

Effect of bokashi dose and frequency of administration of Plant Growth Promoting Rhizobacteria (PGPR) against pest and disease attacks on Pakcoy (*Brassica rapa* L.)

Nikolas Nik¹, Aloysius Rusae² Egidius Naju³

^{1,2,3}Fakultas Pertanian, Universitas Timor, Kefamenanu, TTU – NTT, Indonesia

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ABSTRACT

Pakcoy is a horticultural plant that has nutritional content tall one. so it is in great demand by the Indonesian people, but production is decreasing. This decline was caused by several reasons factors include soil fertility, pests and diseases which reduce its quality and quantity. This research aims to determine the dose of bokashi and the frequency of PGPR spraying on the growth and yield of pakcoy plants as well as reducing the intensity of pest attacks and diseases of pakcoy plants. This research was carried out on the grounds of the Faculty of Agriculture in July – September 2022. The design used is Design Random Group (RAK) fac tory Which consists of 2 factors with each factor consists of 4 levels, namely: the first factor b okashi (T) which consists of 4 levels, namely: T0 = control/without bokashi, T1= 1:05 kg/ polybag, T2 = 1:1 kg/ polybag, T3 = 1:1, 5 kg / polybag. while the second factor is the frequency of PGPR spraying (F) which consists of 4 levels, namely F0 = control/no PGPR spraying, F1 = 2x PGPR spraying, F2 3x PGPR spraying and F3 4x PGPR spraying so there are 16 treatment combinations available. repeated 3 times for a total of 48 experimental units. The parameters observed include: plant height, number of leaves, fresh weight of plants, economic weight of plants, intensity of pest attacks, and incidence of plant diseases. All observational data were analyzed using the Duncan Multiple Range Test (DMRT) with significant 5%. The results of the research show that the dose of box h i 1: 1.5 kg/polybag and the frequency of PGPR spraying 4 times can increase plant height, number of leaves, plant fresh weight whereas in the treatment, 2 spraying of PGPR with bokashi 1:1 kg/polybag reduced pest intensity by 9.12% and disease incidence by 7.20%.

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Corresponding Author:

Nikolas Nik

Fakultas Pertanian, Universitas Timor

Sasi, Kec. Kota Kefamenanu, Kabupaten Timor Tengah Utara, Nusa Tenggara Tim

Email: nikolasmanikin@gmail.com

1. INTRODUCTION

Pakcoy (*Brassica rapa* L) is a short-lived plant belonging to the Brassicaceae family , its leaves or flowers are used as food because they have nutritional content. tall one. so it is in great demand by the Indonesian people. Pakcoy plants can grow in the highlands and lowlands. Pakcoy is also beneficial for health such as anticancer, antioxidants and contains high vitamins, minerals, low fat, fiber, beneficial photochemical components. Vitamins C and E contained in this type of vegetable are antioxidant components that can fight free radicals. This plant is one of the plants

cultivated by farmers in North Central Timor Regency (TTU). Vegetable production in 2015 was 231.8 tons and pak choy production was 50.4 tons (BPS Kab.TTU 2021).

Pakchoy production fluctuates from time to time, which is caused by several reasons factors include soil fertility, unstable weather which causes physical damage to pak choy plants, the presence of pest attacks and diseases that cause the quality of vegetables decreases as indicated by the presence of holes in the leaves and yellowing. Hollow leaves are caused by destructive pests that eat Pakchoy leaves like leaf caterpillar (*Plutella xylostella*), aphid (*Aphis craccivora*), grasshopper caterpillar (*Spodoptera litura* F.) and grasshoppers. Apart from that, there is a leaf spot disease on the surface of the leaves, reducing its quality. As a result of pest and disease attacks, farmers use synthetic pesticides to control it, instead of overcoming the problem of pests and disease, excessive use of pesticides actually damages the environment, resulting in the loss of nutrient elements which play an important role in the growth of pak choy plants. This is in accordance with the opinion of Zupriadi *et.al.*, (2018) who say that fertilizer is a very important nutrient or nutrient element added to plants. Furthermore, Marlita *et.,al*, (2022) said that to get pak choy vegetables that are free of pesticide residue, additional nutrients are needed in the form of using organic fertilizers such as bokashi fertilizer and PGPR which have multi-functions both for fertilizing plants and as biological agents. to control pests and diseases in plants. The use of bokashi and PGPR is environmentally friendly, reduces environmental pollution, and is selective in killing pests.

