Integrating Social and Field Data to Understand Farmers' Adoption of Biofertilizer in Rose Cultivation

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ABSTRACT

The growing demand for sustainable agriculture has sparked interest in biofertilizers as an alternative to chemical fertilizers. However, adoption among farmers remains low, particularly in floriculture, due to limited knowledge and concerns about its effectiveness. This study integrates social and field data to understand farmer perceptions and evaluate the impact of biofertilizers on the growth of Rose (*Rosa hybrida* L.) cv Hermosa. Primary data was collected through a focus group discussion (FGD) distributed to local farmers in Cikahuripan Village, Parongpong District. A field experiment was conducted using a Completely Randomized Block Design with three biofertilizer treatments: AB-Mixed chemical fertilizer without and with BION-UP (nitrogen-fixing bacteria (NFB) - phosphate-solubilizing microbes (PSM) consortium), and Bacillus consortium. The FGD revealed that most farmers had never received biofertilizer knowledge and its application method, highlighting the need for better training and outreach. Experimental results showed that while plant height remained unaffected by biofertilizers in the early stages, the NFB-PSB consortium significantly boosted growth in later weeks. Both biofertilizers enhanced microbial populations, soil health, and flower diameter, proving their potential as eco-friendly alternatives to synthetic fertilizers. These findings emphasize the importance of bridging scientific innovation with farmer adoption to promote sustainable rose cultivation. Long-term studies and policy support are crucial for encouraging biofertilizer use in commercial floriculture.

Keywords: Biofertilizer, Farmer Perception, Rose, Sustainable Agriculture

Integrasi Data Sosial dan Budidaya untuk Memahami Penerapan Pupuk Hayati oleh Petani dalam Budidaya Mawar

ABSTRAK

Peningkatan permintaan akan pertanian berkelanjutan telah memicu minat terhadap pupuk hayati sebagai alternatif pupuk kimia. Namun, adopsi di kalangan petani masih rendah, khususnya di bidang florikultura, karena keterbatasan pengetahuan dan kekhawatiran tentang efektivitasnya. Studi ini mengintegrasikan data sosial dan lapangan untuk memahami persepsi petani dan mengevaluasi dampak biofertilizer terhadap pertumbuhan bunga mawar (*Rosa hybrida* L.) cv Hermosa. Data primer mengenai persepsi petani diperoleh melalui diskusi kelompok terfokus yang dibagikan kepada petani lokal di Desa Cikahuripan, Kecamatan Parongpong. Percobaan lapangan dilakukan dengan menggunakan Rancangan Blok Acak Lengkap dengan tiga perlakuan pupuk hayati yaitu pupuk kimia AM-MIX dengan dan tanpa BION-UP yg mengandung ekonsorsium bakteri penambat nitrogen (BPN) - mikroba pelarut fosfat, (MPF), dan konsorsium Bacillus. Diskusi dengan petani mengungkapkan bahwa sebagian besar petani belum pernah menerima pengetahuan tentang pupuk hayati dan metode aplikasinya, yang menyoroti perlunya pelatihan dan sosialisasi yang lebih baik. Hasil percobaan menunjukkan bahwa meskipun tinggi tanaman tidak dipengaruhi oleh biofertilizer pada tahap awal, konsorsium BPN-MPF secara signifikan meningkatkan pertumbuhan pada minggu-minggu berikutnya. Kedua biofertilizer tersebut meningkatkan populasi mikroba, kesehatan tanah, dan diameter bunga, yang membuktikan potensinya sebagai alternatif ramah lingkungan untuk pupuk sintetis. Kajian ini

menekankan pentingnya menjembatani inovasi ilmiah dengan adopsi petani untuk mempromosikan budidaya mawar yang berkelanjutan. Studi jangka panjang dan dukungan kebijakan sangat penting untuk mendorong penggunaan pupuk hayati dalam budidaya bunga komersial.

