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# EVALUATION OF SEVERAL FORMULATED BIOFERTILIZERS TO CONTROL FRUIT ROT AND IMPROVE YIELD ON CHILI PEPPER

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## ABSTRACT

The objective of this study was to evaluate several commercially formulated biofertilizers in reducing chemical fertilizers and pesticides to control of fruit rot and promote growth and yield on chilli pepper. The experiment was carried out at the experimental field of Indonesian Ornamental Crops Research Institute (IOCRI) located at 1100 masl from April to December of 2015. Eight formulated biofertilizers applied based on recommended instructions and simultaneously compared with common farmer practices. The results showed that biofertilizers gave varied effects on disease suppression, vegetative growths and reproductive characteristics. Super Biost, Biotrico and Bio-Pf gave comparable affectivity with chemical pesticides employed by common farmer in disease suppression. Bio-Pf induced better vegetative growth with wider plant architecture In terms of reproductive characteristics, Bio-Pf, Bio-SRF and Biotrico and Super Biost promoted competitive number of fruits and fruit weight per plant from common farmer practice. Based on advantage analysis, the application of Bio-Pf and Biotrico had more potential feasibilities than other biofertilizers. Both biofertiizers not only gave comparable fruit rot suppression, growth and yield improvement, but reduced chemical fertilizers and pesticides up to 50% employed by common farmer practices as well.

**Keywords:** Capsicum annum L, biofertilizers, vegetative and reproductive plant performances, Colletotrichum disease control

## 1. INTRODUCTION

Red chili (*Capsicum annuum* L) is one vegetable that widely used in many cuisines to add spiciness to dishes. Formerly originated form Mexico, the plants have been spread and cultivated around the world and become one economically important crops in most countries including Indonesia (Djarwaningsih, 2005). On the consumption side, the demand of the product reached 60 to 70 tons per months and contributed average inflation value of 0.35% in last five years (Farid & Subekti, 2012). Having these high economic values, grower tended to put costly agro inputs with intensive care expecting maximum plant growth and yield to meet market demand (Soetiarso, Setiawati, & Musaddad, 2011). The average national production, however, was still considered low (5.61 tons/ha) compared to potential productivity of 12 to 20 tons/ha (Gunaeni & Wulandari, 2010; Soetiarso & Setiawati, 2010). These conditions were due to several factors, i.e. agricultural land degradation, improper application of chemical agroinputs and pest and diseases attacks.

Fruit anthracnose (red rot) casued by pathogenic fungi *Colletotrichum* sp is one of the major economic constraints to chilli production worldwide, especially in tropical and subtropical regions. The fungus has a wide range of hosts including cereals, legumes, vegetables, perennial crops and tree fruits (Saini, Gupta, Char, Zehr, & Anandalakshmi, 2016; Diao et al., 2017; Montri, Taylor, & Mongkolporn, 2009). In severe infection, the fungus might cause significant economic yield and has become one of the main barriers to pepper production in many production area including Indonesia (Syukur, Sujiprihati, Koswara, & Widodo, 2013). Typical anthracnose symptoms on chilli fruit included sunken necrotic tissues, with concentric rings of acervuli. Fruits showing blemishes have reduced marketability (Saxena, Raghuwanshi, Gupta, & Singh, 2016).

Growers tended to use chemical pesticides to control the disease expecting the optimal growth and the reduction of the disease attacks. Synthetic fungicide with active ingredient of traizole group viz., tebuconazole, difeconazole, hexaconazole, trycyclazole and propioconazole, mancozeb, propineb, sopper oxychloride and carbedazim etc were commonly used (Kumbhar & More, 2013) and often applied regardless the presence of the symptoms and intensity of the diseases to ensure the marketable fronds. Such practices were considered not only costly and dangerous to the environment and human health, but could make the business uncompetitive and less profitable (Handiso & Alemu, 2017).

