The effect of biofertilizer and double row 2:1 planting system on hybrid corn growth and yield on dry land acid soils in Lampung

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Abstract. One of the functions of biofertilizers containing live microbes is that they can stimulate plant growth. The study aims to determine the growth and production of hybrid corn plants with the application of biofertilizers and “jajar legowo” planting systems. The study was conducted at Natar Experimental Station, South Lampung Regency in February 2017 until June 2017. The study used a Randomized Block Design (RBD) of 5 Bio-Triba biofertilizers with treatments; B0 (manure/control), BT-1 (25 ml/l), BT-2 (10 ml/l), BT-3 (15 ml/l), and BT-5 (20 ml/l). The spacing between corn rows used by “Jajar Legowo” 2:1 is 20 cm x 50 cm - 100 cm with 1 seed per hole, 5 replications (25 trial plots), and the population was 66,000 plants/ha. The dose of chemical fertilizer used was Urea 350 kg/ha, SP-36 200 kg/ha and KCl 100 kg/ha and 1 ton of rock phosphate. The results showed that the application of biofertilizer had a significant effect on the components of yield (weight of dry seeds and weight of 100 corn grains) but did not significantly affect growth components (plant height, number of leaves) compared to non-biological fertilizer, using cow manure.

1. Introduction
The extension of the planting area is one of the efforts to increase national corn production, especially by utilizing dry land that is still widely available. Lampung is one of the highest corn-producing provinces. Corn production in Lampung over the past five years has continued to increase. In 2013, corn production was 1,760,278 tons and in 2017 was 2,518,895 tons [1]. The use of chemical fertilizers is thought to be less effective and efficient and has an adverse impact on soil conditions. In view of this, it is increasingly recognized the importance of using organic matter and biological fertilizers in soil nutrient management [2].

Excessive and continuous application of chemical fertilizers can have a negative impact on soil and environmental conditions [3], thus it causes low plant growth. Therefore, efforts need to be made to utilize and manage organic materials to improve soil health, including using biofertilizers. Ultisol soil has a very low content of organic matter which shows the color of the soil is yellowish red, acidic soil reaction, low base saturation, high Al content, and low productivity level [4].

Ultisol soil is generally sensitive to erosion and has an aerated pore and a low stability index so that the soil easily becomes dense. As a result, the growth of plant roots is hampered because the penetrating potential of the roots into the soil is reduced. The acidic dry land in Indonesia has great potential for agriculture, but its productivity is low. This is caused by several factors, including the
presence of toxic Al, Fe and Mn elements and nutrient deficiencies of N, P, Ca and Mg [5]; [6]. In addition, acidic dry land is also microbial poor, with populations ranging only from 57 x 103 - 29 x 104 cfu/g soil [7].

The low microbial population on acidic dry land made the biological management is absolutely necessary, including the input of microbial cultures [8]. Microbes can improve root capacity in absorbing nutrients [9] and [10]. Giving organic fertilizer and biological fertilizer is an effort to increase soil fertility so that it can increase crop production [11]. The use of Bio-Triba biofertilizer containing microorganisms *Rhizobium* sp, *Azospirillum* sp, *Azotobacter* sp, *Pseudomonas* sp, *Bacillus* sp, *Trichoderma* sp, and growth hormones.

Aside from being a bio-activator, this biological fertilizer also simultaneously decomposes organic matter into nutrients that can be used directly by plants and nourish the environment. This study aims to determine the effect of biofertilizer and Jajar Legowo cropping system on the growth and production of hybrid maize on acid dry land.

2. Materials and Methods

The study was conducted at Natar Experimental Station, South Lampung in dry season 2017. Planting was carried out on February 20, 2017, and harvest on June 30, 2017. The study used a randomized block design with 5 replications, there were 25 plots of experimental units. The treatment consists of 5 levels of Bio-Triba biofertilizers (B0: without biofertilizer/control, BT-1: 25 ml/l, BT-2: 10 ml/l, BT-3: 15 ml/l, BT-4: 20 ml/l). Planting space used “jajar legowo” 2: 1 (20 cm x 50 cm - 100 cm), planted using 1 seed per hole with total population of 66,000 plants/ha. Plots size was 4.5 x 5 m and plot distance was 1 m. Paddy variety used DKLB-22 Hybrid Corn.

