The effect of rhizobacteria on a local and composite variety of maize (Zea mays L.) growth in rainy

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Abstract. Maize is the source to have high carbohydrate and grow well in the dry season. Furthermore, climate change causes as long rainy seasons in some areas which are hampering maize growth. The research study the effects of rhizobacteria on local and composite variety growth. The research was did in Prambanan, Sleman, Yogyakarta, Indonesia. It was done by a split-plot design. The first factor was variety maize. The variety maize is local, composite, and hybrid 3 as control. The second factor was rhizobacteria. The rhizobacteria include the concentration of 0% and 20%. The results show that rhizobacteria give a total growth rate more than non-rhizobacteria treatment on maize. The rhizobacteria treatment gives the highest tolerance index. Hybrid 3 and composite variety (Bisma) are suitable variety rainy season

I. Introduction
Maize (Zea mays L.) is a strategic food ingredient and has economic value. The demand for maize continues to increase from year to year in line with the increase in population and the development of the food and feed industry. In Indonesia, maize is used as a food and feed ingredient. Maize is one of the main food commodities after rice, maize is a strategic commodity in agricultural development and a driving force for the national economy.

With the government policy to encourage domestic maize production, the value of maize imports has subsequently decreased significantly, especially since the special effort program for maize was launched [1]. Domestic demand for maize is stochastic and the amount fluctuates following fluctuations in the demand for broiler and layer animal feed industry.

Maize is a crop that is grown in the dry season and cannot withstand rain. In the rainy season, maize plants are often attacked by downy mildew. Downy mildew is a primary disease of maize [2]. It was caused by a fungus Peronoscleropora sp. [3]. It is attacks the leaves of maize plants and starts from the conidia falling and growing on the surface of the maize leaves and developing to form appressoria and then entering the young plant tissue through the stomata [4]. Maize plants attacked by downy mildew disease quickly spread to other crops and quickly cause the maize plant to die.

Filled land is usually planted with rice in the rainy season in the dry season with maize planting, or following a rice-rice-maize cropping pattern. Seasonal changes cause difficulties in determining cropping patterns, especially in rainfed land. If there is a change in the season, namely the longer rainy season, it caused humidity and air temperature greatly affect the development of Peronosclerospora sp. especially in humidity above 80% and temperature of 28-30°C and the presence of dew [5]. It will cause difficulties in planting maize, especially susceptible to disease maize variety (composite and local variety).
Composite and local maize is not the result of a cross, so the resulting seeds can be used as seeds. Local and composite maize weakness is not resistance to rain which causes downy mildew disease. Therefore, efforts are needed to support the resistance of maize plants to environmental stresses, including downy mildew due to seasonal changes.

One of the ways to increase the production of maize is with environmentally friendly fertilizers such as biological fertilizers. Biofertilizers with various processes that support each other in fertilizing the soil and at the same time conserving and nourishing the soil ecosystem and avoiding the possibility of environmental pollution [6]. Plant growth-promoting rhizobacteria which are more popularly called Plant Growth Promoting Rhizobacter (PGPR) are a group of beneficial bacteria that actively colonize the rhizosphere. PGPR plays an important role in increasing plant growth, crop yields, and land fertility [7].

2. Material and method
The research was conducted November 2019 - February 2020 in Sumberharjo Village, Prambanan, Sleman, Yogyakarta, Indonesia. The altitude of ± 150 m above sea level, soil pH 5.6 to 6.0, air humidity 50 to 70%, light intensity 12 hours, rainfall per month during the study between 400-550 mm, and an average temperature of 24-32°C. The type of soil is vertisol.

The research was conducted using a slit plot. The main plot is a variety of maize consisting of Bisma variety, and Kretek variety, and the hybrid 3 variety as a comparison. Subplots were rhizobacteria Pseudomonas fluorescens and Bacillus polymixa which consisted of three levels including concentrations of 0%, 10%, and 20%. The observation variables included: plant height, number of leaves per plant, ear length, ear diameter, plant fresh weight, plant dry weight, seed fresh weight per plant, dry shelled seed weight per plant, and yield per hectare. The data were used to calculate sgr, harvest index, and tolerance index. Yield data per hectare were analyzed using analysis of variance or ANOVA at 5% level then continued with Duncan's multiple range test (DMRT) at the level of α 5%.

