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Research Article

Application of Cow Manure and Plant Growth Promoting Rhizobacteria on Growth and Production of Mustard (*Brassica juncea* L.)

E.D. Purbajanti, A. Muzakki and S. Budiyanto

Department of Agroecotechnology, Faculty of Animal and Agricultural Sciences, Diponegoro University, Tembalang Campus, Semarang 50275, Indonesia

Abstract

Background and Objective: *Brassica juncea* is a vegetable crop belonging to the genus Brassica and the mustard family Brassicaceae, which is widely consumed in Asian countries. The short harvest period and the wide-open market cause mustard greens to be favoured by farmers for cultivation. The study aimed to determine the effect of cow manure and PGPR doses on the growth and yield of mustard plants. **Materials and Methods:** The experimental design that will be used in this study is a 3×4 factorial experiment with a 2 factorial randomized block design (RBD) with 3 replications to form 36 experimental units. The first factor is the dose of cow manure, 10, 15 and 20 tons ha⁻¹ and the second factor is the dose of PGPR 5, 7.5, 10 and 12.5 mL L⁻¹ given every 2 weeks. Parameters observed included plant height, number of leaves, shoot weight, root weight and shoot-root ratio. **Results:** The results showed that the cow manure and PGPR were significantly different for the leaf number of observations. **Conclusion:** Based on the research that has been done, it can be concluded that the treatment of cow manure and plant growth-promoting rhizobacteria (PGPR) have a significant effect on the number of leaves, but did not have a significant effect on plant height, shoot weight, root weight and shoot-root ratio.

Key words: Mustard, cow manure, rhizobacteria, height, number of leaves, shoot weight, root weight and shoot-root ratio

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Corresponding Author: E.D. Purbajanti, Department of Agroecotechnology, Faculty of Animal and Agricultural Sciences, Diponegoro University, Tembalang Campus, Semarang 50275, Indonesia

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Brassica juncea is a vegetable crop belonging to the genus Brassica and the mustard family Brassicaceae, which is widely consumed in Asian countries¹. The short harvest period and the wide-open market cause mustard greens to be favoured by farmers for cultivation. Mustard greens (*Brassica juncea* L.) can adapt well to hot and cold climates, so they can be cultivated in both highlands and lowlands. Mustard greens (*Brassica juncea* L.) grow well in fertile, loose soil, easily bind water and are rich in organic matter². A good soil acidity for this growth is pH 6-7. One way to get good plant growth is by fertilization. Fertilization is an effort to add nutrients to the soil that can increase the production of soil fertility and the quality of crop yields³.

Plant growth-promoting rhizobacteria (PGPR) are a group of beneficial soil microorganisms that live and develop well in soils rich in organic matter⁴. The main roles of PGPR for plants are biofertilizer (accelerating the growth process by accelerating nutrient absorption), biostimulant (stimulating plant growth through the production of phytohormones) and bioprotectant (protects plants from pathogens)⁵. The way PGPR in increasing plant growth is to produce growth hormone gibberellins and indole 3-acetic acid (IAA). IAA is an auxin growth hormone that functions to increase stem cell growth, inhibits leaf shedding, stimulates fruit formation, stimulates cambium growth and inhibits the growth of axillary shoots⁶. PGPR accelerates the growth of maize plants and increases the maximum plant height, maximum number of branches, maximum number of leaves, wet and dry weight of roots and dry weight of seeds⁷. The mechanism of PGPR in helping to increase plant growth is by fixation of free nitrogen, production of siderophores that chelate iron (Fe) and make it available to plant roots, dissolving minerals such as phosphorus and synthesis of phytohormones such as auxins and suppressing the growth of pathogens⁸.

The purpose of this study was to determine the effect of the dose of cow manure and the dose of PGPR on the growth and yield of mustard plants.

MATERIALS AND METHODS

Study area: This research will be conducted in Kalipucang Kulon Village, Welahan District, Jepara Regency, 2019.

Research material: The tools used in this research are a hoe, sprinkler, seedling place, ruler, stationery, camera, hoe and water pump. The materials used include mustard seeds, PGPR and cow manure.

