
Formulate and Apply Plant Growth Promotion Rhizobacteria (PGPR) as Biofertilizer and Bioprotectant on Shallot Plantations

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Received: 27 July 2022 – Revised: 3 August 2022 - Accepted: 15 August 2022

Abstract. UPT Bulupountu Jaya is the one of many shallots or red onions and other vegetables production center in Sigi Regency. The farmers rely heavily on pesticide and chemical fertilizer in their business. Even, the residual pesticide on the plant is beyond permitted standard. The main factor is the lack of awareness and skills of the farmers towards environment-based cultivations and pest control. Our community service with regional featured product schematics, aim to spread the information about the technology of formulation and application of Plant Growth Promoting Rhizobacteria (PGPR) as biofertilizer and bioprotectant on red onion plantations. The methods that were going to be implemented, there are training, demonstration plot of technology application, and assistances. The result of our community service, shows that participants are really into this daily program in the moment, shown by the activeness of participants at various stages of activity. This program of our community service increases the farmers skill points to create own PGPR. For the clearest, about 70% participants increased their knowledge and skill to create PGPR and about 60% participants have had interest to develop and apply PGPR as biofertilizer. As doing so, we expect independent of the farmers from being rely on chemical inputs on red onion plantations.

Keywords: Red Onions, Biofertilizer, Bioprotectant, PGPR, Shallots

Citation Format: Rosmini, Hayati, N., Lasmini, S.A., Hasriyanty, Lakani, I., & Nasir, B.H. (2022). Formulate and Apply Plant Growth Promotion Rhizobacteria (PGPR) as Biofertilizer and Bioprotectant on Shallot Plantations. *Journal of Community Practice and Social Welfare*, 2(2), 1-10.

INTRODUCTION

Unit Permukiman Transmigrasi (UPT) Bulupountu Jaya District of Sigi Biromaru is the one of many red onion and other vegetables production centre in Sigi Regency, which also supplied the vegetables stocks for the people of Palu City. UPT Bulupountu Jaya located on the South of Palu City, which populated by 1,650 residents (BPS Kabupaten Sigi Dalam Angka, 2018). Majority working as a farmer with superior commodities in the form of red onions or shallots of the Palu Valley variety. This local shallot is the base ingredient for Palu fried shallots with several advantages, namely: crunchy or crispy with a distinctive aromatic taste and can be stored for a relatively long time. These UPT Bulu Pountu Jaya area of shallot plantations at about 83 hectares wide.

The cultivation of shallots is repeatedly constrained by the lack of production facilities, especially inorganic fertilizers and the presence of pests and diseases. One type of disease that infect shallot plantations in the Palu Valley is fusarium wilt disease caused by *Fusarium oxysporum* f.sp. *cepae*. This disease causes the plants to wilt rapidly, the roots become rotten, the plants to droop as if it were going to collapse, and at the base of the tuber there are visible white fungal colonies (Hadiwiyono et al., 2015). To overcome this, other efforts need to be made in the form of providing production facilities that are cheap, easy to obtain, and environmentally friendly.

Plant Growth Promoting Rhizobacteria (PGPR) is a root bacterium that stimulate plant growth. These bacteria live surrounding the roots, both on the surface of the roots and the soil that is still affected by the activity of plant roots, by utilizing the exudate released by the plant. Bacterium were not going to damage nor disrupt life, and on the contrary provide a secretion for plants to grow better (mutualistic symbiosis). PGPR has 3 roles in plant growth, namely as: bio-fertilizer, bio-stimulant and bio-protectant (Widodo, 2016).

PGPR functionality as a bio-fertilizer because of its ability to transform nutrient sources that exist in nature or applied synthetic fertilizers to become easily available and absorbed by plant roots through enzymes or other compounds produced by these bacteria. Some of the capabilities of PGPR as a biological fertilizer include fixating N and dissolving phosphate (P) so that it is available to plants (Majeed et al., 2015). PGPR functionality as bio-stimulant because it is able to produce siderophore compounds that can bind iron elements (Fe^{3+}) when it's limited (i.e. caused by $pH > 7$) and transferred to plants (Souza et al., 2015) and as a bio-protectant because it is able to protect plants from

infestation by plant pest organisms (OPT), or pests, or infection by plant pathogens (Jadoon et al., 2019). The mechanism of protection can be direct, namely by producing anti-microbial compounds (antibiotics) or lytic enzymes that destroy pathogenic cells, or indirectly by activating plants to produce immunity induction (Prihatiningsih et al., 2017).

Several studies have shown that the application of PGPR as a biological fertilizer could suppress the usage of inorganic fertilizers on horticultural crops (Parlakova Karagöz & Dursun, 2019; Utami et al., 2017), increase plant growth and its yield (Jumiati & Rosmini, 2021; Mohamed et al., 2019), increase leaf chlorophyll content (Rosida & Nugroho, 2017), reduce farming production costs and create healthy agriculture and its products that are safe for consumption (Susanti et al., 2020).