The basic fertilizer used is a single fertilizer 350 kg Urea/Ha, 200 kg SP-36/ha and 100 KCl/ha. The application of Urea fertilizer is divided into 3 times, at the age of 7 days after planting (DAP), 35 days after planting and 45 days after planting. While SP-36 and KCl fertilizers are given when planting. Land preparation is carried out with a non-tillage system (TOT). The land used is the former corn plantations in the previous planting season. The land is sprayed with a systemic herbicide at a dose of 4 litres/ha or 1 litre for the area of research used, covering an area of 1000 m2. Then the land is left for 3-5 days, after weeds die, sprinkled with rock tons of phosphate as much as 1 ton/ha. Before planting, the seeds are treated, soaked in a Cruiser solution with a concentration of 0.2% per 1 kg of seed or 2 g/kg of seeds. To prevent pests, Furadan 3G is used at the time of planting, given to the planting hole.

Planting used “jajar legowo” 2: 1 planting system, with space 25 cm in rows and 50 cm between rows and 100 cm inter-plot distance (legowo). 1 seed per planting hole was done, then planting hole was closed with 10 g of manure/planting hole or 2 tons/ha. Basic fertilizer is given when planting in a way beside the right planting hole. Data collected included: analysis of the chemical properties of the soil before the study was carried out in the Lampung AIAT soil laboratory. Weeding was carried out 2 times, at the age of 35 plants and 65 DAP. Data which is collected are growth components (plant height, cm), the number of leaves, yield components production (Ton/ha), harvest water content, the weight of 6 corn cobs (kg), cobs length (cm), cobs diameter (cm) and 100 grain weight (g). The data collected were analyzed by variance and continued with LSD at 5% significance level, data analysis using Minitab version 10.1.

3. Result and Discussion

3.1. Soil analysis

The results of the analysis of soil chemical properties at the study site in the Natar Experimental Station, South Lampung Regency showed that the land used was Ultisols which had low organic matter content.
Table 1. Soil chemical properties at Natar Experimental Station, South Lampung.

| Criteria     | Value | Variable |
|--------------|-------|----------|
| • pH H2O     | 5.2   | Acid     |
| • pH- KCl    | 4.6   | Acid     |
| • Organic C (%) | 1.09 | Low      |
| • Total N (%) | 0.10 | Low      |
| • C / N      | 10.9  | Medium   |
| • P potential| 29.73 | Medium   |
| • K potential| 20.50 | Medium   |
| • P-available| 9.44  | Very low |
| • K-available| 10.23 | Very low |
| • Ca-dd (cmol / kg) | 3.76 | Low      |
| • Mg-dd (cmol / kg) | 1.05 | Low      |
| • K-dd (cmol / kg) | 0.44 | Medium   |
| • Na-dd (cmol / kg) | 0.40 | Medium   |
| • CEC (cmol / kg) | 12.30 | Low      |

Source: Laboratory of Soil and Plant Lampung AIAT (2017).

From the analysis of soil chemical properties, it was seen that the soil acidly reacted, the C organic content was low (1.09%), the N total content was low (0.10%) and the phosphate (P) content was very low (9.44 ppm), and K content was also available very low. Soils that have low nutrient content are infertile soils. Ultisol soils are often identified with infertile soils, because of their low organic material content, low nutrition and low pH (less than 5.5), but can still be used for potential agricultural land if the management takes care of existing constraints [12]. Therefore, to increase the productivity of Ultisol, it is necessary to add organic materials, which serve to increase soil fertility. One of them is biological fertilizers. Giving organic fertilizer and biological fertilizer is an effort to increase soil fertility so that it can increase crop production [13]. Therefore, to increase the productivity of Ultisol so it is necessary to add organic matter, which serves to increase soil fertility. One of them is using biological fertilizers. Giving organic fertilizer and biological fertilizer is an effort to increase soil fertility so that it can increase crop production [14].

Bio-Triba is biofertilizer which contains microorganisms like *Rhizobium* sp, *Azospirillum* sp, *Azotobacter* sp, *Pseudomonas* sp, *Bacillus* sp, *Trichoderma* sp, and also growth hormones. Aside from being a bio-activator, this biological fertilizer also simultaneously decomposes organic material into nutrients that can be used directly by plants and nourish the environment.