Kata kunci: Bunga Mawar, Pertanian Berkelanjutan, Persepsi Petani, Pupuk Hayati

INTRODUCTION

The increasing demand for sustainable agriculture has driven interest in biofertilizers as an alternative to chemical fertilizers. Biofertilizers, which contain beneficial microbes such as *Bacillus* spp., play a crucial role in enhancing soil fertility, improving plant nutrient uptake, and promoting plant growth through biostimulant mechanisms [1]. Despite these benefits, the adoption of biofertilizers remains limited among farmers, particularly in floriculture, due to a lack of awareness, skepticism about their effectiveness, and limited field trials to validate their impact in specific field conditions.

The Roses are essential floral commodities in Bandung Barat Regency, West Java. In 2023, the harvest area of roses in that regency was 595,200 m^2, the highest compared to other flower plants, such as chrysanthemums, which were only harvested from an area of 397,520 m^2 [2]. Floricultural farmers in West Java are limited in using biofertilizer; most farmers apply chemical fertilizer during rose cultivation.

A preliminary survey conducted among rose farmers in Cikahuripan Village determined that chemicals alone were not the best way to optimize rose growth and flower quality. Moreover, the farmers' knowledge and perceptions of biofertilizers are unknown. Normative processes, situational influence, and attitudes determine intentions to use biofertilizers [3]. Many farmers had never received any extension or training related to biofertilizers. To improve farmers' adoption of biofertilizer technologies, organized training and demonstrations on biofertilizer technologies and utilization are needed [4].

Rose cultivation requires an appropriate amount of Nitrogen, Phosphorus, and Potassium to obtain the highest bud length, stalk length, flower diameter, number of flowers per plant, and vase life [5]. However, sustainable agriculture requires balanced fertilization, including organic matter and biofertilizer. Conventional fertilization practices rely heavily on synthetic inputs, which, if overused, can lead to soil degradation, nutrient imbalances, and environmental pollution [6]. The N-fixing Azotobacter and Phosphate-solubilizing microbes significantly affected the growth, flowering, and flower yield parameters [7]. This study investigates whether biofertilizers can reduce chemical dependency while maintaining or enhancing rose performance.

This research integrates farmer adoption insights and scientific field data to understand biofertilizer effectiveness comprehensively. The findings highlight the need for more extensive education and outreach programs to encourage farmers to adopt microbial-based fertilization as part of a sustainable agricultural system. The objectives of the study were 1) to understand farmer perceptions on biofertilizers, 2) to evaluate the impact of biofertilizers on the growth of Rose (*Rosa hybrida* L.) cv Hermosa grown in the greenhouse, and 3) to evaluate the bacterial population, pH, and EC of Rose substrate.

MATERIALS AND METHODS

Agricultural extension and field research were conducted at the Grace Rose Farm company in Bandung Barat Regency from August to December 2022.

The Survey Instrument for Farmers

Primary data was collected through a questionnaire distributed to local farmers. A questionnaire was given before the training

activity. The respondents included 15 rose farmers who work in the Rose Garden of Cikahuripan Village, Parongpong District, Bandung Barat Regency. The questionnaire is intended to assess farmers' knowledge and perspectives. The data collection involves direct engagement with farmers, ensuring a comprehensive response. The intended results of this extension were the increased knowledge of biofertilizers and farmers' understanding of agricultural practices.

The questionnaire is composed of open questions concerning a) information on farmers regarding biological fertilizers from extension workers, agricultural offices, and related parties; b) Use of biofertilizers, the content and benefits of biofertilizers; c) farmers' knowledge of the content of biofertilizers; d) farmers' knowledge about the content of biofertilizers; e) Farmers' knowledge about the benefits of biofertilizer. After filling in the questionnaire, an intensive discussion was performed.

Field Test of Biofertilizers on Rose Plants

Two types of liquid biofertilizer used in this experiment were the consortium of Nitrogen-fixing bacteria (NFB) and Phosphate-solubilizing microbes (PSM) under the commercialized brand of BION-UP and the Bacillus consortium that has not been commercialized. All biofertilizers were developed by the Soil Biology Laboratory, Department of Soil Science, Faculty of Agriculture, Universitas Padjadjaran, in collaboration with PT Pupuk Kujang.