The use of *Plant Growth Promoting Rizhobacteria* (PGPR) to replace chemical fertilizers, pesticides and supplements in plant production has been reported to have better impact on growth, yield and disease control in some plants. PGPR affect plant growth in two different ways, indirectly or directly. The direct promotion of plant growth by PGPR entails either providing the plant with a compound that is synthesized by the bacterium, for example phytohormones, or facilitating the uptake of certain nutrients from the environment (Datta, Palit, Sengupta, Pandit, & Banerjee, 2011). The indirect promotion of plant growth occurs when PGPR lessen or prevent the deleterious effects of one or more phytopathogenic organisms. This can happen by producing antagonistic substances or by inducing resistance to pathogens (Beneduzi, Ambrosini, & Passaglia, 2012). A particular PGPR may affect plant growth and development by using any one, or more, of these mechanisms. PGPR, as biocontrol agents, can act through various mechanisms, regardless of their role in direct growth promotion, such as by known production of auxin, gibberellic acid and cytokinins (Ahmed & Hasnain, 2014; Gupta, Parihar, Ahirwar, Sheni, & Singh, 2015; Gupta et al., 2015), decrease of plant ethylene levels (Wang et al., 2015) or nitrogen fixing associated with roots (Reed, Cleveland, & Townsend, 2011). It is well established that only 1 to 2% of bacteria promote plant growth in the rhizosphere. Bacteria of diverse genera have been identified as PGPR, of which *Bacillus* sp. and *Pseudomonas* spp. are predominant (Raaijmakers, de Bruijn, Nybroe, & Ongena, 2010).

Certain strains of *Bacillus sp*. and *Pseudomonas flourescens* have been proven to be effective in suppressing leaf soft rot caused by *Psedumonas viridiflava* in Phalaenopsis (Nuryani, Yusuf, Hanudin, Djatnika, & Marwoto, 2012), white rust (*Puccinia horiana*) in chrysanthemum (Hanudin, Budiarto, & Marwoto, 2017), cucumber mosaic virus (CMV) in pepper (Taufik, Rahman, Wahab, & Hidayat, 2010). Another genera, free living diazothrops *Azotobacter* sp. and *Azospirillum* sp. have been known to have capacity in non symbiotic fixation of nitrogen. While *Aspergillus* sp., *Bacillus megatherium* and *Penicillium* sp. are able to solubilize phosporus (P) and pottasium (K) (Karakurt & Aslantas, 2010). These useful bacteria have been combined in a formulation to widen their beneficiaries as biopesticides and biofertilizers. Considering the potential use of these PGPR to control many important crop diseases, the experiment was conducted to evaluate the formulated biofertilizers/biopesticides containing PGPR againts anthracnose in chili pepper and the apllication was expected not only to reduce fruit rot incidence, but promote plant growth and increase the yield as well.

## 2. MATERIALS AND METHODS

The research was conducted at the experimental field of Indonesian Ornamental Crops Research Institute (IOCRI) from April to December 2015. The experimental site was located at 1100 m asl and the soil type was classified as Andosol. Before the experiment was conducted, the planting site was previously for carrot production. The research was arranged in a complete randomozed block experiment with three replications, including the common farmer cultural practices in pest and disease control and fertilizers applications. The chilli variety used was cv. Golden Red from Agrosindo Manunggal Sentosa Co. Ltd. The detail description of the treatments was presented in Table 1.

**Table 1. Description of fertilizers and formulated biofertilizers/biopesticides treatments used in the study.**

| Treatment code(s) | Treatment description(s) |
|---|---|
| No fertilizer | The plants were maintained whitout any fertilizers from planting until harvesting period. These treatment served as a negative control. |
| Common farmer practices | The plants were maintained based on common farmer practices. The practices included the application of manures 15 tons/ha before planting and 54 kg/ha $P_2O_5$ at 7 days after planting (DAP). Nitrogen and Kalium fertilizer were applied at 4, 7 and 9 weeks after planting with the dosages of 51 kg/ha N and 30 kg/ha $K_20$. For pest and disease control, synthetic fungicides were employed using twice a week of spinosad 0.5ml/l and alternately twice a week of mancozeb 2 g/l and macozeb+asilbesolar s- |

