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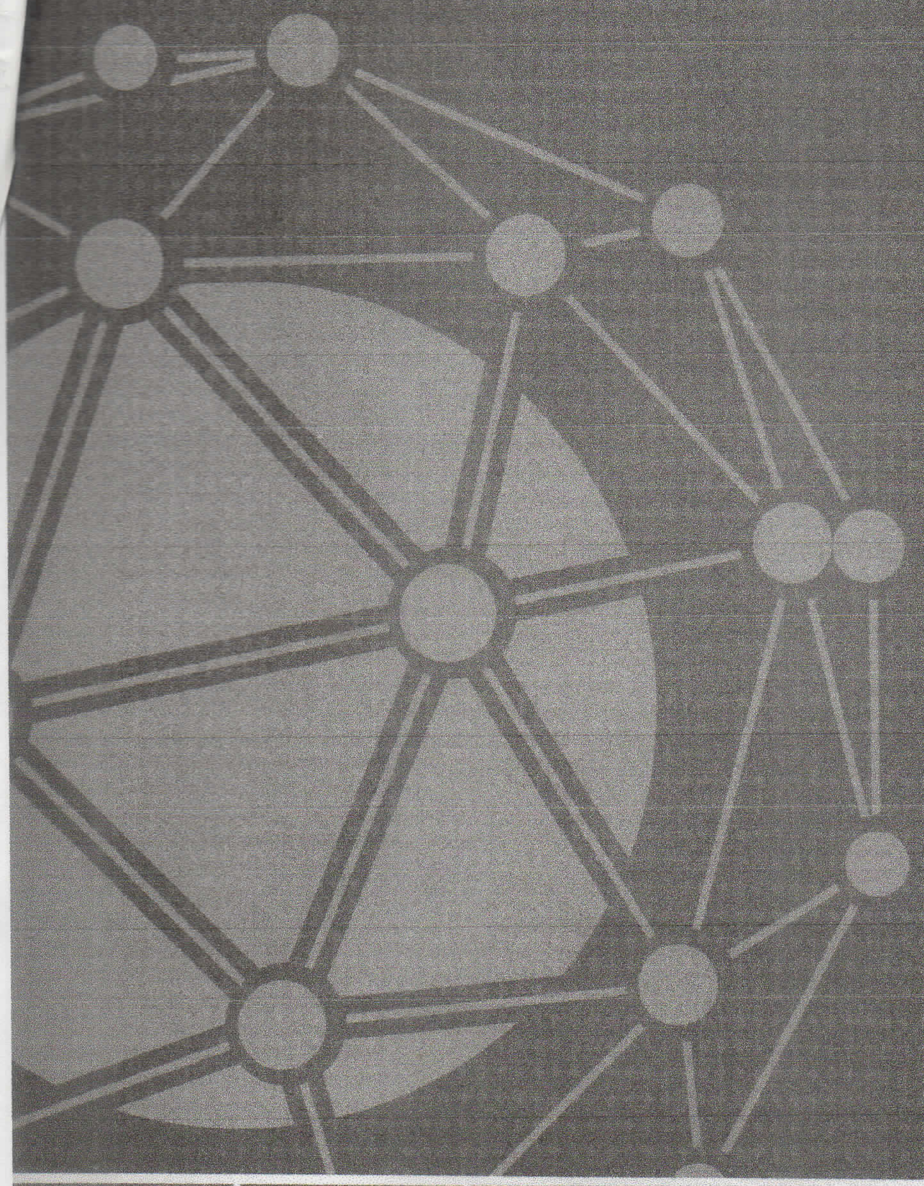

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SHALLOTS GROWTH STIMULATION BY PLANT-GROWTH PROMOTING FUNGI (PGPF) AND ORGANIC FERTILIZER

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Abstract

Plant Growth Promoting Fungi (PGPF) constitutes non-pathogenic fungi in the rhizosphere that have beneficial effect for various plants through their role to promote growth and also control diseases in plants. The purpose of this study is to determine the effect of plant-growth promoting fungi and organic fertilizer on the growth and yield of shallots. A Randomize Completely Block Design is used as the experimental design to evaluate two plant-growth promoting fungi (Trichoderma sp. and Penicillium sp.) which is combined with three organic fertilizers (compost, chicken manure and baglog waste). to determine their promoting effect on the growth and yield improvement of shallots. The plants without treatments were served as control. The combination of Penicillium sp. and compost is resulted the best effect on plant growth and yield showed by plant height, bulb number, bulb weight, and dry weight of bulb. The treatment of PGPF and organic fertilizer gives better results than control showed by number of leaves, bulb diameter, plant height, bulb number, bulb weight, and dry weight of bulb.