The greenhouse experiment used red-coloured Hermosa rose (*Rosa hybrida* L.) cv. Hermosa. The experimental design was a Completely Randomized Block Design to test two types of biofertilizer and one control treatment. The treatments were as follows:

1. Control fertilizer (A): AB-Mix liquid chemical fertilizer is applied according to standard practices in each greenhouse.
2. BION-UP + Control (B): Application of BION-UP liquid biofertilizer combined with control fertilizer
3. Bacillus Consortium + Control (C): Application of Bacillus spp. liquid biofertilizer combined with control fertilizer

The experiment was conducted on three planting beds, each 20 meters long, with 12 replications per bed, resulting in 36 experimental units in total (Figure 1). The Rose plants have grown in the raised cocopeat, soil, and manure beds for 4 months.

The biofertilizer concentration was 1% in water, requiring 100 mL of biofertilizer per 10 liters for each planting bed. The AB-Mix fertilizer was diluted in water with a concentration of 5 mL/L. The fertilizer was applied every two weeks, following the standard fertilization schedule in the Rose Farm.

Plant height was measured once every two weeks for 9 weeks. The total population of bacteria was counted using the serial dilution plate method in nutrient agar. The data were subjected to a one-way variance analysis followed by the Duncan Multiple Range Test (DMRT) at $p<0.05$.

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Figure 1. Plot of treatments and sampling plants or rose in each plot (a) of the greenhouse experiment in raised bed (b).

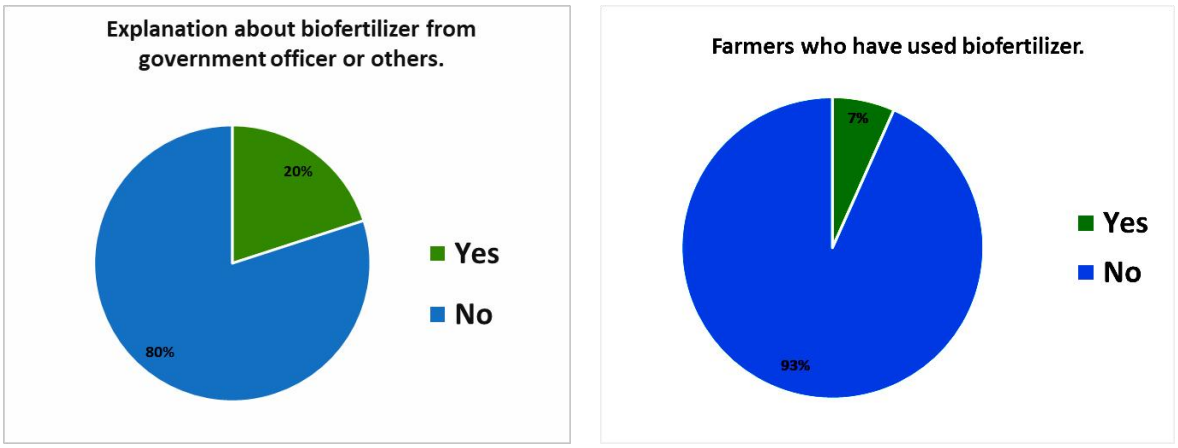
RESULTS AND DISCUSSION

Knowledge and Use of Biofertilizers at the Farmers' Level

The results showed that most farmers do not understand the role of soil microbial inoculants in increasing plant growth. Most respondents are more familiar with chemical fertilizers and have not fully understood the benefits and mechanisms of soil microbes in promoting plant growth. Moreover, they questioned the effectiveness and consistency of the results of biofertilizers compared to chemical fertilizers that have been used for a long time.