Bokashi is compost produced through fermentation by administering *Effective Microorganism* -4 (EM-4) which is an activator to speed up the compost making process (Indriani, (2001) in Kusuma, 2013). Many research results show that bokashi has better quality compared to simple composting techniques (Kusuma, 2013). Providing bokashi fermented with EM-4 is one way to improve the physical, chemical and biological properties of the soil and can suppress pests and diseases as well as increase the quality and quantity of crop production (Nasir, 2008 in Kusuma, 2013)

PGPR is a bacteria that is active in colonizing plant roots which plays an important role in increasing plant growth, crop yields and land fertility (Gusti *et., al .*, 2012). The principle of administering PGPR is to increase the number of active bacteria around plant roots, thereby providing benefits to the plant. The advantages of using PGPR are increasing mineral levels and nitrogen fixation, increasing plant tolerance to environmental stress, as a biofertilizer, biological control agent, protecting plants from plant pathogens and increasing the production of indole-3-acetic acid (IAA) (Figueiredo *et., al .*, 2010; Mafia *et., al .*, 2009).

Microorganisms in PGPR not only ensure the availability of essential nutrients for plants, but also increase the efficiency of nutrient use (Nandal & Hooda, 2013) . Apart from stimulating plant growth, PGPR also plays an important role in speeding up composting and increasing crop yields. PGPR plays a role in stimulating plant growth because of its ability to produce plant hormones (IAA, cytokinin, ethylene, and gibberlic acid), nitrogen fixation, P solvent, nutrient and water uptake, and potassium solvent (Gupta *et al .* 2015; Zhou & Huang, 2016) . PGPR is a biocontrol agent that has been widely tested to be effective and used in controlling various plant pathogens (Jiao *et.al.* , 2021; Takishita *et al.* , 2021).

2. METHOD

This research was carried out in July - September 2023 in Land of the Faculty of Agriculture, University of Timor and continued with sample examination in the Laboratory The design used in this research is a factorial Randomized Block Design (RAK) , which consists of 2 factors , the first factor is bokashi (T) which consists of 4 levels, namely: T0 = control , T1 = 1: 0.5 kg/ polybag (1 kg soil + 0.5 kg bokashi) T2 = 1:1 kg/ polybag (1 kg soil + 1 kg bokashi), T3 = 1:1.5 kg / polybag (1 kg soil + 1 kg bokashi .5 kg), while the second factor is the PGPR spraying frequency (F) which consists of 4 levels, namely F0 = control , F1 = 2x application, F2 = 3x application and F3 = 4x application. All data was collected and analyzed using factorial Randomized Group Design (RAK) ANOVA analysis of variance. To find out the real difference between the treatment averages, it will be tested further using DMRT (Duncan multiple range test) with a significance of 5% according to the instructions of Gomez and Gomez (2010). Data analysis uses the SAS 9.1 program.

3. RESULTS AND DISCUSSION

3.1 Research results

3.1.1 Plant Height (cm)

The results of the ANOVA variance showed that there was an interaction between the treatment dose of bokashi and the frequency of PGPR watering on plant height at 21 HST observations. The combination of a 1:1 bokashi dose with a PGPR spraying frequency of 2 times increased the height of the pakcoy plant by 19.50cm. However, it did not show a significant difference with other treatments. Furthermore, during observations at 28 HST, no interaction occurred, but the dose of 1:1.5 bokashi had a plant height of 22.92 cm and the spraying frequency of 2 times also increased the height of the bok choy plant by 22.29 cm. Then, observations at 35 HST also showed that there was no interaction, but the 1:1 dose of bokashi had the highest plant height value of 24.34 cm, while the frequency of spraying PGPR 3 times had a plant height value of 24.05 cm. Plant growth will tend to increase if supported by loose soil factors which are influenced by bokashi and PGPR which provide nutrition for packhoy plants. Research results of Siahaan *et al.*, (2023); Choudhary *et al.*, (2011) said that the ability of plants to absorb nutrients from the rhizosphere through nitrogen fixation and phosphate dissolution will increase so that it will have a positive effect on plants.

