Rhizobacteria response to the yield of corn variety (*Zea mays* L.) in Sleman Regency, Yogyakarta, Indonesia

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Abstract. Corn is a type of plant that contains high carbohydrate. It can grow in dry season. Current climate change causes disadvantages in climatic condition such as short rainy season and long dry season. The purpose of this research is to study the effect of rhizobacteria to the yield of several corn varieties. The research was conducted in Kalasan, Sleman, Yogyakarta, Indonesia. The research used a Split Plot Design. The first factor as main factor showed a high variety of corn yield, namely Hybrid 1, Hybrid 2, Hybrid 3, and Hybrid 4. The second factor as sub-factor was rhizobacteria level (0% and 15%). The data was analyzed using Analysis of Variance. Based on the research results, there was a long dry season and short rainy season which were caused by climate change. Corn variety did not affect growth rate, yield and yield index for it’s resistant to climate change. Rhizobacteria increases the growth rate and tolerance index and making yield index to be higher than non-rhizobacteria which can help corn to survive in climate change.

1. Introduction
Corn is a food substitute for rice that is consumed by the community. Corn can also be used for animal feed having a dominant composition. [1] Corn component in animal feed industry reaches 51.4%. In 2015 and 2016 there was a surplus. In 2016, corn production was estimated to have a surplus of 2.48 million tons. In 2017, the surplus of corn production dropped to 1.90 million tons. In 2018, it decreased to 1.16 million tons. In 2019, corn production surplus was roughly 308 thousand tons [1].

In Indonesia, corn is cultivated in a diverse environment with a total area of about 3.3 million ha per year, 80% of which are planted with superior varieties consisting of composite corn and hybrid corn. It has an impact on increasing production and added value of corn farming, because corn fields in Indonesia are very diverse in their agro-climate properties, respectively requires a suitable variety [2].

Agricultural Research Agency and seed company have released hybrid corn varieties with a potential yield of 9.0-10.0 tons ha\(^{-1}\). The Cereals Research Institute (Balitsereal) in early 2007 released 2 varieties of single cross-hybrid corn, namely *Bima-2 Bantimurung* and *Bima-3 Bantimurung* which have the potential of 11 tons ha\(^{-1}\) and 10 tons ha\(^{-1}\) of dry seed, tolerant of downy mildew that can adapt to optimal and sub-optimal land [3].

Both composite and hybrid corn variety can increase productivity. The use of chemicals (fertilizers and pesticides) has to be minimized for it damages the soil. Land degradation problem can be addressed by the use of Plant Growth Promoting Rhizobacteria (PGPR) and by adding organic matter. PGPR actively colonizes plant roots as bio-fertilizer, bio-stimulant and bio-protectant [4]. In fact, organic
matter is necessary for it provides nutrients for plants and encourages a balanced environment for bacteria. The function of Plant Growth Promoting Regulator (PGPR) is divided into three categories, namely first as growth stimulants (bio-stimulant) such as indole acetic acid (IAA), gibberellins, cytokinin, and ethylene in the root environment. Second, PGPR as a provider of nutrients (biofertilizers) by N₂ fixation from the air by a symbiosis and dissolving P nutrients that are bound in the soil. PGPR as a pathogen control comes from the soil (bio-protectants) by producing various anti-pathogenic compounds or metabolites such as siderophore, β-1,3-glucanase, chitinase, antibiotics, and cyanide [5].

The research was carried out in Sleman regency, Yogyakarta, Indonesia during long dry season due to climate change. Rhizobacteria treatment can help plant to survive and grow. Some rhizobacteria produces IAA hormone. Plant growth inoculated by *Azotobacter* sp and *Azospirillum* sp to fix the N₂ nitrogen. In addition, there is also IAA hormone produced by bacteria [6]. Halmedan et al. [7] stated that PGPR concentration of 3% significantly affected plant height, leaf area, root weight, and weight of cob on sweet corn. Miryani [8] conducted the same research on sweet corn and the results showed significant differences in the combination of 2% PGPR concentration and 20 ton ha⁻¹ of cow manure increased plant height, leaf area, dry weight, fresh weight of cob, ear length, content sugar, cob yields per ha. Then, it was compared for control. So the purpose of this research is to study the effect of rhizobacteria to the yield of selected corn varieties.

### 2. Materials and method

The research was carried out in Bugisn Village, Prambanan, Sleman, Yogyakarta, Indonesia. The altitude reaches ± 150 m above sea level with an average rainfall per year from 1400 to 1900 mm; soil pH from 5.6 to 6.0; air humidity from 50 to 70%; light intensity 12 hours and average temperature - average 24–32 °C. The type of soil is vertisol soil.

This research was conducted using a Split plot. The main plot is corn variety. It is Hybrid 1, Hybrid 2, Hybrid 3, and Hybrid 4. Sub-plot is *Rhizobacteria* with a concentration of 0% and 30%. Growth variables including plant height, number of leaves, leaves fresh weight and corn dry weight. Yield variables include dry seed weight per hectare.

### 3. Results and discussion

#### Table 1. Plant dry weight, fresh cob weight, yield per hectare

| Treatment       | Variable | Plant dry weight (g) | Yield (ton ha⁻¹) |
|-----------------|----------|---------------------|-----------------|
| Variety         |          |                     |                 |
| Hybrid 1        |          | 7.52 a               | 9.64 a          |
| Hybrid 2        |          | 7.64 a               | 10.54 a         |
| Hybrid 3        |          | 7.29 a               | 9.84 a          |
| Hybrid 4        |          | 7.38 a               | 10.77 a         |
| Rhizobacteria   |          | 6.97 p               | 10.81 p         |
| 0%              |          | 7.95 p               | 11.56 p         |
| 30%             |          |                     |                 |

Mean followed by the same letters is non significantly different at α = 5%.