Based on questionnaire data, 80% of farmers have never received biofertilizer training from agricultural extension workers or local agricultural offices. In comparison, 20% of farmers already know about the existence of biofertilizers. Among the 15 farmers, only 7% have used biofertilizers, but not for rose cultivation, without knowing their role in plant growth (Figure 2). Their knowledge of biofertilizers' composition was also limited; 54% of respondents related the biofertilizers to a nutrient source similar to organic matter. Meanwhile, 13% of farmers know biofertilizers contain microorganisms such as bacteria and fungi (Figure 3).

The FGD revealed that farmers believed biofertilizers were produced from mature compost mixed with water. They had no idea that the microbes in biofertilizers were specific in genus/species and had a particular role in plant growth. Farmers were not widely aware of biofertilizers and their use. Farmers consider biofertilizers to be similar to organic fertilizers (54%), chemical fertilizers (54%), and neither organic nor chemical fertilizers (13%). These data show that farmers have not received sufficient explanation regarding biological fertilizers and are less interested in knowing about biofertilizers. Therefore, more intensive courses, training, and plot demonstrations are needed to increase their knowledge of the benefits of biofertilizers in rose cultivation.



a b

Figure 2. Farmer information about biofertilizers: a) information on farmers regarding biological fertilizers from extension workers, agricultural offices, and related parties; b) Use of biofertilizers in the field.

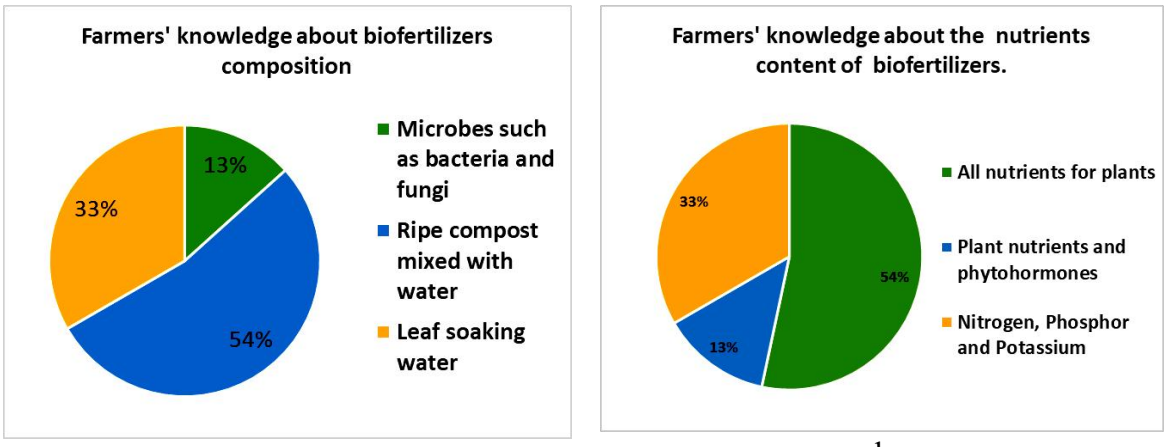


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Figure 3. Farmer Knowledge Regarding the content and benefits of biofertilizers; a) farmers' knowledge of the content of biofertilizers; b) farmers' knowledge about the content of biofertilizers

Biofertilizer Effect on Rose cv. Hermosa

Based on the variance analysis, biofertilizer inoculation did not influence plant height until the 7th week after. However, in the 9th week, both biofertilizers increased plant height, mainly in plants treated with BION-UP (Table 1).

The application of BION-UP enhanced the pH and EC; a slight increase of both parameters was found in the substrate of Rose grown with the Bacillus consortium (Table 2). The total number of soil bacteria depends on the fertilizer treatment. A significant increase in soil bacteria in the growth media was shown below in the plants treated with both biofertilizers (Table 2).