Keywords: shallots, pgpf, organic fertilizer.

INTRODUCTION

One of the important cultivation plant is shallots (Allium cepa L.), an important horticulture commodity that have high economic value, both in terms of the fulfillment of national consumption, the source of income of farmers, as well as its potency as a producer of foreign exchange (Rajiman , 2009; Iriani, 2013). Shallots production depends on the season, decreases in the rainy season and is abundant in the dry season. In line with the increase in population which in 2025 is estimated to reach 299 million people, the supply of shallots that must be realized to meet domestic needs is projected to increase to 1,541,737 tons (Ditjen BP Hortikultura,. 2004). Total supply of about 1.3 times of national production in year 2014 is a challenge, as well as a development opportunity. Increased production of shallots is directed to meet domestic demand and enhance competitiveness can be achieved through the expansion of new areas and productivity improvement (Iriani, 2013).

The growth and development of

a plant other than determined by its genetic properties, is also influenced by environmental factors. Environmental factors that have much influence on the growth and development of plants are climate (light, temperature, water, day length, wind and gas); soil (texture, structure, organic matter, cation exchange capacity, pH, basic saturation, and nutrient availability) and biological (weeds, insects, pathogens, nematodes, herbivores and soil microorganisms) (Gardner et al., 2008). Soil conditions as a growing medium requires good physical, chemical and biological conditions. The ideal soil for growth and production of shallots is loose soil, fertile and contains lots of organic material or humus, as it will encourage the development of bulbs so that the shallots yield becomes higher and soil with good drainage and aeration conditions is preferred (Wibowo, 1988) .

Organic matter, in addition to the effect on soil nutrient supply, is also no less important effect on the physical, biological and chemical properties of the soil. Although the role of organic matter for nutrient supply for plants is lacking, the greatest and important role of organic matter is its relation to soil physical fertility (Stevenson, 1982). The effects of organic matter on soil chemical fertility are, among others, the capacity of cation exchange, anion exchange capacity, soil pH, soil buffer ability and to soil nutrient (Atmojo, 2003). Organic matter is a source of energy for soil macro and micro-fauna. The addition of organic matter in the soil will cause the activity and the microbiological population in the soil to increase, especially related to the activity of decomposition and mineralization of organic matter. Some microorganisms that have a role in the decomposition of organic matter are fungi, bacteria and actinomycetes. Another positive effect of adding organic matter is its effect on plant growth. There are compounds that have an influence on the biological activity found in the soil, is the stimulating compound (auxin), and vitamins (Stevenson, 1982). These compounds in the soil are derived from plant exudates, manure, compost, plant residues and also derived from microbial activity in the soil.

The sources of organic materials that we can use may come from waste and animal waste (manure), crop residues, green manure, municipal waste, industrial waste, and compost. Since the earliest civilizations, manure is considered a major source of nutrients. Compost can be produced by decomposition of organic materials derived from crop residues, animal or human waste by microorganisms. *Baglog* or mushroom growing medium is a substrate where the mushroom grows. *Baglog* is made from mixing sawdust with bran, lime and plaster (Susilowati and Raharjo, 2004). The *baglog* of unused mushrooms will again be discarded resulting in waste. Waste media planting mushroom is a material derived from the media planting mushrooms after harvest. The composition of the waste has nutrient

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content such as P, K, N total and C-organic, so it is useful to improve soil fertility (Sulaiman, 2011).

It has long been known that microorganisms are able to associate closely with plant roots, and can directly affect the growth and development of plants. This influence can be both positive and negative (Widyastuti, 2007). Plant Growth Promoting Fungi (PGPF) is a non-pathogenic fungus in soil that is reportedly beneficial to some plants through its role in promoting growth and also protecting plants from pathogenic attacks (Shivana et al., 1994). From various studies that have been done, obtained some fungi that can be classified as PGPF, among others *Phoma* sp. (Hamayun *et al.*, 2010a), *Rhizopus* sp. (Lakshmi *et al.*, 2011), *Trichoderma* spp. (Worosuryani *et al.*, 2006; Shivanna *et al.*, 1994; Shivanna *et al.*, 1995), *Penicillium* spp. (Worosuryani *et al.*, 2006; Shivanna *et al.*, 1994; Shivanna *et al.*, 1995), *Aspergillus* spp. (Worosuryani *et al.*, 2006), and *Cladosporium* sp. (Hamayun *et al.*, 2010b). Various types of fungi are among others obtained from coastal sand (Worosuryani *et al.*, 2006); Zoysiagrassrhizosphere (Shivanna *et al.*, 1995; Meera *et al.*, 1995); wheat rhizosphere (Shivanna *et al.*, 1994); cucumber rhizosphere (*Cucumissativus* (L.) Duch.ex.poir) (Lakshmi *et al.*, 2011; Hamayun *et al.*, 2010a; Hamayun *et al.*, 2010b).

