertilizer. In general, an optimum plant uptake on multi nutrient, especially nitrogen, was associated with the greater vegetative growth performance (Deli *et al.* 2019). In addition, biofertilizer was also reported to improve chili plant growth performance (Gou *et al.* 2020), through several mechanisms, namely (i) the uptake of microbe-secreted phytohormones (Abou-Zeid *et al.* 2021); (ii), the regulation of auxin homeostasis (Ryu *et al.* 2003; Zhang *et al.* 2007); (iii) the increase of plant resistance to pest and disease (Tahmasbi *et al.* 2011); (iv) boosting nutrient acquisition (Andrade *et al.* 2013; Pii *et al.* 2015; Gou *et al.* 2020) and (v) the improvement in soil fertility (Shang *et al.* 2017), chlorophyll content and photosynthetic rate (Zhang *et al.* 2007). The improvement of plant photosynthetic rate is predominantly followed by the increase of plant growth and yield obtained (Budiarto *et al.* 2019). However, there was a need to control plant vegetative growth through pruning (Budiarto *et al.* 2018; Widyastuti *et al.* 2019) or pinching in particular condition, such as the excessive vegetative growth rather than generative ones, leading to the lesser yield obtained.

In terms of yield, the mean of individual chili fruit weight in the best combination treatment of biofertilizer and alkaline based multi nutrient fertilizer was 3.8 g, while at control treatment was only 3.5 g. Not only fruit weight but also fruit number, the best combination treatment of 8 L/ha biofertilizer + 10 kg multi nutrient fertilizer could increase the yield up to 179%. In the absence of biofertilizer on combination treatment, the increase of multi nutrient fertilizer dose up to 10 kg/ha could only increase chili production to 74% compared to control. This finding emphasized the importance of biofertilizer on chili yield booster, as previously reported by numerous studies on chili worldwide (Datta *et al.* 2011; Gou *et al.* 2020; Tashi *et al.* 2023). However, the absence of multi nutrient fertilizer, leaving only biofertilizer solely, also produce lower chili fruit number than its best combination treatment. Therefore, combination of both fertilizers was the best practices recommended. This finding was in agreement with previous studies by Azizi *et al*. (2021) and Widyastuti *et al*. (2021).

Not only yield quantity, but chili fruit quality also highlighted in present study, since there was significant reduction of damaged fruit as the effect of fertilizer application. The best treatment was assumed to have best protection effect on chili fruit. Damaged fruit could be characterized by the abnormalities in form, texture and color, that mostly caused by pest and disease attack, leading to be unmarketable chili fruit. Previous study showed the increase of marketable fruit, at the same time with the decrease of un-marketable fruit as the effect of precision fertilizer application, especially potassium (Hamdani *et al*. 2019).

Agricultural practice is proved to influence the success of production of pepper (Abuzahra 2011). Determination of best agricultural practices, specifically fertilizer application within this case, is important point to highlight. Numerous positive impacts resulted by biofertilizer administration on plant growth and yield (Bhattacharjee and Dey 2014), still need accompanied by the presence of multi nutrient fertilizer to have the best and sustainable result. Intensification in terms of biofertilizer and inorganic fertilizer input application is strongly recommended for chili production, due to the susceptibility of chili plant in response to numerous biotic and abiotic stress during its cultivation period.

Conclusion

Growth and production of red chili var. Indrapura significantly affected by the applications of biofertilizers and alkaline based multi nutrient fertilizers. The improvement of growth performances mostly affected by multi nutrient fertilizer, whereas the increase of production was generally caused by the interaction of both factors. The best combination treatment was 8 L/ha biofertilizer + 10 kg/ha multi nutrient fertilizer.

Acknowledgements

Authors acknowledge the technical assistance from people of Desa Sukabanjar, Gedongtataan, Pesawaran, Lampung and research grant from Universitas Lampung, Indonesia

Author Contributions

RADW planned the experiments, RADW, IL, HY, and PS interpreted the results, RADW, AR, RB, and AM made the write up and RB statistically analyzed the data and made illustrations.

