# Response of Growth and Yield of Sweet Corn Plants

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*Journal of Agriculture and Ecology Research International*

*Volume 24, Issue 6, Page 47-52, 2023; Article no.JAERI.108084*
*ISSN: 2394-1073*

# Response of Growth and Yield of Sweet Corn Plants in Rainfed Land to Providing Plant Growth Promoting Rhizobacteria Bamboo Roots

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***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

***Article Information***

DOI: 10.9734/JAERI/2023/v24i6560

**Open Peer Review History:**
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/108084

***Original Research Article***

***Received: 14/08/2023***
***Accepted: 19/10/2023***
***Published: 26/10/2023***

## ABSTRACT

Sweet Corn is an important food crop that functions as a source of food, feed, and industrial raw materials. Efforts to increase corn production require technological input to increase yields and be environmentally friendly. One way is by using Plant Growth Promoting Rhizobacteria (PGPR). This research aims to determine the response of growth and yield of sweet corn plants on rainfed land to the application of PGPR bamboo root plants and to determine the appropriate PGPR concentration for the growth and yield of sweet corn plants. This research was carried out from February to June 2020 in Rantau Panjang, Sambaliung District, Berau Regency. East Kalimantan, Indonesia. The research used a Randomized Completely Block Design (RCBD) consisting of 6

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treatments of bamboo root PGPR concentration, namely treatment: p0 = control; p1 = 5.0 ml $l^{-1}$ water; p2 = 7.5 ml $l^{-1}$ water; p3 = 10.0 ml $l^{-1}$ water; p4 = 12.5 ml $l^{-1}$ water; and p5 = 15.0 ml $l^{-1}$ water. Each treatment was repeated 4 times. The results of the research showed that: (1) The responses of cob diameter and cob production were significantly different, while the responses of plant height, number of leaves, age at flowering, cob length, and number of rows of seeds per cob were not significantly different to PGPR treatments; and (2) Giving PGPR with a concentration of 10 ml $l^{-1}$ water (p3) resulted in high cob production, namely 12.80 Mg $ha^{-1}$.

*Keywords: Utilization of bamboo roots as PGPR; sweet corn products; Rainfed Land.*

## 1. INTRODUCTION

Corn (*Zea mays*) is an important food crop because it functions as a source of food, feed, and industrial raw materials. This commodity has a strategic role in the national economy and society which is competitive in the quality of production results cited here.

The demand for corn continues to increase from year to year as a result of the high rate of world population growth citation is needed here. Progress in the food processing industry and the increasing need for raw materials for animal feed, especially poultry, from corn, have also contributed to the increase in national and world consumption of corn. Currently, national corn production is not sufficient for needs, so Indonesia is still importing with a volume of up to 1 million tons per year [1].

East Kalimantan is one of the provinces in Indonesia with a relatively high level of diversity of flora, especially rice and secondary crops, including corn. The Regional Government of Berau Regency has implemented a policy of increasing corn production since 2000.

The rate of productivity of corn commodities in East Kalimantan tends to decline, low corn productivity is mainly caused by: seeds labeled free, fertilization and amelioration not following recommendations, attacks by plant pests, and land management, planting and harvesting not being implemented properly. Rainfed land is a resource that can be managed for the development of sweet corn because most of it has not been utilized optimally [2].

In this modern era, people are aware of the negative impact of the continuous use of chemical fertilizers on the environment. However, in Indonesia, farmers still apply a lot of inorganic fertilizer, excessive and continuous use of inorganic fertilizer has a negative impact, namely it can cause land productivity to decrease [3]. To reduce the use of inorganic fertilizers, you can use organic fertilizers.

Efforts to increase land productivity for cultivating sweet corn require the use of organic fertilizer and plant input technology to obtain optimal and environmentally friendly results. One way is by providing Plant Growth Promoting Rhizobacteria (PGPR). which plays a role in increasing plant resistance from pathogen attacks, increasing soil fertility, and increasing plant yields citation is needed here.

Plant Growth Promoting Rhizobacteria are bacteria that colonize with roots. Can increase plant growth and development thanks to its ability to produce growth regulators and biocatalysts to support the availability of N, P, and K and other important organic acids for plants. PGPR as an environmental conservation agent, maintains root microbial biodiversity to support environmentally friendly agriculture which can increase agricultural yields. This is very important to support sustainable national food security as planned by the government [4]. PGPR is a group of bacteria that are beneficial to plants play an important role in increasing root development and have an impact on plant growth, crop yields, and land fertility [5].