Table 1. Plant Height (cm)

Observation time	Measurement of Bokashi (Kg/polybag)	PGPR Spraying Frequency				Average
		Control	2 times	3 times	4 times	
21 HST	Control	15.03b	16.66ab	14.90b	16.83ab	15.86
	1:0.5	16.73ab	14.86b	14.76b	15.60ab	15.49
	1:1	16.56ab	19.50a	16.90ab	16.96ab	17.48
	1:1.5	18.56ab	16.00ab	17.76ab	18.46ab	17.70
	Average	16.72	16.76	16.08	16.96	(+)
28 HST	Control	22.84	21.36	23.16	20.06	21.86a
	1:0.5	21.20	20.80	20.06	22.76	21.21a
	1:1	21.13	24.73	21.90	22.43	22.55a
	1:1.5	22.80	22.26	23.30	23.30	22.92a
	Average	21.99a	22.29a	22.11a	22.14a	(-)
35 HST	Control	21.83	22.06	25.00	22.73	22.91a
	1:0.5	23.73	21.56	22.46	25.76	23.38a
	1:1	23.16	27.10	25.23	21.86	24.34a
	1:1.5	25.80	22.56	23.50	25.46	24.33a
	Average	23.63a	23.32a	24.05a	23.95a	(-)

Note: Numbers in rows and columns followed by the same letter indicate no difference at the 5% significant level (α) according to DMRT; (-) There is no interaction between factors; (+) There is an interaction between factors.

3.1.2 Number of Leaves (Strands)

The results of the ANOVA variance showed that there was an interaction between the combination of bokashi dose treatment and the frequency of PGPR spraying on the observation of the number of pakcoy plant leaves. The combination of 1:1.5 bokashi treatment with a spraying frequency of 4 times increased the number of leaves by 11 and 15.33 at 21 and 28 HST observations. Meanwhile, in the initial observations at 14 DAP there was no interaction, but the 1:1.5 bokashi treatment had the highest number of leaves, 6.25, then the frequency was 4 and the control had the same number of leaves, 6.08.

Table 2. Number of Leaves (Strands)

Observation time	Measurement of Bokashi (Kg/polybag)	PGPR Spraying Frequency				Average
		Control	2 times	3 times	4 times	
21 HST	Control	6.00	6.00	5.33	6.33	5.92a
	1:0.5	6.00	5.33	5.66	5.66	5.66a
	1:1	6.00	5.66	6.33	6.00	6.00a
	1:1.5	6.33	6.00	6.33	6.33	6.25a
	Average	6.08a	5.75a	5.91a	6.08a	(-)
28 HST	Control	8.00b	9.00ab	8.00b	9.33ab	8.58
	1:0.5	8.66ab	8.66ab	9.66ab	9.33ab	9.08
	1:1	9.00ab	9.66ab	9.33ab	9.00ab	9.25
	1:1.5	10.66a	9.33ab	9.66ab	11.00a	10.16

	Average	9.08	9.16	9.16	9.67	(+)
35 HST	Control	12.00bcd	12.33abcd	10.33abcd	11.33cd	11.50
	1:0.5	12.00bcd	13.00abcd	12.66abcd	15.00ab	13.17
	1:1	15.00ab	12.66abcd	12.66abcd	11.66cd	13.00
	1:1.5	14.00abc	14.00abc	13.33abcd	15.33a	14.17
	Average	13.25	13.00	12.25	13.33	(+)

Note: Numbers in rows and columns followed by the same letter indicate no difference at the 5% significant level (α) according to DMRT; (-) There is no interaction between factors; (+) There is an interaction between factors.