| | |
|---|---|
| | methyl 2 g/l. These treatment served as a positive control. |
| Half dosage of common farmer practices | The plants were maintained based on half dosage of fertilizers and synthetic pesticides applied by common farmer practices. The practices included the application of manures 7.5 tons/ha before planting and 27 kg/ha $P_2O_5$ at 7 days after planting (DAP). Nitrogen and Kalium fertilizer were applied at 4, 7 and 9 weeks after planting with the dosages of 25.5 kg/ha N and 15 kg/ha $K_20$. For pest and disease control, synthetic fungicides were employed using twice a week of spinosad 0.25 ml/l and alternately twice a week of ioferti 1 g/l and macozeb+asilbesolar s-methyl 1 g/l. |
| Agrofit | Agrofit is a formulated iofertilizers produced by Indonesian Research Institute for Soils. The biofertilizer has been registered with active ingredients of endophytic bacterial consortia of *Azotobacter* sp. JBN05, *Azospirilium* sp. KR6, *Bacillus* sp. KT6D, *Candida* sp.YBN3 and yeast. The seeds (planting materials) were soaked in a 45-50$^0$C warm water for 15 to 20 minutes then mixed with Agrofit before seed germinating process. 10 kg/ha Agrofit was also mixed wtith the top soil before the young plants were planted on beds. The application of manure before planting and the plant maintences after planting were carried out based on half dosage of farmer common practices. |
| Beyonic | Beyonic is a formulated iofertilizers produced by Indonesian Institute of Science. The biofertilizer has been registered with active ingredients of *Bacillus* sp., *Pseudomonas* sp., *Painibacillus* sp., *Burkholderia*. The seeds (planting materials) of were soaked in warm water then mixed with beyonic before germinating process. These biofertilizer was also apllied at planting time in the dosage of 1.5 g/plant. Further plant maintenances were conducted based on half dosage of farmer common practices. |
| Bio-Pajar | The biofetilizer is formulated and produced by The University of Padjadjaran containing *Azotobacter* sp, *Azospirilium* sp, *Pseudomonas* sp, *Bacillus* sp, *Acinetobacter* sp, and *Trichoderma* sp. The application of Bio-Pajar was conducted in 3 stages. First, on the germination process, by mixing the biofertilizer with germination media with the dosage of 100 g per 20 kg media. Secondly, the biofertilizer was also given at planting time with the dosage of 10 g/plant and finally, the bioferilizer was also sprayed at 30, 60, 90 and 120 DAP. Other plant maintenances were conducted based on half dosage of farmer common practices. |
| Super-Biost | Super Biost is a formulated iofertilizers produced by Bogor Agricultural University with active ingredient of *Azotobacter* sp., P-solubilizing bacteria, and *Trichoderma* sp. The first application of the biofertilizer was at |

| | |
|---|---|
| | planting bed preparation with the dosage of 200 kg/ha. The biofertilizer was also applied at 4, 7 and 9 weeks after planting with the dosages of 75 kg/ha. Further plant maintenances were conducted based on half dosage of farmer common practices. |
| Bion-Up | The biofetilizer is formulated and produced by The University of Padjadjaran with active ingredient of *Azotobacter* sp., *Azospirilium* sp., *Pseudomonas* sp., *Penicilium* sp, and *Acinetobacter* sp. The application of the biofertilizer was at planting bed preparation with the dosage of 75 kg/ha. Other plant maintenances were carried out based on half dosage of farmer common practices. |
| Biotrico | The biofetilizer is formulated and produced by Indonesian Vegetable Research Institute (IVEGRI) with active ingredient of *Trichoderma* sp. The application of the biofertilizer was at planting bed preparation with the dosage of 50 kg/ha. Other plant maintenance was carried out based on half dosage of farmer common practices. |
| Bio SRF | The biofertilizer is formulated by Indonesian Agency for the Assesment and Application of Technology with the active ingredient of *Nitrobacter* sp. For about 10 kg of biofeftilizer was used for seed-coating treatment before planting. Furtehr applications were at 4, 7 and 9 weeks after planting with the dosages of 30 kg/ha. Other plant maintenances were conducted based on half dosage of farmer common practices. |
| Bio-PF | The biofertilizer is formulated by Indonesian Ornamental Crops Research Institute (IOCRI) with the active ingredient of *Pseudomonas fluorescens*, *Azotobacter* sp., *Azosprillium* sp. The seeds of were soaked in 1% biofertilizer solution for 20 minutes before germination process. Spraying applications were also carried out the soil surface near the stems at 15 and 30 DAP. Other plant maintenances were conducted based on half dosage of farmer common practices. |

## Land and planting bed preparations

The soils were tilled and the weeds were disposed outside from the experimental sites. One month before planting, Propamokarb hidroklorida 2 g/l were applied for preventive disease development. Planting beds with 1 m wide 30 cm in height with the length along the planting sites were constructed. The distance between beds was 50 cm and between treatment combinations was 1 m. Manures, Nitrogen, Phosporus and Kalium fertilizers were applied and mixed with the bed top soil according to the treatment arrangements.