This research aims to evaluate/assess the response of growth and yield of sweet corn plants on rainfed land to the application of PGPR bamboo root plants and to identify/select the appropriate PGPR concentration for the growth and yield of sweet corn plants.

## 2. METHODOLOGY

### 2.1 Time and Place

The research was carried out in the village of Rantau Panjang, Sambaliung District, Berau Regency. East Kalimantan, Indonesia. from February to June 2020.

## 2.2 Materials and Tools

The materials used are: sweet corn seeds, bamboo roots, bran, shrimp paste, sugar, lime, clean water, and compost; and the tools used are a hoe, machete, stake, jerry can/bucket, water sprinkler container, fermentation container, meter, measuring cup, stationery, label paper, camera, ruler and raffia rope.

## 2.3 Experimental Design

The research used a randomized completely block design (RCBD) consisting of 6 treatments of bamboo root PGPR concentration, namely as treatments: p0 = control; p1 = 5.0 ml $l^{-1}$ water; p2 = 7.5 ml $l^{-1}$ water; p3 = 10.0 ml $l^{-1}$ water; p4 = 12.5 ml $l^{-1}$ water; and p5 = 15.0 ml $l^{-1}$ water. Each treatment concentration was repeated 4 times.

## 2.4 Research Procedures

### 2.4.1 PGPR creation

The stages of making a PGPR solution are: (1) the bamboo roots are cleaned and then soaked in water for 3 days, then filtered, the filtered water is used as a source for making PGPR; (2) Ingredients in the form of bran, shrimp paste, sugar, lime, and compost are mixed evenly, add clean water boil for 2 hours, cool, then filter; and (3) The filtered solution is mixed with 1 liter of PGPR starter and then left for 2 weeks in a fermenter, after which the PGPR solution is ready for use.

### 2.4.2 Preparation of PGPR solution treatment concentration and its application

The PGPR concentration for bamboo root cause consists of 6 concentrations, namely without PGPR or control, 5.0; 7.5; 10.0; 12.5; and 15.0 ml $l^{-1}$ water. Application of PGPR bamboo root crop was carried out: (1) sprinkled on the research plot 3 days before planting; (2) when the seeds are soaked in the PGPR solution for 3 hours, and (3) the PGPR solution is sprinkled evenly around the plants at 7, 14, 21, and 28 days after planting.

### 2.4.3 Land preparation

The land was cleared of weeds, and then the land was cultivated and loosened using a hoe, the research location was divided into 4 blocks, and in each block, a research plot was made measuring 1.5 m x 1.5 m with a distance of 0.5 m between plots. Next, a treatment label was attached to each research plot according to the results of simple random sampling.

### 2.4.4 Seed preparation

The seeds are soaked in the bamboo root PGPR solution for 3 hours, then drained and the seeds are ready to be planted.

### 2.4.5 Seed planting

The seeds have been soaked in the PGPR solution for 3 hours, then drained and the seeds are ready to be planted. The seeds are planted in planting holes made with a drill with a planting distance of 50 cm x 40 cm. Each hole is planted with 2 seeds and then covered again with soil.

### 2.4.6 Maintenance

Maintenance includes watering, replanting, and controlling weeds, pests, and diseases.

### 2.4.7 Harvest

Harvesting is done when the sweet corn hairs have started to dry and turn brown.

## 2.5 Plant Samples and Observation Parameters

In each research plot, there were 12 plants and 4 plants were selected as samples which were determined using simple random sampling. Data collected were: plant height aged 4, 8, and 11 weeks after planting, number of leaves aged 4, 8, and 11 weeks after planting, age of the plant at flowering, cob length, cob diameter, number of rows of seeds in the cob, and yield of cob.

## 2.6 Data Analysis

Data analysis uses variance and if the variance results are significantly different, a further test is carried out with Duncan's multiple range test (DMRT) at the 5% level. Data analysis using SPSS software.

# 3. RESULTS AND DISCUSSION

## 3.1 Plant Height and Number of Leaves

The results of research on plant height and number of leaves at 4, 8, and 11 weeks after planting at various concentrations of PGPR solution are presented in Table 1.