The hybrid corn variety does not affect the growth and yield (Table 1). Hybrid 4 variety gave sum growth rate (figure 2) and yield index higher (figure 3) than hybrid 1, hybrid 2 and hybrid 3 variety. Maryani [5] states that one of genetic characteristic was variety. High variety produces high yield and is resistance to *Bulai* pathogen. *Bulai* pathogen is the disease *Peronosclerospora maydis* which caused by fungi. It is the pathogen that attacks corn root and killing it. This pathogen grows and develop very
fast when air temperature and humidity increase due to climate change. So, hybrid corn was suitable for climate change and has a wide tolerance range. Daryono [9] claimed that high variety corn is resistance to Bulai pathogen.

Figure 1. Sum growth rate of corn variety

![Figure 1](image1.png)

Figure 2. Sum growth rate of rhizobacteria treatment

![Figure 2](image2.png)

Figure 3. Yield index of corn variety

![Figure 3](image3.png)

Figure 4. Yield index of corn rhizobacteria treatment

![Figure 4](image4.png)

Figure 5. Tolerance index of corn rhizobacteria treatment

![Figure 5](image5.png)

Rhizobacteria treatment does not affect growth and corn yield (table 1) for it enhances the growth rate (figure 2), tolerance index (figure 5), corn yield index (figure 4) and increases corn growth rate higher than non-rhizobacteria. Rhizobacteria *Pseudomonas fluorescens, Bacillus polymixa* produce indole acetic acid. Indole acetic acid is plant growth promoting regulator that effects cell wall width, cell extension and cell division stimulating plant growth. Based on Maryani [5] and Ratna [10] findings, indole acetic acid stimulates enzyme activity to degrade cell wall. Marom [11] found out about enzyme
such as cellulose, chitinase, protease. According to Nasib [12] *Bacillus Sp, Serratia sp*, dan *Pseudomonas fluorenscens* can produce indole acetic acid. Kumar [13] asserts that *Pseudomonas sp* produces Plant Growth Promoting Regulator such as IAA 44.40 – 95.60 µg/ml.

4. Conclusion
Based on the result of the research in Yogyakarta, Indonesia undertaken during long dry season and short rainy season as caused by climate change, corn high variety did not affect growth rate, yield and corn yield index for it is suitable to plant despite of climate change. Rhizobacteria increases growth rate and tolerance index and gave corn yield index to be higher than non-rhizobacteri which can help corn to survive in climate change.

References
[1] Chafid M, Nuryati, Waryanto, Noviati, and Widaningsih 2015 *Outlook Agriculture comudity corn* (Jakarta: Centre for Agricultural Data and Information System Ministry of Agriculture)
[2] Made J M, Azral M, and Iriany R N 2007 *High Variety corn Synthesis that is free stament* (Maros: Cereals Plant Research Institute)
[3] Takdir M A, Sri, and Made J M 2007 *Hybrid corn variety synthesis* (Maros: Cereals Plant Research Intitute)
[4] Maryani Y, Sudadi, Dewi W S, and Yunus A 2018 Study on osmoprotectant rhizobacteria to improve mung bean growth under drought stress. *IOP Conf. Series: Earth and Environmental Science* 129 012014
[5] Maryani Y, Sudadi, Dewi W S, and Yunus A 2019 Isolation and screening of calcareous and non calcareous soil rhizobacteria producing osmoprotactant and indol acetic acid in Gunung Kidul, Yogyakarta, Indonesia *Bulgarian Journal of Agricultural Science* 25 36-41
[6] Maryani Y, Sudadi, Dewi W S, and YunusA 2018 Study on rhizobium in interaction with osmoprotectant rhizobacteria tor improving mung bean yield *IOP Conf. Series: Earth and Environmental Science* 129 012011
[7] Halmadan J, Yogi S, and Sudiarso 2017 *Response of sweet corn (Zea mays saccharata) to Plant Growth Promoting Rhizobacteria (PGPR) and manure chicken* (Malang: Brawijaya University)
[8] Maryani Y 2018 Study bamboo root rhizobacteria to growth red onion (*Allium ascalonicum* L.) variety *Agrivet* 25 28-33
[9] Daryono B D, Purnomo, and Aniza P 2018 Resistance test seven corn cultivar (*Zea mays* L.) to *Bulai* pathogen (*Peronosclerospora sp.*) *Biogenesis* 6 11-17
[10] Ratna F and Savitri 2018 *The effect PGPR and sheep urine to growth and yield sweet corn (Zea mays saccharata Strut.)* (Malang: Brawijaya University)
[11] Marom N, Rizal and Bintoro M 2017 Test effectiveness time application and concentration PGPR (Plant Growth Promoting Rhizobacteria) to produce and quality peanut seed (*Arachis hypogaea* L.) *Agriprima* 1 191–202
[12] Nasib S B, Ketty S and Winarno D W 2016 The effect of Plant Growth Promoting Rhizobacteria to initial growth papaya *Bul. Agrohorti* 4 63–69
[13] Kumar A, Prasad S, and Kumar S 2014 Screening of free living rhizobacteria associated with wheat rhizosphere for plant growth promoting traits *African Journal of Agriculture Research* 9 1094–1100.

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