### Planting material preparation

The seeds were warm-water soaked and treated with biofertilizers according to the treatments in Table 1. The seed were then air dried for couple minutes and planted in 10 cm in diameter polybags containing 1 : 1 (v:v) mixtures of manure and top soil. The biofertilizer treatments during these germination processes were apllied also based on the treatments in Table 1. The germinated young plants were then maintained by sufficient water supply until 21 days. After 21 days, the young plants were then planted in experimental beds.

### Planting and plant maintenance

Before the young plants were planted, selected biofetilizers were also applied based on the treatment arrangement on Table 1. The young plants were then planted in the distance of 50 x 70 cm along the bed length and the number of plants/treatment/replication was arranged 80 plants. Water irrigations were poured to facilitate humidity with the volume of 500 ml/plants. The water supply was given every 2-3 days with the same volume until harvesting period. For insect pest prevention, the plants were sprayed with Spinosad 0.5 ml/l every week. Yellow traps were also employed during the conduct of the experiment.

The observations included disease intensity, percentage of suppression, agronomic and yield improvements from the application of biofertilizer treatments. Samples were taken randomly from 10% total population. The data gathered were analysed using ANOVA and DMRT with 95% level of condifident. Analysis of improvement was carried out to measure degree of advantages of certain treatment based on advantage frequency compared to control. The advantage criteria were given the value of 1 if the respected treatment had an advantage and 0 if the treatment had opposite condition. The percentages of improvement (PI) was calculated using the following formula :

$$PI = \frac{T - C}{C} \times 100\%$$

Where :

PI = Percentage of improvement

C = Parameter value of control

T = Parameter value of respected treatment

## 3. RESULTS AND DISCUSSION

**Effect of formulated biofertilizers on fruit rot incidence**

Frut rot incidences were found varied among the applied formulated biofertilizers (Table 2). The plants with no fertilizer and pesticide application (negative control) was found the most severe in terms of disease intensity followed by the plants treated by various biofertilizers with negligible differences. The least disease intensity was observed in common farmer practices (positive control) which totally employed synthetic fertilizers and pesticides. The relations of pesticide and nutrition applications with disease development were also detected on half common farmer practices. The plants within these treatment had lower disease attacks than negative control, yet still higher than positive control. The high disease intensity on the plants with no fertilizer and pesticide application reflected that the disease development was less restricted. With no pesticide application, the plants had less exogenous preventive mechanism from the the disease infection (Kim & Yun, 2013). While no fertilizer also inferred that the plants depended to nutrient availability on the exisiting soil to grow. Though no visual symptom of nutrient deficiency was detected during the growing period, the supply of certain minerals were not optimal to induce higher plant resistance. Several minerals like K, Cu, P, Ca, etc. were reported to involve in the formation cell/tissue structures and many biochemical processes within the plants which were related to the plant defend system to pathogens (Bhaduri, Rakshit, & Chakraborty, 2014) . These conditions might increase plant susceptibility to disease attacks (Dordas & Dordas, 2008; Veresoglou, Barto, Menexes, & Rillig, 2013; Muryati, Octriana, Emilda, Santoso, & Sunarwati, 2009).

**Table 2. Fruit rot incidences on various biofertilizer treatments in chilli pepper**.

| Treatment(s) | Fruit rot incidence | |
|---|---|---|
| | Intensity*) (%) | Degree of supression from the control (%) |
| No pesticide and fertilizer (negative control) | 19.08 a | 0 |
| Common farmer practices (positive control) | 6.45 c | 66.19 |
| 50% common farmer practices | 11.88 b | 37.74 |
| Agrifit | 10.63 b | 44.29 |
| Beyonic | 11.72 b | 38.57 |
| Bio-Pajar | 11.30 b | 40.78 |

| | | |
|---|---|---|
| Super-Biost | 8.03 bc | 57.91 |
| Bion-Up | 13.89 ab | 27.20 |
| Biotrico | 9.06 bc | 52.52 |
| Bio-SRF | 11.45 b | 39.99 |
| Bio-Pf | 9.00 bc | 52.83 |

Remarks : *) values followed by different letters in the same column differ significantly based on DMRT (α = 5%).