3. Result and discussion

![Index tolerance to Rhizobacteria](image-url)
Rhizobacteria treatment gives a tolerance index of more than non rhizobacteria (Figure 1), meaning that giving rhizobacteria can increase maize plant resistance to environmental conditions. Rhizobacteria treatment with concentrations of 0%, 10%, and 20% gave a difference in Sum Growth Rate below 10% so that the treatment of rhizobacteria did not affect the growth of maize (Figure 3). Treatment of maize varieties gave a difference in Sum Growth Rate of more than 10% so that the treatment of maize varieties affected the growth of maize plants. Hybrid maize 3 gave the highest Sum Growth Rate, then followed by Bisma variety and Kretek variety gave the lowest Sum Growth Rate (Figure 2).

Rhizobacteria treatment with a concentration of 10% gave the highest harvest index, then followed by a concentration of 0%, 20% (Figure 5). Bisma's maize variety gave the highest yield index, followed by hybrid variety 3, kretek variety (Figure 4).

Rhizobacteria treatment concentrations of 0%, 10%, and 20% showed no effect on maize yield per hectare (Figure 6). Local kretek variety gave a lower yield of maize per hectare than composite Bisma variety. The composite Bisma variety gave the same yield hybrid variety 3 (Figure 7).

Rhizobacteria increase resistance to environmental changes in both biotic and abiotic environments. Maize plants could not withstand the rain that occurred during the study and triggered downy mildew attacks which caused the plant roots to clot, causing death. The increase in the ability of the maize plant to the environment is supported by the growth and yield of the maize plant. The growth of maize plants in rhizobacteria treatment gave a higher sum growth rate (SGR) than those without rhizobacteria.
The yield of maize per hectare of rhizobacteria treatment also showed higher than without rhizobacteria. *Pseudomonas fluorescens* and *Bacillus polymixa* produce IAA which stimulates plant growth. IAA is a growth hormone that activates enzymes that stimulate cell enlargement and further stimulate cell division. Cell extension and division are basic principles in plant growth [8]. This is in accordance with [9] which states that rhizobacteria can improve the quality of plant growth through the production of growth hormones. IAA stimulates enzyme activity to degrade cell walls [10]. It is an enzyme such as cellulose, chitinase, protease [11]. This statement is supported by Maryani [12] which explains that rhizobacteria are capable of producing hormones such as auxins, gibberellins, and cytokinins, as phosphate solvents and nitrogen fixers. *Bacillus* sp. and *Pseudomonas fluorescens* can produce IAA [13]. *Pseudomonas* sp produces such as IAA 44.40 – 95.60 µg/ml [14].

Hybrid maize 3 gave the highest Sum Growth Rate, then followed by Bisma variety and Kretek variety gave the lowest Sum Growth Rate (Figure 2). This condition was supported by the composite Bisma variety and hybrid variety 3 which gave no significant difference and was higher than the local kretek variety (Figure 7). Hybrid varieties of maize are superior maize varieties resulting from crosses. This variety has the advantage of high yield and resistance to downy mildew [15]. The weakness of hybrid maize is that the seed yields cannot be used for seeds, the seeds must be purchased and it is difficult for farmers. Bisma varieties are composite maize, not crosses, and also have resistance to downy mildew [7]. Kretek varieties are local varieties, not crosses [6]. Local kretek variety can survive the attack of downy mildew disease, although the yield is lower than the hybrid and Bisma varieties. The low yield of local variety kretek is a genetic trait. The advantages of composted and local maize that the seed yields can be used for seed and practical.

Downy mildew in maize is a fungus that attacks and grows rapidly when exposed to rain. The weaknesses of composite and local varieties are not all resistant to downy mildew, so it is necessary to test the varieties against downy mildew. Downy mildew is a fungus that attacks the roots of maize plants and causes the roots of the plants to clot so that the roots are unable to carry out the function of absorbing soil solutions including water, so the plant dies. This fungus thrives on the roots of maize plants when exposed to rain.

4. Conclusion

Based on climate change, rhizobacteria gives the total growth rate on maize more than non-rhizobacteria. The rhizobacteria give the highest tolerance index. Hybrid 3 and composite variety (Bisma) are suitable for a variety of the rainy season.

Acknowledgment

The authors are indebted to the ministry of Sarjanawiyata Tamansiswa University, Yogyakarta, Indonesia.
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