References

Abou-Zeid HM, NES Saber, BI Abdelrahim, GSM Ismail (2021). Nitrogen biofertilizer alleviates the inhibitory effect of cadmium on physiology and nitrogen assimilation in maize plants. *Intl J Agric Biol* 25:98–108

Abuzahra TR (2011). Influence of agricultural practices on fruit quality of bell pepper. *Pak J Biol Sci* 14:876–881

Ali S, M Rizwan, MF Qayyum, YS Ok, M Ibrahim, M Riaz, MS Arif, F Hafeez, MI Al-Wabel, AN Shahzad (2017). Biochar soil amendment on alleviation of drought and salt stress in plants: A critical review. *Environ Sci Pollut Res* 24:12700–12712

Aminifard M, H Aroiee, H Nemati, M Azizi, M Khayyat (2012). Effect of nitrogen fertilizer on vegetative and reproductive growth of pepper plants under field conditions. *J Plant Nutr* 35:235–242

Amisnaipa A, AD Susila, A Sutandi, D Nursyamsi (2014). Penentuan metode ekstraksi P tanah Inceptisol untuk tanaman cabai (*Capsicum annum* L.). *J Hortic* 24:42–48

Amutha R, S Karunakaran, S Dhanasekaran, K Hemalatha, R Monika, P Shanmugapriya, T Sornalatha (2014). Isolation and mass production of bio-fertilizers (Azotobactor and Phosphobacter). *Intl J Lat Res Sci Technol* 3:79–81

Andrade MMM, NP Stamford, CERS Santos, ADS Freitas, CA Sousa, L Junior, A Mário (2013). Efects of biofertilizer with diazotrophic bacteria and mycorrhizal fungi in soil attribute, cowpea nodulation yield and nutrient uptake in field conditions. *Sci Hortic* 162:374–379

Asad SA, A Bano, M Farooq, M Aslam, A Afzal (2004). Comparative study of the effects of biofertilizers on nodulation and yield characteristics of mung bean (*Phaseolus vulgaris* L.). *Intl J Agric Biol* 6:837–843

Aseri GK, N Jain, J Panwar, AV Rao, PR Meghwal (2008). Biofertilizers improve plant growth, fruit yield, nutrition, metabolism and rhizosphere enzyme activities of pomegranate (*Punica granatum* L.) in Indian Thar desert. *Sci Hortic* 117:130–135

Ayodele OJ, EO Alabi, M Aluko (2015). Nitrogen fertilizer effects on growth, yield, and chemical composition of hot pepper (rodo). *Intl J Agric Crop Sci* 8:666–673

Azizi S, Afandi, K Hendarto, H Buchari (2021). The effect of bio fertilizer and alkaline fertilizer addition on soil aggregate stability and production of red chili (*Capsicum Annuum* L.). *J Plant Simb* 3:26–33

Baloch QB, QI Chachar, MN Tareen (2008). Effect of foliar application of macro and micro nutrients on production of green chillies (*Capsicum annuum* L.). *J Agric Technol* 4:177–184

Biswas JC, JK Ladha, FB Dazzo (2000). Rhizobia inoculation improves nutrient uptake and growth of lowland rice. *Soil Sci Soc Amer J* 64:1644–1650

Bhattacharjee R, U Dey (2014). Biofertilizer, a way toward organic agriculture: A review. *Afr J Microbiol Res* 8:2332–2342

Bhuvaneswari G, R Sivaranjani, S Reeth, K Ramakrishnan (2013). Application of nitrogen and potassium efficiency on the growth and yield of chilli *Capsium annuum* L. *Intl J Curr Microbiol Appl Sci* 2:329–337

Bosland PW, EJ Votava (2012) *Peppers: Vegetable and Spice Capsicums*. CABI publication, New York, USA

BPS – Badan Pusat Statistik (2018). *Statistik Tanaman Sayuran dan Buah-buahan Semusim Indonesia 2017*. Badan Pusat Statistik, Jakarta, Indonesia

Budiarto R, R Poerwanto, E Santosa, D Efendi, A Agusta (2019). Agronomical and physiological characters of kaffir lime (*Citrus hystrix* DC) seedling under artificial shading and pruning. *Emir J Food Agric* 31:222–230

Budiarto R, R Poerwanto, E Santosa, D Efendi (2018). Shoot manipulations improve flushing and flowering of mandarin citrus in Indonesia. *J Appl Hortic* 20:112–118

Datta M, R Palit, C Sengupta, MK Pandit, S Banerjee (2011). Plant growth promoting rhizobacteria enhance growth and yield of chilli (*Capsicum annuum* L.) under feld conditions. *Aust J Crop Sci* 5:531–536

Deli SZA, AD Susila, Purwono, K Suketi (2019). Nitrogen sources and rate for drip irrigated polyethylene mulched chilli pepper. *J Trop Crop Sci* 6:112–120