Disease intensities were also varied among biofertilizers applications (Table 2). The plants treated with Bion-Up had higher disease attacks among the biofertilizers treatments and showed insignificant differences with those of negative control treatment. While on the other hands, several biofertilizer treatments, i.e. Super-Biost, Bio-Pf and Biotrico were observed to have better suppression on the disease development viewed from less disease intensities that had negligible differences with positive control. *Trichoderma* and *Pseudomonas fluorescens* were the common containment of these biofetilizers. The PGPR-active ingredients of the biofertilizer might establish and more effectively act to interfere the pathogenic fungus devepment thus reduced the disease attacks. Several authors had also reported the successful control of *Colletotricum* in chilli pepper through the application of *Trichoderma* (Handiso & Alemu, 2017; Bhadra, Khair, Hossain, & Sikder, 2015; Mishra et al., 2017) and *Pseudomonas fluorescens* (Linu & Jisa, 2013; Sutariati, Widodo, Sudarsono, & Ilyas, 2006). The protective mechanism of these beneficial PGPR was through various ways either directly and/or indirectly which included production of antibiotics, siderophores, lytic enzymes production that exhibited hyperparasite activity to the pathogenic fungus, exo-polysaccharide production to dominized root colony and induced systemic resistances (Gupta et al., 2015).

**Agronomic characteristics**

Chilli plants treated by various biofertilizer treatments showed different growth performances as presented on Table 3. Pesticides and fertilizers applied following common farmer practices and bioferilizers treatments insignificantly affected stem diameter and plant height, though negative control (no fertilizer and pesticide treatment) plants had the least values among the applied treatments. In canopy growth, several treaments i.e. common farmer practice (positive control), Beyonic, Bion-Up, Biotrico and Bio-PF gave wider sizes compared to negative control, ½ common farmer practice, Agrifit, Bio-Pajar, Super-Biost and Bio-SRF treatments. Bio-PF gave the highest canopy size increament among the treaments being applied. Super Biost gave less canopy growth, yet reduced disease intensity and in the contrary, Beyonic and Bion-Up induced wider canopy, but less disease suppression (Table 2 and 3). According to Ahemad & Kibret (2014) PGPR could be classified based on their functional activities (1) biofertilizer (increasing the availability of nutrient to plants), (2) phytostimultors (plant growth promotion, enerally through phytohormones), (3) rhizomediators (degrading organic pollutants) and (4) biopesticides (controlling diseases, mainly by the production of antibiotics and antifungal metabolites). A single PGPR might have singe function or show multiple mode actions and the active ingredient of these Super Biost, Beyonic and Bion-Up biofertilizers were presumably had a single mode of action i.e promoting plant growth or reducing disease devopment.

**Table 2.Agronomic characteristics of chilli plants treated by various bio- and fertilizer treatments after 105 days planting.**

| Treatment(s) | Agronomic characteristics at 105 DAP | | | |
|---|---|---|---|---|
| | Stem diameter*) (cm) | Plant height*) (cm) | Canopy width*) (cm) | Increment of canopy width*) (%) |
| No pesticide and fertilizer (negative control) | 1.21 a | 73.26 a | 52.88 b | 0 |
| Common farmer practices (positive control) | 1.38 a | 85.88 a | 62.93 a | 19.01 |
| 50% common farmer practices | 1.33 a | 82.76 a | 58.76 b | 11.12 |
| Agrifit | 1.38 a | 84.38 a | 59.45 b | 12.42 |
| Beyonic | 1.32 a | 81.57 a | 62.41 a | 18.02 |
| Bio-Pajar | 1.26 a | 80.94 a | 59.16 b | 11.88 |
| Super-Biost | 1.32 a | 84.32 a | 58.72 b | 11.04 |
| Bion-Up | 1.36 a | 82.47 a | 62.13 a | 17.49 |
| Biotrico | 1.35 a | 84.97 a | 60.59 a | 14.58 |
| Bio-SRF | 1.31 a | 83.04 a | 58.51 b | 10.65 |
| Bio-Pf | 1.39 a | 86.66 a | 67.13 a | 26.95 |
| CV (%) | 11.17 | 12.71 | 17.27 | |

Remarks : *) values followed by different letters in the same column differ significantly based on DMRT (α = 5%).