Research methods: The experimental design that will be used in this study is a 3×4 factorial experiment with a 2 factorial randomized block design (RBD) with 3 replications to form 36 experimental units. The first factor is the dose of cow manure, namely 10, 15 and 20 t ha⁻¹ and the second factor is the dose of PGPR 5, 7.5, 10 and 12.5 mL L⁻¹ given every 2 weeks.

Observation parameter: Parameters observed included (1) Plant height calculated using a ruler (cm), (2) Number of plant leaves (strands), (3) Fresh weight of mustard greens (grams), (4) Wet weight of roots (g) and (5) Crown-root ratio.

RESULTS AND DISCUSSION

Plant height: The results of the analysis of variance showed that the treatment of cow manure and PGPR had no significant effect on plant height. The results of the observation of mustard research parameters and the shoot-root ratio due to various treatments of cow manure and PGPR are shown in Table 1. The range of plant height due to different concentrations of PGPR was 44.38-49.30 cm. While the plant height due to different doses of manure treatment ranged from 44.36-47.39 cm.

The various treatments that have been given do not have a real effect, it could be since the manure has not been fully decomposed so that it cannot be utilized optimally by plants. If manure can be utilized by plants to the maximum, plants will grow better. Manure is a source of soil organic matter. Soil organic matter usually makes up 5% of the total weight of the soil and plays an important role in soil fertility. Fertile soil has a direct effect on plant development and growth⁹. Besides containing macro elements (nitrogen, phosphorus, potassium, calcium, magnesium) manure also contains manganese, copper, barium which can provide elements or nutrients for the benefit of plant growth and development¹⁰.

Some PGPR concentrations applied to mustard plants also did not show a significant difference. According to a study¹¹ added although the concentration of PGPR solution is increased to a certain extent, the difference is not significant. It has good yield potential, wide adaptability and possesses high oil content of good quality. There are eight cultivated crops in rapeseed-mustard crop; the main characteristics features.

A number of leaves: The results of the analysis of variance showed that the treatment of cow manure and PGPR had no significant effect on the number of leaves.

Table 1 shows that the treatment of cow manure and PGPR gave different results. The highest yield was the

Table 1: Observations of mustard research parameters due to various fertilizer treatments cow manure and PGPR

Cow manure (t ha ⁻¹)	PGPR (mL L ⁻¹)	Plant height (cm)	Leaves number	Shoot weight (g)	Root weight (g)	Shoot root ratio
10	5	40.39	15.0 ^d	215.85	12.25	10.80
	7.5	45.56	16.4 ^d	322.29	12.44	8.24
	10	40.81	16.9 ^c	248.58	15.20	12.15
	12.5	50.67	18.2 ^b	400.71	15.34	8.75
15	5	50.85	19.2 ^b	395.93	16.05	8.56
	7.5	44.37	16.8 ^c	378.64	13.21	9.65
	10	44.69	16.3 ^d	280.87	14.43	10.95
	12.5	48.81	16.8 ^c	403.23	14.14	7.98
20	5	42.99	17.1 ^c	307.51	15.09	10.86
	7.5	50.51	21.0 ^a	457.67	16.75	8.71
	10	47.65	17.2 ^c	364.43	17.33	9.03
	12.5	48.41	16.7 ^c	345.62	15.07	8.80
10		44.36	16.6	296.86	13.81	9.99
15		47.18	17.3	364.67	14.46	9.29
20		47.39	18.0	368.81	16.06	9.35
	5	44.74	17.1	306.43	14.46	10.07
	7.5	46.81	18.1	386.20	14.13	8.87
	10	44.38	16.8	297.96	15.65	10.71
	12.5	49.30	17.2	383.19	14.85	8.51
Cow Manure		ns	ns	ns	ns	ns
PGPR		ns	ns	ns	ns	ns
Cow Manure*PGPR		ns	*	ns	ns	ns

combination of the addition of manure as much as 20 t ha⁻¹ with PGPR 7.5 mL L⁻¹ (21.0) which was different from all applied treatments. Hindersah *et al.*¹² state that the speed of nutrient absorption is influenced by the speed of the decomposition process of each type of manure treatment. One of the factors that affect the speed of the decomposition the process is the humidity of the organic matter, the decomposition process can take place in the humidity range of 30-100%.

