Application of various types of local microorganisms to the growth and production of two rice varieties

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Abstract. An experiment was conducted to determine the effect of application of various types of local microorganisms (LM) to the growth and production of two rice (Oryza sativa L.) varieties. The experiment was conducted in the form of a 2-factor factorial design trial in the Randomized Block Design (RBD). The first factor was the variety, namely: Variety Mira-1 and Diah Suci. The second factor was 6 types of LM, namely: LM of gamal leaf, LM of vegetable waste, LM of fruit waste, LM of banana suckers, LM of cow urine and a mixture of those five LM ingredients; Therefore, there were 12 treatment combinations. The results showed that the Diah Suci variety gave higher yields than the Mira-1 variety on plant height, panicle length, number of grains, percentage of grain filled per panicle, 1000 grain weight, and grain production per hectare (11.42 tons/ha) The application of a mixture of the five types of LM resulted in a shorter flowering age of 66.33 HST, and a shorter harvest age of 102.33 HST. There are no results that indicate interactions between varieties and types of LM.

1. Introduction

Indonesian national rice production growth in recent years has been fluctuating, in 2011 the product amount was 65.39 million tons, in 2012 was 69.05 million tons, in 2013 it was 71.29 million tons, in 2014 it was 70.83 million tons, in 2015 it was 75.55 and rice production in 2016 was 79,141 million tons of milled dry grains [1]. Pinrang Regency is one of the rice production center areas in South Sulawesi Province which is included in the Bosowasipilu Region namely; Bone, Soppeng, Wajo, Sidrap, Pinrang and Luwu (rice production center area) with a potential rice field area of ± 44,861 ha (22.87% of Pinrang Regency area) [2].

Local microorganisms are useful in providing nutrients for the growth and development of rice plants. Local microorganisms can also be applied to reduce the use of inorganic fertilizer. Utilization of microorganisms derived from local materials is not yet widely known, and research on the application of inorganic fertilizers combined with LM has not been much studied. Local microorganism (LM) materials consist of substance that can stimulate plant growth and development (fitohormon) such as: giberlin, cytokinins, auxins, and inhibitors [3].

Rice plants are distinguished based on their variety. Many varieties of rice plants appears almost every year with better genetic traits. One institution that produces quality rice seeds for the community is BATAN. Some rice varieties produced by BATAN include: Atomita, Cilosari, Situ Gintung, Lake Atas, Merauke, Winongo, Kahayangan, Diah Suci, Mayang, Yuwono, Mira-1, Mira-2, Inpari Sidenuk (Nuclear Dedication), Bestari , Pandan Putri [4].
The Diah Suci variety is a superior variety that has been released by BATAN since 2013, the original parent from pedigree selection from F1 seed radiation (Cilosari / IR74) with a gamma ray dose of 0.2 kGv. This variety has the potential of highest 9.4 tons/ha and average 6-7 tons/ha, lifespan of 115-120 days and upright shape, plant height 110-115 cm with many productive tillers (15-20), the color of stems and leaf strands are green while ear leaves are colorless [5].

The Mira-1 variety is a superior rice plant variety that has a potential highest yield of 9.20 tons/ha and an average of 6.29 tons/ha. Specific characteristics such as, lifespan of 115-120 days, upright plant growth, 105-110 cm high, number of productive tillers 15-20, resistant to brown planthopper pests biotypes 1 and 2, moderately resistant biotype 3, resistant against bacterial leaf blight strain III and somewhat resistant to strain IV. Mira-1 is suitable to be planted in paddy fields with an altitude of 0 - 700 m above sea level [6].

Local microorganisme (LM) is a collection of microorganisms that can be propagated by providing food as an energy source that functions as a starter in making compost [7]. Local microorganisms used as decomposers of solid organic matter into compost are known as decomposers. There are now many commercial decomposers containing microorganisms that can breakdown waste into compost. The decomposers most sold today are decomposers produced by factories such as: EM4, Superdegra, Stardec, Probion, etc., but the price of the decomposer is expensive, so not all farmers can buy it [7]. Types of microorganisms that have been identified in LM of banana suckers are Bacillus sp., Aeromonas sp., Aspergillus niger, Azospirillium, Azotobacter and cellulolytic microbes. It is this microbe that breaks down organic matter. Microbes on LM of banana weevil will act as decomposers of organic material to be composted [8].