This community service program for the regional superior product schematics is going to train and assist farmers and the community in formulating PGPR and applying it to the shallot plantation area to make it easier for farmers to adopt for its usability on their farms to supporting the development of shallots as a leading commodity in the Central Sulawesi region.

PROBLEMS

The main problems faced by the farmers based on priority scale are as follows:

1. Lack of production facilities, especially organic fertilizers that support the growth of shallots.
2. The presence of pests and diseases that often attack shallot plants.
3. The shallot bulb products produced by the farmers are often rejected by the industry of fried onion because of its small diameter.
4. The farmers have found difficulty to obtain farmer inputs.

METHOD OF IMPLEMENTATION

To support the realization of the community service program for this regional superior product schematic, several approaches are carried out, namely: counselling and training; introduction and application of technology as well as coaching, mentoring and empowering the community.

RESULTS AND DISCUSSION

1. Counselling and Training for Formulating PGPR

The counselling and training were carried out in one of the farmer-partnering-group's meeting rooms (Figure 1). In this community service program, the farmer group is

"Tunas Sejahtera" Farmer Group became our partner and it had 20 members. Also, there are a presence at the counselling and training program who were Mr. Head of UPT Bulupountu Jaya and Mrs. PPL Coordinator of Sigi Biromaru District.



Figure 1. Atmospheric candid photos during counseling program

The speakers in the counselling and training program, besides the presence of the executive teammates, there are also presented Mr. and Mrs. Lecturers from the Faculty of Agriculture, which same as our department who have expertise in the field of PGPR Technology. They were Mr. Dr. Irwan Lakani, Mrs. Dr. Hasriyanti, and Prof. Dr. Mohammad Yunus. The counselling was given by the lecturing methodology while the training is given in the form of a technology demonstration. The presenter first showed how to formulate PGPR, starting from the materials and tools needed, how to manufacture and formulating PGPR, also how to apply it. Furthermore, the participants tried to make the PGPR accompanied by the executive team and the presented expert team (Figure 2). There are the steps PGPR (from various resources).

1. First, the thing that must be prepared is the PGPR starter. The starter of PGPR is obtained by soaking 250g of cut bamboo roots in 1 liter of cold boiled water for 3-6 days. After 3-6 days, the root bath is filtered and then set aside.
2. After the starter of PGPR is finished, boil all the substances there are 1 kg of granulated sugar, 0,5 kg of shrimp paste, 0,5 kg of bran, 1 tablespoon of lime betel and 20 liters of water and awaits until completely boiled, in about 20 minutes over low

heat. Then let it cold in a room temperature (25°C). This solution is the nourishment for the PGPR starter.

3. After it was cold, filter the solution from the waste then mix with PGPR starter from first step. Then fermented it in a tightly closed jerrycan or barrel.
4. During the process, let air circulation flows freely towards fermentation container.
5. Fermentation was carried out for 15 to 21 days.
6. At last, the PGPR is finished. The sign of the finished PGPR is the appearance of thick yellowish white foam on top of the fermented PGPR solution with a strong smell of ammonia (NH₃).



Figure 2. Materials and the process of making PGPR

2. Application of PGPR on Shallot Plantations

The PGPR application was carried out to determine the effectiveness of PGPR as a biofertilizer and bioprotectant agent. To apply PGPR, first made a demonstration plot application in the shallot plantation area. The beds for planting shallots are 10 m long and 90 cm wide. The application of PGPR starts from soaking the seeds, watering the PGPR solution on young plantings, and the plants that were well developed (see Figure 3). Observations on the growth of shallots were including plant height, number of leaves, and number of tillers. As a comparison, there were also shallots that are not applied with PGPR (Jumiati & Rosmini, 2021).

The results of the application demonstration plot showed that shallot plants were given PGPR showed better growth than those that were not given. PGPR given to the soil 2 weeks before the planting and those shallot bulb seedlings that were first dipped in PGPR solution for 10 minutes also showing the growth, showed that plant height at the age of 28 days was reaching 17.75 cm with its 4 tillers. Meanwhile, on land without the application of Trichoderma, plant height was only reaching 13.25 cm with its 3 tillers. The results are in accordance with (Novatriana & Hariyono, 2020) the research reported that soaking

PGPR for 30 minutes at a dose of 30 ml was able to increase plant height, number of leaves, leaf span, both fresh weight and dry weight, number of tubers, and tuber diameter.