One of the macro elements needed by plants is the element N which serves to increase leaf growth. This makes the plants have more leaves in number and are wider and greener in color¹³. The increased number of leaves on the mustard plant due to the application of manure will allow an increase in the photosynthetic yield of the plant. The more the number of leaves formed, the more leaf cross-sectional area that can be used as a place for plant photosynthesis. states that plants with larger leaf areas will be more efficient in the process of absorbing sunlight for the photosynthesis process. The results of photosynthesis will directly affect the fresh weight of the mustard plant.

Giving PGPR to mustard plants turned out to give significant results on the number of leaves. This is in line with the results of research conducted¹⁴ plant growth promotions can be achieved indirectly through biocontrol activity against plant pathogens. Several ways of controlling bacterial pathogens have been described in PGPR, antagonism, systemic response induction, interference with a quorum-sensing system and iron competition.

Shoot weight: The results of the analysis of variance showed that the treatment of cow manure and PGPR had no significant effect on the shoot weight. Shoot weight was not significantly affected by the application of cow manure and PGPR. The shoot weight of the canopy ranged from 215.85-457.67 g. The shoot weight is related to the number of leaves on the plant. With relatively the same leaf area and weight, the higher the number of leaves, the higher the shoot weight.

The treatment that modifies the growing environment of mustard greens does not have a real effect, it could be due to the dominant influence of plant genetics. The number of leaves is influenced by genetic and environmental factors, these factors play a role in the speed of plant growth. In addition to being influenced by the growth environment, the number of leaves is also influenced by genetic factors, so that although given different growth environmental treatments, the genetic role appears to be dominant in influencing the number of plant leaves¹⁵.

Root weight: The results of the analysis of variance showed that the treatment of cow manure and PGPR had no significant effect on the root weight. The calculation of the root weight is carried out at harvest by first cleaning the roots from the soil. The root weight was not significantly affected by the application of PGPR and cow manure. The root weight due to treatment ranged from 12.25-17.33 g. The results obtained in this study are not in line with

research conducted by Backer *et al.*⁶ which states that the application of PGPR can increase the wet weight of plants by giving an effect on roots. PGPR inoculation provides enhanced root development, thereby enabling better rates of water and mineral uptake. Root-associated microbial community (the rhizo-microbiome), is the densest and most complex of all associated with higher plants.

The mechanism of PGPR in promoting or enhancing plant growth is not fully understood. This is related to the complexity of the role of PGPR for plant growth and the various physical, chemical and biological conditions in the rhizosphere environment. However, it is believed that the process of promoting plant growth begins with the success of PGPR in colonizing the rhizosphere¹⁶.

Shoot-root ratio: The results of the analysis of variance showed that the treatment of cow manure and PGPR had no significant effect on the shoot-root ratio. Treatment of various doses of cow manure and PGPR did not affect the shoot-root ratio. The shoot-root ratio is the ratio between shoot biomass divided by root biomass. The shoot-root ratio was carried out to determine the level of plant development, both roots and leaves, in the given treatment. The shoot-root ratio is related to the number of leaves, the diameter of the bulb and the length of the root. According to Bláha¹⁷, root crown ratio means the growth of a plant followed by the growth of another part. Another factor that can affect the shoot-root ratio is the influence of location and climatic conditions.

CONCLUSION

Based on the research that has been done, it can be concluded that the treatment of cow manure and plant growth-promoting rhizobacteria (PGPR) have a significant effect on the number of leaves, but did not have a significant effect on plant height, shoot weight, root weight and shoot-root ratio.

SIGNIFICANCE STATEMENT

This study found the highest leaf number (19.2) due to the treatment of 20 tons ha⁻¹ with PGPR 7.5 ml L⁻¹ (21.0) which could be useful for production and this study will help researchers to uncover critical areas of PGPR that cannot be produced. explored by many researchers. Thus a new theory of PGPR can be obtained.

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