Table 1. Shoot height of Rose cv Hermosa grown with and without biofertilizer during 9-week observation

Treatments	Plant height in the week (cm)				
	1	3	5	7	9
A (Control)	9.00a	20.30a	22.42a	35.53a	51.06a
B (BION-UP + AB-Mix)	9.06a	20.69a	22.44a	37.19a	54.78b
C (Bacillus Consortium + AB-Mix)	8.97a	19.42a	21.72a	36.53a	54.14ab

Numbers in the column followed by the same letters were not significantly different based on DMRT ($p<0.05$)

Table 2. Effect of biofertilizer on pH, EC, and total bacteria in the growth substrate of Rose cv. Hermosa at week nine

Treatments	pH*	EC (ms/cm)*	Total bacteria (log CFU/mL)
A (Control, AB-Mix)	6.99a	0.75a	9.7a
B (BION-UP + AB-Mix)	7.41ab	0.92b	9.9b
C (Bacillus Consortium + AB-Mix)	7.52b	0.91b	9.9b

Numbers in the column followed by the same letters were not significantly different based on DMRT ($p<0.05$)

Flower diameter was measured using a digital vernier calliper (Figure 4). The average diameter of the flower in the ninth week was significantly increased after biofertilizer application (Table 3). These results indicate that biofertilizer application impacts flower development since both biofertilizers provide Phosphate for generative stadia. Moreover, the N-fixing bacteria in BION-UP can increase the N availability and further their uptake.

Table 3. Effect of biofertilizers on the diameter of roses cv. Hermosa

Treatments	Diameter (mm)*
B (BION-UP + AB-Mix)	32.33 a
C (Bacillus Consortium + AB-Mix)	35.27 b
B (BION-UP + AB-Mix)	35.83 b

Numbers in the column followed by the same letters were not significantly different based on DMRT ($p<0.05$)

The plants did not immediately respond to biofertilizers since their mechanisms to provide nutrients and phytohormones are enzymatic. The increase in plant height might have been caused by a sufficient supply of macronutrients N and P. Inoculating plants with BION-UP was better to boost plant growth since this biofertilizer provides N and P through nitrogen fixation and phosphate solubilization. All bacteria in BION-UP and Bacillus Consortium produced the indole acetic acid and auxin [8] [9] that determine plant growth. Table 1 shows that the Bacillus consortium and NFB-PSM in BION-UP boost plant height. Bacillus plays an important role in supporting plant growth through its ability

to dissolve phosphate and fix nitrogen, so it can help meet plant needs for both essential nutrients [10][11].

The result indicates that biofertilizers are biostimulants that influence plant growth, possibly due to modest improvements in soil microbial activity and nutrient availability[12]. This increase might be due to bacteria's function in improving nutrient availability and soil health, supporting plant growth more optimally during observation.

Figure 4. *Measurement* of the diameter of a rose's flower

Higher bacterial populations indicate that the biofertilizers promote microbial augmentation and colonization, contributing to improved nutrient cycling and organic matter decomposition in the soil [13]. Biofertilizers considerably impacted pH and EC; BION-UP and Bacillus consortium raising both. These changes imply better soil conditions, which can help plants absorb nutrients more efficiently [14]. In general, suitable soil for growing rose flowers has a pH value between 5.5 and 7.0; At the same time, the EC between 0.8 and 1.2 ensures plant growth and flower number [15]. However, the pH in this research was increased up to 7, which might decrease the rose growth, so further research about the effect of biofertilizers on pH is required.

CONCLUSION

The farmer's knowledge about biofertilizer's role, composition, and utilization for rose cultivation is limited. The short-time field experiment is essential to increase their understanding and interest in biofertilizers since the BION-UP and Bacillus Consortium enhanced the plant height and flower diameter compared to the control plant that only used liquid chemical fertilizer. The experiment found that the biofertilizer also increased the pH, EC, and total bacterial count in the growth substrate of Rose cv. Hermosa. However, a long-term experiment is required to evaluate its effectiveness under a broader production scale and in different locations. Moreover, routine agricultural extension is

needed to enhance farmers' knowledge and adoption of biofertilizers.

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