Figure 3. The series of demonstration plot activities for the PGPR

The increase in the growth parameters and the yields of the shallots plant since PGPR was able to modify natural sources of nutrients to be easily available for the plants, through enzymes or other compounds produced by bacteria. These bacteria are nitrogen-fixing bacteria such as the genera *Azospirillum*, *Rhizobium*, *Azotobacter* and phosphate solubilizing bacteria such as the genera *Bacillus*, *Pseudomonas*, *Arthrobacter*, *Bacterium*, and *Mycobacterium* (Biswas et al., 2000).

3. Evaluations and The Follow-ups

At the end of the activity, an evaluation was carried out in the form of a questionnaire to found out the response and enthusiasm of the participants. Post-test results indicates (see Table 1) that 70% of participants increase their knowledge and skills in making PGPR and 60% of participants intend to develop and apply PGPR as a biofertilizer.

Table 1. Program Participants Post-Test Results

No.	Questions	Answers	Quantity (%)
1	Before joining the training, did you know the function of PGPR?	a. Yes	0
		b. No	100
2	Before joining the training, did you know how to make PGPR?	a. Yes	100
		b. No	0
3	After attend the training, do you know the function and how to make PGPR?	a. Yes	80
		b. No	20
4	After attend the training, do you know how to make PGPR?	a. Yes	70
		b. No	30
5	After attend the training, are you intended to create and develop PGPR?	a. Yes	60
		b. No	25
		c. Not sure	15
6	After attend the training, are you interested in applying PGPR on your farm?	a. Yes	60
		b. No	20
		c. Not sure	20

The community service program for the regional superior product schematics has succeeded in informing about the formulation technology and application of Plant Growth Promotion Rhizobacteria (PGPR) as a biofertilizer and bioprotectant as well as motivating farmers to develop and apply PGPR. With the application of PGPR as a biofertilizer, it is expected to suppress the usage of inorganic fertilizers in order to reduce farm production costs and create healthy agriculture and its products that are safe for consumption.

CONCLUSION

The results of the program of community service showed that participants were very enthusiastic about participating in the activity stages, so that it had an impact on increasing knowledge and skills in making PGPR. There were as many as 70% of participants increasing their knowledge and skills in making PGPR and as many as 60% of participants intending to develop and apply PGPR as a biofertilizer and bioprotectant. Thus, the results of community service are expected to be able to independent for being rely on chemical inputs on onion plantations.

ACKNOWLEDMENT

The community service program was carried out by the support by DIPA of the Faculty of Agriculture, Tadulako University in 2022, in concordance by Decree of the Chancellor of Tadulako University Number: 3654/UN28/KU/2022 dated 11th April 2022. The author would like to thank the Chancellor of Tadulako University and the Dean of the Faculty of Agriculture, Tadulako University who provide support in the implementation of community service.

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Original Title:

Perakitan dan Aplikasi *Plant Growth Promotion Rhizobacteria* (PGPR) Sebagai *Biofertilizer* dan *Bioprotectant* Pada Pertanaman Bawang Merah

Abstrak. UPT Bulupountu Jaya merupakan salah satu sentra produksi bawang merah dan sayuran lainnya di Kabupaten Sigi. Para petani sangat mengandalkan penggunaan pestisida dan pupuk kimia dalam kegiatan usahatannya. Bahkan residu pestisida pada umbi bawang yang mereka hasilkan sudah melebihi ambang yang dapat ditoleransi. Perilaku para petani tersebut tidak terlepas dari kurangnya pengetahuan dan keterampilan dalam budidaya dan pengendalian hama yang ramah lingkungan. Kegiatan pengabdian kepada masyarakat skema produk unggulan daerah bertujuan untuk menyebarluaskan informasi teknologi perakitan dan aplikasi *Plant Growth Promoting Rhizobacteria* (PGPR) sebagai *biofertilizer* dan *bioprotectant* pada pertanaman bawang merah. Metode yang diterapkan adalah pelatihan, demplot aplikasi teknologi, dan pendampingan. Hasil pelaksanaan pengabdian kepada masyarakat menunjukkan bahwa peserta sangat antusias mengikuti setiap materi kegiatan yang ditunjukkan oleh keaktifan peserta pada berbagai tahapan kegiatan. Kegiatan pengabdian kepada masyarakat ini berdampak pada peningkatan keterampilan petani bawang merah untuk membuat PGPR. Terdapat sebanyak 70% peserta meningkat pengetahuan dan ketrampilannya dalam membuat PGPR dan sebanyak 60% peserta berniat untuk mengembangkan dan mengaplikasikan PGPR sebagai biofertilizer. Dengan demikian hasil pengabdian tersebut diharapkan dapat melepaskan ketergantungan terhadap input bahan kimia pada lahan tanaman bawang.

Kata kunci: Bawang merah, *Biofertilizer*, *bioprotectant*, *PGPR*