**Table 1. Plant height and number of leaves in various pgpr solution concentration treatments**

| Treatments | Plant Height (cm) | | | Number of Leaves (sheet) | | |
|---|---|---|---|---|---|---|
| | 4 WAP | 8 WAP | 11 WAP | 4 WAP | 8 WAP | 11 WAP |
| Control (p0) | 28,54 | 96,00 | 156,00 | 6,13 | 7,38 | 7,88 |
| 5,0 ml $l^{-1}$ water (p1) | 33,50 | 113,31 | 166,28 | 6,50 | 8,50 | 8,50 |
| 7,5 ml $l^{-1}$ water (p2) | 30,44 | 103,00 | 160,50 | 6,00 | 7,625 | 8,25 |
| 10,0 ml $l^{-1}$ water (p3) | 28,81 | 97,79 | 161,06 | 6,38 | 7,75 | 8,25 |
| 12,5 ml $l^{-1}$ water (p4) | 23,56 | 82,19 | 142,56 | 5,50 | 6,88 | 7,75 |
| 15,0 ml $l^{-1}$ water (p5) | 26,19 | 94,25 | 148,20 | 5,25 | 7,75 | 7,75 |

*Note: The results of the variances were not significant, so no further tests were carried out with DMRT at the 5% level. WAP = Weeks after Planting*

Based on Table 1 above, it shows that the response to growth in plant height and number of sweet corn leaves at 4, 8, and 11 weeks after planting was not significantly different from PGPR administration. According to [6]; and [7] increased plant growth by PGPR can occur through one or more mechanisms related to its functional characteristics and rhizosphere environmental conditions.

Based on research data, shows that giving increasing concentrations of PGPR to bamboo roots tends to inhibit the growth of plant height and number of leaves, especially at concentrations > 7.5 ml $l^{-1}$ water. The best growth in plant height and number of leaves was produced in the treatment of 5.0 ml $l^{-1}$ water (p1). This is because the p1 treatment has the availability of organic fertilizer as a supplier of nutrients originating from the treatment of providing homogeneous fertilizer and the availability of biological fertilizer as a supplier of sufficient microorganisms so that the two support each other. As stated by [8] PGPR is a bacteria that colonizes with roots and can provide benefits to support immunity, growth, and development of plants thanks to its ability to produce growth regulators (ZPT), biocatalysts to support the availability of Nitrogen, Phosphorus, Potassium and acid other important organic acids for plants. As an environmental conservation agent, maintaining root microbial biodiversity to support environmentally friendly agriculture can increase agricultural yields. This is very important to support sustainable national food security as planned by the government. As stated by [9] the principle of giving PGPR is to increase the number of active bacteria around plant roots so that it provides benefits for plants, the advantages of using PGPR are increasing mineral and nitrogen levels, providing plant tolerance to environmental stress, as a biofertilizer, biological control agent, protecting plants from plant pathogens.

### 3.2 Flowering Age and Yield of Cob

The results of research on age at flowering, length, and diameter of cobs, number of rows of seeds per cob, and yield of sweet corn cobs in various PGPR solution concentration treatments are presented in Table 2.

The parameters of plant age at flowering showed no significant difference in response to PGPR administration. The research results in Table 2 show that plant age at flowering ranged from 49.25 to 50.00 days after planting. This is

**Table 2. Age at flowering, length and diameter of cobs, number of rows of seeds per cob and cob yield in various PGPR solution concentration treatments**

| Perlakuan | Flowering Age (DAP) | Cob Lenght (cm) | Cob Diameter* (cm) | Number of Rows of Seeds | Yied of Cob* (Mg $ha^{-1}$) |
|---|---|---|---|---|---|
| Control (p0) | 50,00 | 17,25 | 15,34 b | 13,13 | 10,53 c |
| 5,0 ml $l^{-1}$ water (p1) | 50,00 | 19,25 | 16,04 b | 13,75 | 10,90 c |
| 7,5 ml $l^{-1}$ water (p2) | 49,25 | 18,98 | 15,63 b | 13,38 | 10,58 c |
| 10,0 ml $l^{-1}$ water (p3) | 50,00 | 18,31 | 15,31 b | 14,00 | 12,80 c |
| 12,5 ml $l^{-1}$ water (p4) | 50,00 | 13,93 | 13,56 a | 13,00 | 4,30 a |
| 15,0 ml $l^{-1}$ water (p5) | 50,00 | 16,01 | 15,13 b | 13,50 | 7,58 b |