Efendi D, R Budiarto, R Poerwanto, E Santosa, A Agusta (2021). Relationship among agroclimatic variables, soil and leaves nutrient status with the yield and main composition of kaffir lime (*Citrus hystrix* DC) leaves essential oil. *Metabolites* 11:1–14

El-Bassiony AM, ZF Fawzy, EHA El-Samad, GS Riad (2010). Growth, yield and fruit quality of sweet pepper plants (*Capsicum annuum* L.) as affected by potassium fertilization. *J Amer Sci* 6:722–729

Farhoudi R, MA Mehrnia, DJ Lee (2019). Antioxidant activities and bioactive compounds of five Jalopeno peppers (*Capsicum annuum*) cultivars. *Nat Prod Res* 33:871–874

Foley JA, N Ramankutty, KA Brauman, ES Cassidy, JS Gerber, M Johnston, ND Mueller, C O'Connell, DK Ray, PC West, C Balzar, EM Bennet, SR Carpenter, J Hill, C Monfreda, S Polasky, J Rockstrom, J Sheehan, S Siebert, D Tilman, DPM Zaks (2011). Solutions for a cultivated planet. *Nature* 478:337–342

García-Fraile P, E Menéndez, R Rivas (2015). Role of bacterial biofertilizers in agriculture and forestry. *Aims Bioeng* 2:183–205

Golcz A, P Kujawski, B Markiewicz (2012). Yielding of red pepper (*Capsicum annuum* L.) under the influence of varied potassium fertilization. *Acta Sci Pol Hort Cult* 11:3–15

González-Zamora A, E Sierra-Campos, R Pérez-Morales, C Vázquez-Vázquez, MA Gallegos-Robles, JD López-Martínez, JL García-Hernández (2015). Measurement of capsaicinoids in chiltepin hot pepper: A comparison study between spectrophotometric method and high performance liquid chromatography analysis. *J Chem* 2015:1–10

Gou JY, SZ Suo, KZ Shao, D Yao, HP Li, JL Zhang, C Rensing (2020). Biofertilizers with beneficial rhizobacteria improved plant growth and yield in chili (*Capsicum annuum* L.). *World J Microbiol Biotechnol* 36:86–97

Gunarto L (2013) *Bio Max Grow*, Unggul Niaga Pelaras, Tangerang, Indonesia

Hamdani KK, AD Susila, Purwono, K Suketi (2019). Potassium sources and rates for drip irrigated polyethylene mulched chilli pepper. *J Trop Crop Sci* 6:89–97

Hayat R, S Ali, U Amara, R Khalid, I Ahmed (2010). Soil benefcial bacteria and their role in plant growth promotion: A review. *Ann Microbiol* 60:579–598

Knapp S (2002). Tobacco to tomatoes: A Phylogenetic perspective on fruit diversity in the Solanaceae. *J Exp Bot* 53:2001–2022

Kraft KH, CH Brown, GP Nabhan, E Luedeling, JDJL Ruiz, GC d'Eeckenbrugge, RJ Hijmans, P Gepts (2014). Multiple lines of evidence for the origin of domesticated chili pepper, *Capsicum annuum*, in Mexico. *Proc Natl Acad Sci* 111:6165–6170

Mahanty T, S Bhattacharjee, M Goswami, B Bhattacharyya, B Das, A Ghosh, P Tribedi (2017). Biofertilizers: A potential approach for sustainable agriculture development. *Environ Sci Pollut Res Intl* 24:3315–3335

Mohammadi K, Y Sohrabi (2012). Bacterial biofertilizers for sustainable crop production: A review. *ARPN J Agric Biol Sci*. 7:307–316

Molla AH, MM Haque, MA Haque, GNM Ilias (2012). Trichoderma-enriched biofertilizer enhances production and nutritional quality of tomato (*Lycopersicon esculentum* Mill.) and minimizes NPK fertilizer use. *Agric Res* 1:265–272

Mosa EG, LS Paszt, M Frąc, P Trzciński (2016). Microbial products and biofertilizers in improving growth and productivity of apple—a review. *Pol J Microbiol* 65:243–251

Mozumder P, RP Berrens (2007). Inorganic fertilizer use and biodiversity risk: An empirical investigation. *Ecol Econ* 62:538–543

M, FM Anjum, MR Khan, M Saeed, A Riaz (2011). Antioxidant potential of bell pepper (*Capsicum annum* L.) A review. *Pak J Food Sci* 21:45–51

Nath BL (2013). Response of cauliflower to nitrogen fixing biofertilizer and graded levels of nitrogen. *J Agric Environ* 12:41–50