3.1.3 Plant Fresh Weight (grams)

1:1.5 bokashi dose had the heaviest plant fresh weight of 133.08 g while the PGPR spraying frequency of 4 times increased the fresh weight of the plant by 128 g. 84 g. The results of research by Oktafia and Maghoer (2018) show that the use of PGPR can increase the fresh weight and consumption weight of pak choy plants. Anshori *et al.*, (2022) explained that there was an interaction effect of giving PGPR and organic fertilizer on the weight of fresh stover and fruit weight of paprika plants. This is also inseparable from the role of bokashi which has sufficient nutrients for plants. According to (Tanaka *et al.*, (2006), increased plant growth cannot be separated from the uptake of the nutrients N, P and K. Sufficient supply of nutrients can support plant growth and produce higher production.

This is supported by Sahputra (2013) who explained that giving rice straw and PGPR was also able to increase the number of leaves by 24.96%, bulb diameter by 25.59%, tuber weight by 35.80% in garlic plants. Furthermore, Istarofah and Salamah (2017) stated that wet weight is influenced by the availability of optimal nutrients in the soil which are absorbed by the roots. Furthermore, Anjardita *et.al.*, (2018) stated that PGPR can increase peanut production if applied regularly.

Table 3. Fresh Weight of Plants

Measurement of Bokashi (Kg/polybag)	PGPR Spraying Frequency				Average
	Control	2 times	3 times	4 times	
Control	101.55	124.78	106.20	129.83	115.59a
1:0.5	104.26	112.04	134.03	107.49	114.46a
1:1	102.58	122.32	117.24	112.35	113.62a
1:1.5	116.05	121.20	129.36	165.70	133.08a
Average	106.11a	120.09a	121.71a	128.84a	(-)

Note: Numbers in rows and columns followed by the same letter indicate no difference at the 5% significant level (α) according to DMRT; (-) There is no interaction between factors.

3.1.4 Pest Attack Level *Plutella xylostella* (%)

The results of the ANOVA variance showed that there was an interaction between the treatment dose of bokashi and the frequency of PGPR spraying on the observation of pest attacks. The combination of 1:1 bokashi dose treatment with 2 times PGPR spraying frequency had the lowest pest attack value, namely 9.12% but was not significantly different from other treatments. It is suspected that a bokashi dose of 1:1 with a PGPR spraying frequency of 2 times will be optimal for reducing pest attacks on packhoy plants. Nik's research results (2023) stated that at high PGPR concentrations and spraying more than once will reduce the level of aphid attacks on pariah plants.

Table 4. Pest Attack Level

Dose Bokashi (Kg/polybag)	PGPR Spraying Frequency				Average
	Control	2 times	3 times	4 times	
Control	21.04efg	12.10b	12.20b	13.40cd	14.43
1:0.5	19.02e	12.50b	13.00c	10.20ab	13.68
1:1	20.01efg	9.12a	14.00cd	12.10b	13.81
1:1.5	19.80ef	10.10ab	11.50b	11.78b	13.12
Average	19.64	10.96	12.68	11.78	(+)

Note: Numbers in rows and columns followed by the same letter indicate no difference at the 5% significant level (α) according to DMRT; (-) There is no interaction between factors; (+) There is an interaction between factors.

3.1.5 Disease Incidence (%)

The results of the ANOVA analysis showed that there was an interaction between the dose of bokashi treatment and the frequency of PGPR spraying on the observed disease incidence. The

combination of 1:1 bokashi dose treatment with 2 times PGPR spraying frequency had the lowest disease incidence value, namely 7.20% but was not significantly different from other treatments. Spraying more than once will be able to reduce the incidence of disease in pakcoy plants, thereby increasing yields. PGPR functions in accelerating the growth process through nutrient absorption, increasing the plant's immune system or as a biostimulant, and as a bioprotectant. A'yun, *et al.*, (2013) stated that this bacterium actively colonizes plant roots and has 3 main roles for plants, namely: a) as a biofertilizer (capable of accelerating the plant growth process through the absorption of nutrients), b) as a biostimulant (stimulating plant growth through the production of phytohormones), and c) as a bioprotectant (protecting plants from pathogens).