The use of gamal (Gliricidia sepium) leaves as raw material for making LM has become common since this plant is a type of legume plant with high nutrient content. One-year-old gamal contains 3-6% N; 0.31% P; 0.77% K; 15-30% crude fiber; and 10% of Potassium [8]. The results of Amelia’s research [9], found that the C-organic value of banana waste treatment was 2.204% and papaya waste treatment was 0.874%, the results of N-total analysis of banana waste treatment was 0.68%, papaya was 0.46%, the results of Phosphate (P) analysis of banana waste by 0.27% while papaya had the lowest Phosphate (P) content of 0.14%. For the analysis of Potassium (K) banana waste was 0.0045% while papaya was only 0.0040% [9].

Addition of cow urine to LM was performed because it contains high N so it is good to be given to plants in the growth phase. The contents of the cow urine are: Azotobacter, Saccaromices, Azospirillium, phosphate solvent microbes, cellulotic microbes, Bacillus, Rhizobium, Pseudomonas, Aspergillus niger, and Verticillium [10].

2. Methodology
This research was conducted in the village of Mattunru Tunrue, Cempa District, Pinrang Regency, South Sulawesi Province. The research site was the location of irrigated rice fields at an altitude of 6-7 m above sea level with a loamy clay texture.
This research is in the form of an experiment using a Factorial 2 Factor design in the RBD. The first factor was variety (V), namely: Mira-1 (v1) and Diah Suci(v2) varieties. The second factor was the type of LM main ingredients (M) which consists of 6 levels namely: gamal leaves (m1), vegetable waste (m2), fruit waste (m3), Banana suckers (m4), cow urine (m5) and a mixture of the five types of LM (m6). From these two factors, 12 treatment combinations were obtained (v1m1, v1m2, v1m3, v1m4, v1m5, v1m6, v2m1, v2m2, v2m3, v2m4, v2m5, and v2m6). Each treatment combination was repeated 3 (three) times making a total of 36 experimental units. Soil analysis was carried out 2 times before planting and after harvesting.
3. Result and discussion

3.1. Plant height.
Variance analysis showed that the varieties had a very significant effect, while the application of LM types and their interactions did not significantly affect the height of rice plants.

| Variety | Type of LM | Average | LSD 0.05 |
|---------|------------|---------|----------|
| v1      | M1         | 88.12   |          |
|         | M2         | 89.85   |          |
|         | M3         | 87.36   |          |
|         | M4         | 87.21   |          |
|         | M5         | 90.59   |          |
|         | M6         | 90.98   |          |
|         | Average    | 90.02   | 4.53     |
| v2      | M1         | 100.14  |          |
|         | M2         | 100.31  |          |
|         | M3         | 103.86  |          |
|         | M4         | 102.09  |          |
|         | M5         | 99.90   |          |
|         | M6         | 102.37  |          |
|         | Average    | 101.44  | a        |

Table 1. Average plant height (cm) in 2 rice varieties

Table 1 shows the types of varieties significantly affected the average plant height, the Diah Suci variety (v2) showed the highest average plant height of 101.44 cm which was significantly different from the Mira-1 variety (v1) which had only plant height ie 89.02 cm

3.2. Number of leaves per plant (strands)
The variance analysis showed that the treatment of LM types and varieties and their interactions did not significantly affect the number of leaves.

Figure 1. Average number of leaves per plant (strands) of 2 rice varieties (v) in the application of various types of LM (m)

Figure 1 shows that the combination of Mira-1 + LM treatment of vegetable waste (v1m2) and Diah Suci+ LM of vegetable waste (v2m2) tends to provide the highest average number of leaves at 4.92 strands, while the average number of leaves is at least 4, 44 strands were found in the combination of Diah Suci treatment + cow urine LM (v2m5).

3.3. Number of tillers per family (stems)
The variance analysis showed that the treatment of LM types and varieties and their interactions did not significantly affect the number of tillers per family.
3.4. Number of productive tillers per family (stems)
The variance analysis showed that the treatment of LM type and two types of varieties and their interactions had no significant effect on the number of productive tillers per family.