3.2. Germination

The observations of the growth potential of corn plants showed that the treatment of several types of Bio-Triba biofertilizers did not show differences in the growth potential of corn plants.

Table 2. Effect of several types of biological fertilizers on the growth potential of corn plants

| Type of Biofertilizers | Plants grow | Size of plot 20 m² |
|------------------------|-------------|--------------------|
| Control                | 134.6 a     |                    |
| BT-1                   | 136.2 a     |                    |
| BT-2                   | 137.6 a     |                    |
| BT-3                   | 136.8 a     |                    |
| BT-5                   | 135.8 a     |                    |

Note: The numbers in the same column that are taken the same letter are not significantly different from the LSD test error level 5%.
The number of plants that grow or the growth potential from several types of biological fertilizers is not significantly different from without biological fertilizers (manure). The average plant’s growth potential is above 90%. However, there is a tendency that the number of plants grew more with the give of biofertilizers, compared to controls, and the leaf color is greener. This is possible because the biological fertilizer used also contains phytohormones that are useful for increasing growth and nourishing plants.

3.3. Plant height

The observations of the average plant height showed that the treatment of several types of Bio-Triba biofertilizer did not show differences in the height of corn plants compared to those without biofertilizers given cow manure (Table 3.)

| Type of Biofertilizer | Height Plant (cm) 35 dap | Number of leaves 35 dap |
|-----------------------|--------------------------|-------------------------|
| Control | 96.7 a | 8.9 b |
| BT-1 | 97.3 a | 9.1 ab |
| BT-2 | 97.4 a | 9.1 ab |
| BT-3 | 96.2 a | 9.2 a |
| BT-5 | 97.3 a | 9.0 ab |

Note: The numbers in the same column that are taken the same letter are not significantly different from the LSD test error level 5%. dap: days after planting

According to [15] the provision of biological fertilizers containing *Bacillus* sp., *Pseudomonas* sp., and *Azospirillum* sp. able to increase the growth of corn plants compared to without biological fertilizer. In maize, plant height, leaf number, leaf area, and corn stalk circumference were not significantly different from controls without biological fertilizer. In table 1, table 2, and table 3 there are no differences in the components of growth of corn plants with the provision of biofertilizers and without biological fertilizers, but given cow manure (Table 4).

| Type of Biofertilizer | Plant height (cm) 105 dap | Number of leaves 105 dap |
|-----------------------|---------------------------|--------------------------|
| Control | 196.7 a | 12.0 a |
| BT-1 | 195.8 a | 11.7 b |
| BT-2 | 197.0 a | 12.0 a |
| BT-3 | 195.0 a | 11.8 ab |
| BT-5 | 195.0 a | 11.9 ab |

Note: The numbers in the same column that are taken the same letter are not significantly different from the LSD test error level 5%. dap: days after planting

Observations of plant height and number of leaves in the generative phase or before harvest showed that there was no difference in plant height and number of leaves, but there was a tendency for the number of leaves to be more green with biofertilizers than without the provision of biological fertilizers. Likewise for the parameters of ear weight and seed weight, the BT-2 and BT-5 treatments had highest weight and grain weight (Table 5.)
3.4. Yield Component

Table 5. Effect of biofertilizer on the average weight of 6 corn cobs and the net weight on Lampung dry land.

| Biofertilizer | Weight of 6 harvest cobs (g) | Grain weight of 6 harvest cobs (g) |
|---------------|-----------------------------|----------------------------------|
| Control       | 1053.6 a                    | 860.4 a                          |
| BT-1          | 1075.2 a                    | 863.0 a                          |
| BT-2          | 1080.6 a                    | 891.8 a                          |
| BT-3          | 1122.4 a                    | 942.0 a                          |
| BT-5          | 1135.0 a                    | 919.4 a                          |

Note: The numbers in the same column that are taken the same letter are not significantly different from the LSD test error level 5%.

The provision of biofertilizers with various storage times could increase the weight of corn production, although vegetative growth tended not to be significantly different from controls without biological fertilizers with manure given [16]. In line with the results of the study, it was seen that the provision of biofertilizers tended to increase seed weight, cobs weight, and seed weight per plot. While for the weight of 100 corn grains was higher and significantly different than without biological fertilizers, the vegetative growth was not significantly different (Table 5 and Table 6). This is presumably because nutrients, especially phosphorus needed by corn plants for growth and maturity of seeds have been well absorbed by plants because the biological fertilizer used contains phosphate solvent bacteria.