Several treatments, i.e. positive control, Biotrico and Bio-PF showed not only reduced the disease attacks (Table 2), but induced wider canopy growth with the range of 17.49 to 26.95% (Table 3). These indicated the PGPR contains in these biofertilizers had multiple mode of actions (Vejan, Abdullah, Khadiran, Ismail, & Boyce, 2016). *Trichoderma* as the active

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ingredient of Biotrico and *P. fluorescens, Azotobacter* sp., *Azosprillium* sp. as the active ingredient of Bio-Pf have ben reportedly to have beneficial effects on plant gowth through increment of nitrogen fixation (El-Katatny, 2010), direct plant protections through colonization of intercellular root spaces, hyperparasitism, toxic exudate release to pathogen, defence signalling pathway through the induction of SA/JA productions (Hermosa, Viterbo, Chet, & Monte, 2012; Hermosa et al., 2013), phytohormones production, siderophore, increase phosphate solubilization, production ACC deaminase and inducing plant resistance and antifungal activity (Diyansah, Aini, & Hadiastono, 2013; Fouzia, Allaoua, Hafsa, & Mostefa, 2015; Ganeshan & Kumar, 2005).

**Flowering stage, fruit characteristics and vase life**

The effects of various bio- and fertilizers on flowering stages, fruit characteristics and vase of life under room temperature were presented in Table 4. Flowering stage, fruit diameter and length and vase life were not affected by bio- and fertilizer treatments viewed form the insignificant differences of the values among the treatments, though flowering stage postponement and reduced fruit size were observed on negative control plants. In terms of number of fruits per plant and fruit weight per plant, common farmer practice, Biotrico, Bio-Pf, Super Biost and Bio SRF gave significant improvement compared to other treatments. Among them, common farmer practice, Biotrico, Bio-Pf were considered to be the most consistent and in line with lower disease attacks (Table 2) and canopy growth improvement (Table 3). The canopy size reflected the bushiness of braches, in that a potent single flower might emerge on leaf axil (nodes) (Karapanos, Mahmood, & Thanopoulos, 2008). These condition inferred the canopy size might indicate the number of flowers in that might be related with number of fruits.

The positive control gave 14.41% increment when the yield was converted into unit area (Table 4). Among the biofetilizer treatments, only Bio-Pf and Agrifit that gave greater values than positive control. These indicated that these biofertilizers were considered to have more stable performances to improve the plant growth and yield in wider planting sites. The stable and consistent performances was related to the persistency of the PGPR action under field conditions (Nadeem et al., 2016; Adesemoye, Torbert, & Kloepper, 2009).

**Table 4. Reproductive characteristics of chilli plants treated by various bio- and fertilizer treatments.**

| Treatment(s) | Reproductive characteristics | | | | | | | Yield increment**) (%) |
|---|---|---|---|---|---|---|---|---|
| | Flowering stage*) (DAP) | Fruit diameter*) (cm) | Fruit length*) (cm) | Number of fruits/plant*) | Fruit weight/plant*) (g) | Converted yield in tons/ha*) | Vaselife*) (Days) | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| No pesticide and fertilizer (negative control) | 30 a | 0.64 a | 10.19 a | 33.40 c | 167.34 b | b | 4.51 | 11.30 a | 0 |
| Common farmer practices (positive control) | 28 a | 0.71 a | 10.76 a | 109.35 a | 293.14 a | a | 5.16 | 11.30 a | 14.41 |
| 50% common farmer practices | 28 a | 0.74 a | 11.18 a | 66.95 b | 176.59 b | b | 4.60 | 11.30 a | 2.00 |
| Agrifit | 29 a | 0.76 a | 10.81 a | 81.65 b | 224.59 a | a | 5.51 | 11.30 a | 22.17 |
| Beyonic | 29 a | 0.75 a | 10.97 a | 66.95 b | 192.03 b | b | 3.85 | 11.30 a | - |
| Bio-Pajar | 28 a | 0.71 a | 10.44 a | 77.85 b | 199.11 b | b | 4.56 | 11.30 a | 1.11 |
| Super-Biost | 28 a | 0.74 a | 10.77 a | 92.90 a | 239.84 a | ab | 5.14 | 11.30 a | 13.97 |
| Bion-Up | 29 a | 0.74 a | 10.27 a | 65.25 b | 182.00 b | b | 4.21 | 11.30 a | - |
| Biotrico | 29 a | 0.63 a | 10.67 a | 98.35 a | 257.35 a | b | 4.50 | 11.30 a | - |
| Bio-SRF | 29 a | 0.72 a | 10.98 a | 94.50 a | 241.98 a | a | 4.57 | 11.30 a | 1.33 |
| Bio-Pf | 28 a | 0.75 a | 11.08 a | 108.15 a | 299.90 a | a | 5.89 | 11.30 a | 30.60 |