PGPF has been examined on almost all plant species, dicotyl and monocotyl. Almost all the parameters of plant growth in both the vegetative and reproductive growth stages can provide a positive response to the fungi included in the plant growth promotion. The growth promotion activity in the PGPF isolate probably depends on its saprophytic competitive ability and its ability to resist antagonism by local antagonists on the soil. (Shivanna *et al.*, 1995). Hipovirulen in soil fungi indicates that the soil fungus has a low virulence power so that it can not infect plants. The hypovirulent fungus is a soil fungus that has the low ability to infect plants so it does not cause symptoms of the disease, but can develop along with plant growth. Hypovirulent soil fungi can be used as an antagonistic fungus that can inhibit or suppress the development of pathogenic fungi, so plants are not disturbed to growth (Worosuryani, 2006).

There are two mechanisms of growth promotion by PGPF that is direct and indirect mechanism. The indirect mechanism of growth promotion can be through antibiosis, competition, parasitism or lysis, inhibition of enzyme/toxin production by pathogen and induction of endurance. The direct growth-promotion mechanism is through the ability of the fungus in phytohormon production, as a phosphate solvent, enhancing nutrient absorption, and organic solvent.

To support the growth of shallots cultivated plants, application of technology is necessary. In addition to the addition of organic materials to improve the productivity of land, one of them is by utilizing fungi that can play a role in promoting plant growth (PGPF).

The addition of organic matter will increase the activity of PGPF because according to Atmojo (2003), organic materials provide energy to grow and provide carbon as an energy source for soil macro ad micro- fauna.

The purpose of this study is to determine the effect of plant-growth promoting fungi and organic fertilizer on the growth and yield of Shallots plants.

MATERIALS AND METHODS

This research was conducted at the Wedomartani research field, UPN "Veteran" Yogyakarta, in 2018. The location is at an altitude of 104 meters above sea level. The plant used is shallots, Tajuk variety. The study was arranged in Randomized Complete Block Design with three replications. Two types of Plant Growth Promoting Fungi were used as the first factor: isolate fungi of *Trichoderma* sp. and *Penicillium* sp. As the second factor is organic fertilizer, which consists of three levels: compost, chicken manure, and *baglog* waste. Plant without treatment is used as a control. The observed data were analyzed by analysis of variance (ANOVA) and continued by DMRT at 5% real level.

RESULT AND DISCUSSION

The growth parameters observation on shallots are including plant height, number of leaves/plant, number of bulb/plant, bulb height plant, bulb diameter, bulb weight, dry weight of bulb and hardness of bulb. The results of the observation of PGPF and organic fertilizer treatments on shallots plants are presented in the table 1 below.

Table 1. Growth stimulation of shallots plants by inoculation with PGPF and organic fertilizer on number of leaves, bulb height, bulb diameter, and hardness of bulb

Treatment	Number of Leaves/plant	Bulb Height/plant (cm)	Bulb Diameter (mm)	Hardness of Bulb
PGPF:				
Trichoderma sp.	14,00 a	3,18 a	20,60 a	0,88 a
Penicillium sp.	12,89 a	2,97 a	21,81 a	0,84 a
Organic fertilizer:				
Compost	14,33 p	3,12 p	21,50 p	0,83 p
Chicken manure	14,00 p	3,17 p	21,07 p	0,83 p
Baglog Waste	12,00 p	2,93 p	21,05 p	0,92 p
PGPF x Organic Fertilizer (X)	13,44	3,07 (X)	21,20 (X)	0,86 (X)
Control	4,67 (Y)	2,77 (X)	4,53 (Y)	0,87 (X)

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Means of each parameter followed by the same letter are not significantly different according to Duncan Multiple RangeTest 5%.

From the Table 1 it can be seen that the treatment of *Trichoderma* sp. not significantly different from *Penicillium* sp. against the number of leaves/plant, bulb height/plant, bulb diameter, and hardness of bulb on shallots plants. This suggests that although, according to research conducted by Setyaningrum and Ratih (2016), *Penicillium* sp. capable of producing more IAA than *Trichoderma* sp, as well as the overhaul of organic material on *Penicillium* sp. larger than *Trichoderma* sp., both mechanisms did not give a real different effect on the growth and yield of shallots crops.