Table 5. Disease Occurrence

Dose (Kg/polybag)	Bokashi	PGPR Spraying Frequency			Average	
		Control	2 times	3 times		4 times
Control		12.03cd	10.10c	11.20cd	10.12c	10.86
1:0.5		19.02ef	8.25ab	11.00cd	9.20bc	11.87
1:1		14.01e	7.20a	8.12ab	12.11cd	10.36
1:1.5		19.05ef	9.10bc	11.50cd	10.20c	12.46
Average		16.03	8.66	10.46	10.41	(+)

Note: Numbers in rows and columns followed by the same letter indicate no difference at the 5% significant level (α) according to DMRT; (-) There is no interaction between factors; (+) There is an interaction between factors.

4. CONCLUSION

At a bokashi dose of 1:1 with a PGPR spraying frequency of 2 and 3 times, the height of pakcoy plants increases, while the combination of a bokashi dose of 1:1.5 with a PGPR spraying frequency of 4 times increases the number of leaves of pakcoy plants and is able to reduce the level of pest attacks and disease incidence.

REFERENCES

- A'yun, K.Q., T. Hadiastono, and M. Martosudiro. 2013. Pengaruh Penggunaan PGPR (Plant Growth Promoting Rhizobacteria), Pertumbuhan, dan Produksi pada Tanaman Cabai Rawit (*Capsicum frutescens* L.). http://mitalom.com/pengertiandanfungsi_pgprplantgrowthpromotingrhizobacteria
- Anjardita IMD, I Gusti Ngurah Raka, Ida Ayu Mayun, I Nyomann Sutedja. 2018. *Pengaruh Plant Growth Promoting Rhizobakteria (PGPR) terhadap Pertumbuhan dan Hasil Tanaman Kacang Tanah (Arachis hypogaea L .)*. 7(3), 447–456.
- Anshori, B.A., M. Ihsan, L.Widiastuti. 2022. Pengaruh PGPR dan pupuk kandang terhadap pertumbuhan dan hasil tanaman paprika (*Capsicum annum* L.) di dataran rendah. *J. Daun.* 9(1): 01-11.
- Badan Pusat Statistik, 2021. Timor Tengah Utara Dalam Angka. Kabupaten Timor Tengah Utara, Kefamennanu.
- Choudhary, R. K.; Ajmal Ali, M.; Lee, J. Studies on genetic diversity among populations of *Persicaria barbata* (L.) H. Hara from India based on internal transcribed spacer sequences of nuclear ribosomal DNA. *Saudi J. Biol. Sci.* 2011, 18 (2), 123–127
- Gusti, I.N., Khalimi, K., Dewa, I.N. Ketut., & Dani, S. (2012). Aplikasi Rhizobakteri *Pantoea agglomerans* untuk Meningkatkan Pertumbuhan dan Hasil Tanaman Jagung. (*Zea mays*.L) Varietas hibrida BISI-2. *Agrotrop.* 2 (1):1-9.
- Gupta G, Shailendra Singh Parihar, Narendra Kumar Ahirwar, Sunil Kumar Snehi and Vinod Singh. 2015. Plant Growth Promoting Rhizobacteria (PGPR): Current and Future Prospects for Development of Sustainable Agricultura. *J Microb Biochem Technol* 2015, 7:2 <http://dx.doi.org/10.4172/1948-5948.1000188>
- Gomez, A.K. dan A.A Gomez. 2010. *Prosedur Statistika untuk Penelitian Pertanian Edisi Kedua*. Penerjemah : Endang sjamsuddin dan Justika S. Baharsjah. Universitas Indonesia Press. Jakarta
- Istarofah, Z. Salamah. 2017. Pertumbuhan tanaman sawi hijau (*Brassicae juncea* L.) dengan pemberian kompos berbahan dasar daun paitan (*Thitonia diversifolia*). *J. Biosite.* 3(1):39-46.
- Jiao, X., Takishita, Y., Zhou, G., & Smith, D. L. (2021). Plant Associated Rhizobacteria for Biocontrol and Plant Growth Enhancement. *Frontiers in Plant Science*, 12, 634796. <https://doi.org/10.3389/fpls.2021.634796>.
- Kusuma, M. E. 2013. *Pengaruh Pemberian Bokashi Terhadap Pertumbuhan Vegetatif Dan Produksi Rumput Gajah (Pennisetum purpureum)*. 2(2), 40–45.
- Mafia.R., Alfenas. A., Ferreira. E., Binoti. D., Mafia. G., & Munteer. A.(2009). Root Colonization and Interaction Among *Growth Promoting Rhizobacteria* Isolates and *Eucalypts* Species. 33(1) :1-9