Naveed M, MA Shaker, I Mehboob, MB Hussain, M Farooq (2015). Biofertilizers in Pakistan: Initiatives and limitations. *Intl J Agric Biol* 17:411–420

Ortas I (2013). Influences of nitrogen and potassium fertilizer rates on pepper and tomato yield and nutrient uptake under field conditions. *Sci Res Essays* 8:1048–1055

Pawar SS, NV Bharude, SS Sonone, RS Deshmukh, AK Raut, AR Umarkar (2011). Chillies as food, spice and medicine: A perspective. *Intl J Pharm Biol Sci* 1:311–318

Penella C, SG Nebauer, S Lopéz-Galarza, AS Bautista, E Gorbe, A Calatayud (2015). Some rootstocks improve pepper tolerance to mild salinity through ionic regulation. *Plant Sci* 230:12–22

Pii Y, T Mimmo, N Tomasi, R Terzano, S Cesco, C Crecchio (2015). Microbial interactions in the rhizosphere: Beneficial influences of plant growth-promoting rhizobacteria on nutrient acquisition process. a review. *Biol Fert Soils* 51:403–415

Peeraullee N, VM Ranghoo-Sanmukhiya (2013). Assessment of genetic diversity in local chilli (*Capsicum annuum*) varieties in Mauritius. *Intl J Agric Biol* 15:891–896

Prasad CS, S Anandan, NKS Gowda, E Schlecht, A Buerkert (2019). Managing nutrient flows in Idnoan urban and peri-urban livestock systems. *Nutr Cycl Agroecosyst* 115:43–59

Putra BA, K Suketi, M Syukur (2017). Growth and development of potted ornamental chilli (*Capsicum annum* L.) with different types of fertilizer and growing media. *J Trop Crop Sci* 4:41–48

Ryu CM, MA Farag, CH Hu, MS Reddy, HX Wie, PW Pare, JW Kloepper (2003). Bacterial volatiles promote growth in Arabidopsis. *Proc Natl Acad Sci USA* 100:4927–4932

Sanati S, BM Razavi, H Hosseinzadeh (2018). A review of the efects of Capsicum annum L. and its constituent, capsaicin, in metabolic syndrome. *Iran J Basic Med Sci* 21:439–448

Shang C, A Chen, G Chen, H Li, S Guan, J He (2017). Microbial biofertilizer decreases nicotine content by improving soil nitrogen supply. *Appl Biochem Biotechnol* 181:1–14

Tahmasbi D, R Zarghami, AV Azghandi, M Chaichi (2011). Effects of nanosilver and nitroxin biofertilizer on yield and yield components of potato minitubers. *Intl J Agric Biol* 13:986–990

Tashi S, K Wangchuk, E Udas, S Gaki, K Aryal (2023). A solution at the doorsteps: Improved biofertilizer enhances soil fertility and yield of Chili (*Capsicum annuum* L.) in Bhutan. *Intl J Recycl Org Waste Agric* 12:259–267

Tripodi P, T Cardi, G Bianchi, CA Migliori, M Schiavi, GL Rotino, RL Scalzo (2018). Genetic and environmental factors underlying variation in yield performance and bioactive compound content of hot pepper varieties (*Capsicum annuum*) cultivated in two contrasting Italian locations. *Eur Food Res Technol* 244:1555–1567

Widyastuti RD, K Hendarto, A Rahmat, HA Warganegara, I Listiana, S Asmara (2021). The combination of biofertilizer and organic fertilizer to improve shallot (*Allium ascalinocum* L.) production. *J Trop Crop Sci* 7:16–21

Widyastuti RD, S Susanto, M Melati, A Kurniawati (2019). Effect of pruning time on flower regulation of guava (*Psidium guajava*). *J Phys Confer Ser* 1155:1–7

Wu SC, ZH Cao, ZG Li, KC Cheung, MH Wong (2005). Effects of biofertilizer containing N-fixer, P and K solubilizers and AM fungi on maize growth: A greenhouse trial. *Geoderma* 125:155–166

Yang Y, M Fang, M Wu, J Hou, J Zhu (2021). Responses of Ammonia-oxidizing archaea to three biofertilizers in organic soybean fields. *Intl J Agric Biol* 25:33–42

Zhang H, MS Kim, V Krishnamachari, P Payton, Y Sun, G Mark, AF Mohamed, CM Ryu, A Randy, SM Itamar, PW Paré (2007). Rhizobacterial volatile emissions regulate auxin homeostasis and cell expansion in *Arabidopsis*. *Planta* 226:839–851

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