Table 6. Effect of biofertilizers on grain weight per plot, harvest water content and grain weight of 100 corn grains a yield.

| Types of Biofertilizers | harvest water content (%) | Grain weight per plot (20 m²) (g) | Weight100 grains (g) | Yield (t /ha) |
|-------------------------|---------------------------|-----------------------------------|----------------------|--------------|
| Control                 | 21.2 a                    | 22.588,4 a                        | 31.1 bc              | 12.8 a       |
| BT-1                    | 21.0 a                    | 23.547,0 a                        | 30.2 c               | 13.6 a       |
| BT-2                    | 22.4 a                    | 23.874,2 a                        | 32.6 ab              | 13.2 a       |
| BT-3                    | 22.7 a                    | 24.228,8 a                        | 33.0 a               | 13.2 a       |
| BT-5                    | 21.4 a                    | 24.801,2 a                        | 31.9 abc             | 14.1 a       |

Note: The numbers in the same column that are taken the same letter are not significantly different from the LSD test error level 5%.

The provision of biofertilizers can increase the weight of corn production although statistically not significantly different, but the provision of biological fertilizer maize production tends to be higher than without biological fertilizers, although vegetative growth tends not to be significantly different from controls, the results of this study are in line with the results of research by [16]. Combined application of organic and inorganic fertilizers increases plant growth, yield, quality and soil fertility in plants [17].

According to the results of the study by [18] the inoculation of *Azospirillum* has increased the dry weight of seeds per plant, and the weight of 100 grain of corn plants. In line with the study, the provision of biofertilizers can increase the weight of 100 grains and significantly different without the provision of biological fertilizers. In addition to increasing growth, the application of biological fertilizers is also able to increase the growth of corn plants and reduce the senescence of leaves of corn plants between 25-28.57% [19].

[20] study showed that treatment with biological fertilizers was able to reduce the senescence of leaves of corn plants by 20% because there was an increase in AIA content accompanied by an
increase in cytokines so that the interaction of these two hormones could slow the occurrence of senescence. Utilization of biological fertilizers is based on a positive response to increased fertilization effectiveness and efficiency so as to save fertilizer costs and use of labor.

The technology that can be used is the application of microbial fertilizer. In this case, the supply of some nutrients needed by plants can be carried out by rhizosphere bacteria which have the ability to anchor N from the air and microbial phosphate solvents which can mine P in the soil into P-available for plant growth, thus saving the use of chemical fertilizers.

From the results of [21] found that the administration of Phosphate solvent bacteria can increase the number and weight of seeds and significantly increase the vegetative growth of corn plants. The treatment of mycorrhizal biofertilizer gave the best influence on the growth and production of maize in marginal dry land [22].

4. Conclusion
The result showed that application of biofertilizers had significant effect on the components increase the production component (seed weight, cobs weight, seed weight per plot, and production), while for the weight of 100 corn grains, it was higher and significantly different than without biological fertilizers, but vegetative growth was not significantly different.