*Note: * = test results are significantly different; the average number followed by the same lowercase letter is not significantly different based on the DMRT results at the 5% level; and DAP = days t planting* because the age of a plant when it flowers is influenced by environmental factors (external factors) and the genetic factors of the plant itself (internal factors). The results of this research are not different from the description of sweet corn varieties, namely the age at flowering is between 50 - 54 days after planting. As stated by [10] the transition from the vegetative period to the generative period (marked by the appearance of flowers) is partly determined by the genotype or internal factors and partly determined by external factors such as temperature, light, water, and nutrients. and others.

The parameters of cob length and number of rows of seeds per ear gave a non-significantly different response, while diameter gave a real response to PGPR treatment. The research results presented in Table 2 show that in general PGPR with a concentration of between 5.0 - 10.0 ml $l^{-1}$ water produces better cob components compared to other treatments. Giving PGPR with a concentration of 5 ml $l^{-1}$ water (p1) for the longest cob (19.25 cm) and the largest diameter (16.04 cm), while the shortest cob (13.93 cm), the smallest cob diameter (13.56 cm) and the smallest number of rows of seeds per cob (13.00 rows) were produced in the treatment of 12.50 ml $l^{-1}$ water (p4). This is explained by [11] that the function of PGPR in increasing plant growth is: (a) as a growth promoter/stimulant (biostimulant) by synthesizing and regulating various growth regulatory substances (phytohormones) such as indolic acetic acid (AIA), gibberellins and cytokinin in the root environment, (b) as a nutrient provider by fixing $N_2$ from the air symbiotically and dissolving P nutrients bound in the soil and as a nutrient provider, fixing $N_2$ and growth stimulant which is an inseparable whole.

In terms of cob production parameters, the results of the study showed that administration of PGPR with a concentration of between 5.0 – 10.0 ml $l^{-1}$ of water resulted in cob production of between 10.58 – 12.80 Mg $ha^{-1}$ which was higher compared to the control and other treatment concentrations. The highest cob production (12.80 Mg $ha^{-1}$) was produced in the 10.0 ml $l^{-1}$ water (p3) treatment, but this result was not significantly different compared to cob production in the 5 ml $l^{-1}$ water (p1) and 7,50 ml $l^{-1}$ water (p2) treatments which gave 10.90 Mg $ha^{-1}$ and 10.58 Mg $ha^{-1}$ respectively. The results of this study are in line with the results of the research reported by [12] that the treatment of PGPR with a concentration of 10 and 20 ml $l^{-1}$ water combined with the application of manure resulted in better cob length, cob diameter, and cob production compared to treatment without PGPR. The results of another study reported by [13] showed that the yield of sweet corn cobs increased with increasing PGPR concentration given 10 - 30 ml $l^{-1}$ of water, namely between 20.0067 - 21.0733 Mg $ha^{-1}$, while the treatment without PGPR is only 17.6333 Mg $ha^{-1}$. This situation is explained by [14] that PGPR are bacteria around the roots and live in colonies covering the roots which function to increase plant growth, namely as stimulating growth (biostimulants) by synthesizing and regulating the concentration of various growth regulators. such as gibberellins, indole acetic acid, ethylene, and cytokinin, as nutrient providers by binding $N_2$ in the air symbiotically and playing a role in increasing cob yields, and control of soil pathogens (bioprotectants) by producing various anti-pathogenic metabolites such as siderophore, chitinase, β1,3-glucanase, cyanide, and antibiotics. Furthermore, it was stated by [15] that the use of PGPR can be beneficial for soil fertility because the bacteria contained in PGPR can activate microorganisms in the soil which causes organic matter to decompose due to the activity of decomposing microorganisms. Bacteria decompose organic materials that are difficult for plants to absorb into inorganic materials that are easily absorbed by plants. The presence of these microorganisms will affect the level of soil fertility because microorganisms play an important role in the weathering process of organic material so that nutrients are available to plants.