- Marlita dkk. 2022. Pengaruh Dosis Pupuk Bokashi Gulma Air (*Pestia sratitotes*) dan Waktu Pemberian Terhadap Hasil Tanaman Pakcoy (*Brassica rapa L.*). 6, No 1.
- Nandal, M., & Hooda, R. (2013). Plant Growth Promoting Rhizobacteria: a Review Article. *International Journal of Current Research*, 5(12), 3863–3871. <http://www.journalcra.com>
- Nik, N. 2023. Konsentrasi dan Frekuensi Aplikasi *Plant Growth Promoting Rhizobacteria* (PGPR) Terhadap Serangan Hama Pada Tanaman Paria (*Momordica charantia L.*). *Fruitset Sains: Jurnal Pertanian Agroteknologi*. <https://iocscience.org/ejournal/index.php/Fruitset/article/view/4607>.
- Oktafia, T.J., M.D. Maghfoer. 2018. Respon pertumbuhan dan hasil tanaman pakcoy (*Brassica rapa L.*) terhadap aplikasi EM4 dan PGPR. *J. Produksi Tanam*. 6(8):1974– 1981.
- Sahputra 2013. Pupuk Bokashi Jerami Aplikasi dan Manfaatnya . Jakarta, Agromedia Pustaka.
- Siahaan S.A .A. Siregar R. Siahaan M. 2023. Respon Pertumbuhan Dan Produksi Bawang Putih (*Allium sativum L.*) Terhadap Pemberian Jerami Padi I Dan PGPR Media Tanam Agronita . (2) 1..
- Tanaka, H., Kyaw, K. M., Toyota, K., & Motobayashi, T. 2006. Influence of application of rice straw, farmyard manure, and municipal biowastes on nitrogen fixation, soil microbial biomass N, and mineral N in a model paddy microcosm. *Biology and Fertility of Soils*, 42(6).
- Takishita, Y., Smith, D. L., & Smith, D. L. 2021. *Plant Associated Rhizobacteria for Biocontrol and Plant Growth Enhancement*. *March*. <https://doi.org/10.3389/fpls.2021.634796>
- Zhou, D., Huang, X. F., Chaparro, J. M., Badri, D. V., Manter, D. K., Vivanco, J. M., & Guo, J. (2016). Root and bacterial secretions regulate the interaction between plants and PGPR leading to distinct plant growth promotion effects. *Plant and Soil*, 401(1–2), 259–272. <https://doi.org/10.1007/s11104-015-2743-7>
- Zupriadi, R. Chaniago, N., & Ningsih, S.S. 2018. Effect of Organik Granules Cow Manure Fertilizer and Organik Liquid Fertilizer Application Against Growth and Yield of Pakcoy (*Brassica rapa L.*). *Bernas: Jurnal Penelitian Pertanian*, 14 (1).