References
[1] BPS Lampung, 2017.
[2] Munandar, Hayati R, Irmawati. 2009. Seleksi tanaman jagung efisiensi hara berdasarkan pertumbuhan akar, tajuk dan hasil biji. Seminar Nasional dan Kongress Persatuan Agronomi Indonesia. Unpad Bandung, 4-6 Juni 2009.
[3] Saraswati, 1999. Teknologi pupuk multiguna menunjang keberlanjutan sistem produksi kedelai. J. Mikrobiol Indonesia. 4 9
[4] Hardjowigeno, 1993. Klasifikasi tanah dan pedogenesis. Pressindo. Jakarta
[5] Richter, G.S.P. 1989. The chemical behaviour of aluminium, hydrogen and manganese in acid soils. In A.D. Robson (Ed). Soil acidity and plant growth. Acad. Press. Harcourt Brace Jovanovich, Publishers.
[6] Taufiq, A., H. Kuntyastuti, dan A.G. Manshuri, 2004. Pemupukan dan ameliorasi lahan kering masam untuk peningkatan produktivitas kedelai. Makalah Lokakarya Pengembangan kedelai Melalui Pendekatan Pengelolaan Tanaman Terpadu di Lahan Masam. BPTP Lampung. p.21-40.
[7] Prihastuti dan A. Harsono, 2007. Potensi pengembangan mikoriza alami di lahan kering masam, Lampung Agritek 6 1318-1325.
[8] Laboratorium Tanah dan Tanaman BPTP Lampung, 2017.
[9] Kloepper, J.W., R. Lifshitz, and R.M. Zablottowicz.1989. Free living bacterial inocula for enhancing crop productivity. J.Trends Biotechnol.7 39-43.
[10] Hasanudin.2003. Peningkatan ketersediaan dan serapan N dan P serta hasil tanaman jagung melalui inokulasi mikoriza, Azotobacter, dan bahan organik pada Ultisol. J.IImu-IImu Pertanian Indonesia 5 83-89.
[11] Balibangtan 2006. Pupuk organik dan pupuk hayati. http://www.litbang.pertanian.go.id. diakses tanggal 17 Juni 2019.
[12] Mujib M, Setyawati D, Arimurti S.2006. Efektivitas pelarut fosfat dan pupuk P terhadap pertumbuhan tanaman jagung (Zea mays L) pada tanah masam (skripsi) Jember: Fakultas Matematika dan Ilmu Pengetahuan Alam, Universitas Jember.
[13] Harsono, A., Sudaryono, Budi Santoso, R., dan Subandi 2007. Kajian pemanfaatan ruang tumbuh dan produktivitas lahan kering masam berbasis ubikayu dengan tanaman sela kedelai dan kacang tanah. Laporan Teknis 2007. Balitkabi. 13 p.
[14] Rachmawati E.2008. Kandungan IAA dan respon tanaman jagung dan kedelai terhadap perlakuan pupuk hayati [skripsi]. Bogor. FMIPA, Institut pertanian Bogor.
[15] Ainy ITE, 2008. Kombinasi antara pupuk hayati dan sumber nutrisi dalam memacu serapan hara pertumbuhan serta produktivitas jagung (Zea mays L.) dan Padi (Oryza sativa L.). Thesis. Bogor: Fakultas matematika dan Ilmu Pengetahuan Alam, Institut Pertanian Bogor.

[16] Hindersah R, Simarmata T.2004. Potensi Rizobakteri Azotobacter dalam meningkatkan kesehatan tanah. J. Natur Indonesia 2 127-133.

[17] Mahmoud, E. K. 2009. Effects of Different Organic and Inorganic Fertilizers on Cucumber Yield and Some Soil Properties World J. of Agricultural Sciences 4 408-414.

[18] Kristanto HB, SM Mimbar, T.Sumarni.2002. Pengaruh inokulasi Azospirillum terhadap efisiensi pemupukan N pada pertumbuhan dan hasil tanaman jagung (Zea mays L). J.Agrivita 24 74-79.

[19] Fahdiana T, 2010. Efisiensi pemupukan Nitrogen pada beberapa varietas jagung di Gowa Sulawesi Selatan. Prosiding Pekan serelia nasional. p.166-173.

[20] Rachmawati E.2008. Kandungan IAA dan respon tanaman jagung dan kedelai terhadap perlakuan pupuk hayati (Skripsi).Bogor: Fakultas matematika dan Ilmu Pengetahuan Alam, Institut Pertanian Bogor.

[21] Isgitani M, Kabirun S, Siradz SA. 2005. Pengaruh inokulasi bakteri pelarut fosfat terhadap pertumbuhan sorgum pada berbagai kandungan P-tanah. Jurnal Ilmu Tanah dan Lingkungan 5 48-54

[22] Moelyohadi Y., Harun M. Munandar, Hayati R. Gofar, N.2012. Pemanfaatan Berbagai Jenis Pupuk Hayati pada Budidaya Tanaman Jagung(Zea mays. L) Efisien Hara di Lahan Kering Marginal. J. Lahan Sub optimal 1 31-39.

[23] N.M. Pati. Biofertilizer effecct on growth, protein and carbohydrate content in Stevia Rebaudiana Var Bertoni. Recent Research in Science and Technology 10 42-44 www.recent-science.com