The research results also showed that administering PGPR with a concentration of > 10 ml $l^{-1}$ water tended to reduce the yield of sweet corn plants (length and diameter of cobs, number of rows of seeds per cob, and cob production). This is because if the concentration given exceeds the maximum capacity it will hurt the plants, and vice versa if the concentration given is insufficient it can hurt plant growth and yield.

## 4. CONCLUSIONS AND RECOMMENDATIONS

### 4.1 Conclusion

Based on the results of the research and discussion, it can be concluded as follows:

1. The responses of cob diameter and yield of cob were significantly different, while the responses of plant height, number of leaves, age at flowering, cob length, and

number of seed rows per cob were not significantly different from PGPR treatments.

2. Giving PGPR with a concentration of 10 ml $l^{-1}$ water (p3) resulted in high cob production, namely 12.80 Mg $ha^{-1}$.

### 4.2 Suggestions

It is recommended to use a concentration of PGPR bamboo roots with a concentration of 10 ml $l^{-1}$ water.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

## REFERENCES

1. Anjar Wanto. Prediction of Corn Productivity in Indonesia as an Effort to Anticipate Imports Using Backpropagation Neural Networks. SINTECH (Science and Information Technology) Journal. 2019; 2(1):53-62. Available:https://www.researchgate.net/publication/332965199
2. Bahrum S. Sweet Corn Paper. Lancang Kuning University; 2018.
3. Soekamto MH, Fahrizal A. Efforts to Increase Soil Fertility on Dry Land in Aimas Village, Aimas District, Sorong Regency. Abdimas: Papua Journal of Community Service. 2019;1(2):14.
4. Arfandi. The Effect of Several Plant Growth Promoting Rhizobacteria (PGPR) on the Growth and Production of Soybean Plants (*Glycine max* L. Merrill). Maros Muslim University; 2018.
5. Widyaningrum A. The Effect of the Application of PGPR (Plant Growth Promoting Rhizobacteria) and Azolla Compost on the Quality of Seeds from Robusta Coffee Cuttings. University of Jember; 2017.
6. Acne P. Effect of giving plant growth promoting rhizobacteria on the growth and yield of lettuce plants (*Lactuca sativa* L.) Muhammadiyah University of West Sumatera, Payakambuh; 2014.
7. Salamiah WR. Utilization of Plant Growth Promoting Rhizobacteria (PGPR) in Controlling Tungro Disease in Local Rice in South Kalimantan; 2014.
8. Nurasiah D. Interaction of Antagonistic Bacteria with Food Plants. Cereal Research Institute; 2016.
9. Widodo. Utilization of Plant Growth Promoting Rhizobacter (PGPR) in controlling Tungro Disease in Local Rice. South Kalimantan; 2016.
10. Darjanto, Satifah S. Bungaa Biology and Artificial Cross Crossing Techniques. Gramedia, Jakarta; 2002.
11. Fitri R. Isolation and Characterization of Plant Growth Promoting Rhizobacteria (PGPR) from the Rhizosphere of Durian Plants (*Durio zibethinus* Murr.) Doctoral Dissertation, Sultan Syarif Kasim State Islamic University, Riau; 2018.
12. Sari RP. Effect of Plant Growth Promoting Rhizobacteria (PGPR) and Cow Manure on the Growth and Yield of Sweet Corn (*Zea mays* saccharata Sturt). Bachelor's Thesis in Agriculture, Brawijaya University, Malang; 2018.
13. Ningrum WA, Wicaksono KP, Tyasmoro SY. The Effect of Plant Growth Promoting Rhizobacteria (PGPR) and Rabbit Manure on the Growth and Production of Sweet Corn (*Zea mays* saccharata). Journal of Crop Production. 2017;5(3):433-440.
14. Marom N, Rizal FNU, Bintoro M. Effectiveness Test when Application and Concentrating PGPR (Plant Growth Promoting Rhizobacteria) on the Production and Quality of Peanut (*Arachis hypogaea* L.) Seeds. Agriprima, Journal of Applied Agricultural Sciences. 2017;1(2): 174-184.
15. Husnihuda MI, Sarwitri R, Susilowati YE. Growth and Yield Response of Flowering Cabbage (*Brassica oleracea* var. Botrytis L.) to the Application of Bamboo Root PGPR and Planting Media Composition. Journal of Tropical and Subtropical Agricultural Sciences. 2017;2(1):13-16.



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