The effect of organic fertilizer treatment depends on several factors, as stated by Power and Papendick (1997) on the treatment of manure, that the availability of nutrients present in the soil caused by effects of manure is vary widely factors: the source and composition of the manure, the manner and timing of the application, the type of soil and climate, and the farming system. These factors will also affect the application of other types of organic fertilizers such as compost and *baglog* waste. Nutrient composition in the compost with dry leaf waste and manure material (N (1.81%), P2O5 (1.23%), K2O (3.88%), CaO (2.11%), MgO (0.92%) was relatively better compared to nutrient composition on the chicken manure N (1,4%), P (1,32%), K (1,15%), CN (12.66%) (Source: Herastuti *et al.*, 2016) and *baglog* waste that containing nutrients: P (0.7%), K (0.02%), N total (0.6%) and C-organic (49.00%) (Sulaeman, 2011).

Although the source and composition of nutrients in the three organic fertilizers used in this study varied, it was not enough to give a different effect on the availability of nutrients in the soil, will also result in growth and yields in shallots crops are not significantly different, especially on the number of leaves plant, bulb height/plant, bulb diameter, and hardness of bulb. This is because nutrient availability is not only influenced by the source and composition of fertilizer alone but also other factors as described above, in which the manner and timing of the application, the type of soil and climate, and the farming system are relatively similar.

In the PGPF treatment, when compared to the controls it showed that PGPF was better than control of the number of leaves/plant and bulb diameter. This is in accordance with the results of numerous studies which show that PGPF has been examined on almost all plant species, dicotyl and monocotyl. Almost all the parameters of plant growth in both the vegetative and reproductive growth stages can provide a positive response to the fungi included in the plant growth promotion (Shivanna *et al.*, 1995).

Tabel 2. Growth stimulation of shallots plants by inoculation with PGPF and organic fertilizer on plant height, number of bulb, weight of bulb, and dry weight of bulb

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Treatment	Plant Height (cm)	Bulb Number /plant	Bulb Weight (g)	Dry Weight of Bulb (g)
Tricho+Compost	31,33 c	5,33 b	35,37 c	15,50 b
Tricho+Chicken Manure	36,67 bc	6,67 b	44,97 bc	27,30 b
Tricho+Baglog Waste	37,50 b	6,33 b	50,13 b	22,53 b
Peni+Compost	43,89 a	9,00 a	65,07 a	43,37 a
Peni+Chicken Manure	32,00 bc	5,33 b	41,10 bc	16,50 b
Peni+ Baglog Waste	36,67 bc	6,33 b	46,70 b	15,50 b
PGPF x Organic Fertilizer	36,33(X)	6,50(X)	47,22(X)	23,5(X)
Control	28,33 (Y)	4,33(Y)	30,13(Y)	9,23(Y)

Means of each parameter followed by same letter are not significantly different according to Duncan Multiple RangeTest 5%.

The treatment combination of PGPF and organic fertilizer showed better results against plant height, bulb number/plant, bulb weight, dry weight of bulb on shallots plant when compared with control. This indicates that PGPF, when combined with organic fertilizer will show better promote activity of growth and yields in plants compared to PGPF alone. This can happened because the organic matter is a source of energy for soil macro and micro-fauna. The addition of organic matter in the soil will cause the activity and the microbiological population in the soil to increase, especially related to the activity of decomposition and mineralization of organic matter. Some microorganisms that have a role in the decomposition of organic matter are fungi, bacteria and actinomycetes. Another positive effect of adding organic matter is its effect on plant growth. There are compounds that have an influence on the biological activity found in the soil is the stimulating compound (auxin), and vitamins (Stevenson, 1982). These compounds in the soil are derived from plant exudates, manure, compost, plant residues and also derived from microbial activity in the soil.

The combination treatment of *Penicillium* sp. and compost gives the best effect on plant height, bulb number/plant, bulb weight, dry weight of bulb on shallots plant. This is possible because *Penicillium* sp., which has advantages in IAA production and organic material reshuffling compared to *Trichoderma* sp. (Setyaningrum and Ratih, 2016), will have a better effect on plant growth when each is combined with organic fertilizer. The combination treatment of *Penicillium* sp. with compost gives better effect than its combination with chicken manure and *baglog* waste, because the making material of compost used in this research, besides waste of dried leaves, added also manure so that enrich the nutrition composition.

CONCLUSION

The combination of *Penicillium* sp. and compost is resulted the best effect on plant growth and yield showed by plant height, bulb number/plant, bulb weight, and dry weight of bulb. The treatment of PGPF and organic fertilizer gives better results than control showed by number of leaves, bulb diameter, plant height, bulb number/plant, bulb weight, and dry weight of bulb.

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