Remarks : *) Values followed by different letters in the same column differ significantly based on DMRT (α = 5%)**) (-) = the vakue was lesser than negative control

## 4. ADVANTAGE ANALYSIS

Based on Table 2, 3 and 4, the advantage analyses of treatments were carried out using certain criteria. Canopy increment was given positive value when the increment reached more than 14%. The positive remarks were also given in number of fruits, fruit weigth per plant when the calculated value reveled more than 50%, and decrement of fruit rot less than 50%. Another positive score was appraised on the increment of the converted yield more than 14%. The results of advantage analysis of all treatment were presented on Table 5.

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**Table 5. Advantage frequencies of bio- and fertilizer treatments used in the study.**

| Treatment(s) | Advantage frequency | | | | | |
|---|---|---|---|---|---|---|
| | Increment of canopy (≥ 14%) | Increment of fruit number (≥ 50%) | Increment of fruit weight (≥ 50%) | Increment of yield in ha (≥ 14%) | Decrement of fruit rot (≥ 50%) | Total advantage frequency |
| No pesticide and fertilizer (negative control) | 0 | 0 | 0 | 0 | 0 | 0 |
| Common farmer practices (positive control) | 1 | 1 | 1 | 1 | 1 | 5 |
| 50% common farmer practices | 0 | 0 | 0 | 0 | 0 | 0 |
| Agrifit | 0 | 0 | 0 | 1 | 0 | 1 |
| Beyonic | 1 | 0 | 1 | 0 | 0 | 2 |
| Bio-Pajar | 0 | 0 | 0 | 0 | 0 | 0 |
| Super-Biost | 0 | 0 | 0 | 0 | 1 | 1 |
| Bion-Up | 1 | 0 | 0 | 0 | 0 | 0 |
| Biotrico | 1 | 1 | 1 | 0 | 1 | 4 |
| Bio-SRF | 0 | 0 | 0 | 0 | 0 | 0 |
| Bio-Pf | 1 | 1 | 1 | 1 | 1 | 5 |

Among the treatments being applied, common farmer practices and biofertlizer Bio-Pf have maximum frequencies that indicated both treatment s gave comparable results on disease suppression and improvement on ppant growth and yield. Another biofertilizer, Botrico had the frequency of 4 in that these biofertilizer would also give comparable results yet less stable in field conditions than Bio Pf. Based on the treatment descriptions thus, the application two biofertilizers might reduce the use of chemical fertilizers and pesticide up to 50%, gave comparable reduction of fruit rot incidence and better plant growth and yield improvement from those common farmer practices.

## 5. CONCLUSIONS

The treated biofertilizers showed different effectivities in reducing fruit rot intensity and inducing plant growth and yield of chili. Super Biost, Biotrico and Bio-Pf supressed the disease with the same effectivity as chemical pesticides. In terms of canopy size, only Bio-Pf that induced the plants to have wider architecture than common farmer practices. In respect to the reproductive characteristics, Bio-Pf, Bio-SRF and Biotrico and Super Biost promoted the plants to have comparable number of fruits and fruit weight per plant with those common farmer practice treatment. Based on advantage analysis, the application of Bio-Pf and Biotrico had more potential feasibilities in reducing chemical fertilizer and pesticide usage up to 50% from those common farmer practice with comparable fruit rot suppression, and growth and yield improvement.

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