Figure 2. Average number of tillers per cluster (stems) of 2 rice varieties (v) on the application of various types of LM (m)

Figure 2 shows that the highest number of tillers ie 15.67 stems was found in the combination of Mira-1 + LM fruit waste treatment (v1m3), while the smallest number of tillers ie 13.78 stems was found in the combination of Diah Suci + cow urine LM (v2m5).

Figure 3. Average number of productive tillers per cluster (stems) of 2 rice varieties (v) in the application of various types of LM (m)

Figure 3 shows that the highest number of productive tillers per family, 15.58, was found in the combination of Mira-1 + fruit waste LM (v1m3), while the lowest number of productive tillers per family, namely 13.72, was found in the combination of Diah Suci treatment + Cow urine LM (v2m5).
3.5. Flowering time (DAP)
Variance analysis showed that the application of LM types significantly affected, while the variety and interaction did not significantly affect flowering age.

| Variety | Type of LM | Average | LSD 0.05 |
|---------|------------|---------|----------|
| v1      | M1         | 73.00   |          |
|         | M2         | 72.33   |          |
|         | M3         | 73.33   |          |
|         | M4         | 71.33   |          |
|         | M5         | 72.33   |          |
|         | M6         | 65.00   |          |
| v2      | M1         | 66.33   |          |
|         | M2         | 71.67   |          |
|         | M3         | 72.67   |          |
|         | M4         | 72.33   |          |
|         | M5         | 71.67   |          |
|         | M6         | 67.67   |          |

Note: The same letter in the same column shows no difference in the 0.05 LSD test.

Table 2 shows that the fastest average flowering time, 66.33 DAP, was found in the application of a mixture of five types of LM (m6) that were significantly different from the treatment of fruit waste LM (m3) but still the same as LM of gamal leaf waste (m1), LM of vegetable waste (m2), LM of banana suckers (m4), and cow urine LM (m5). The time of flowering later than 73.00 DAP was found in the application of fruit waste LM (m3) which was not significantly different from the application of banana suckers LM (m4), vegetable waste LM (m2), gamal leaf waste LM (m1) and cow urine LM (m5).

3.6. Harvest time (DAP)
The variance analysis showed that the variety and treatment of LM type had a very significant effect while the interaction of both had no significant effect on the time of the harvest.

| Variety | Type of LM | Average | LSD 0.05 |
|---------|------------|---------|----------|
| v1      | M1         | 104.56  |          |
|         | M2         | 104.67  |          |
|         | M3         | 106.67  |          |
|         | M4         | 106.00  |          |
|         | M5         | 104.67  |          |
|         | M6         | 105.33  |          |
| v2      | M1         | 109.06  |          |
|         | M2         | 110.67  |          |
|         | M3         | 111.00  |          |
|         | M4         | 110.67  |          |
|         | M5         | 111.33  |          |
|         | M6         | 110.06  |          |
| Average | M1         | 106.33  |          |
|         | M2         | 108.83  |          |
|         | M3         | 107.67  |          |
|         | M4         | 108.99  |          |
|         | M5         | 109.60  |          |
|         | M6         | 104.56  |          |

Note: The same letter in the same column shows no difference in the 0.05 LSD test.

Table 3 shows that the average harvest time of the Mira-1 (v1) variety was shorter namely 104.56 DAP which was significantly different from the Diah Suci variety (v2) which was 109.06 DAP. Whereas the effect of application of various types of LM showed that a shorter harvest time of 102.33 DAP was found in the application of a mixture of five types of LM (m6) that were significantly different from the type of fruit waste LM (m3) but still the same as LM of gamal leaf waste (m1), vegetable waste LM (m2), banana suckers LM (m4), and cow urine LM (m5).

3.7. Panicle length (cm)
Variance analysis showed that the variety had a very significant effect, while LM and its interaction had no significant effect on panicle length.
Table 4. Average panicle length (cm) of 2 rice varieties

| Variety | Type of LM | Average | LSD 0.05 |
|---------|------------|---------|----------|
| v1      | M1         | 23.52   | 23.64    |
|         | M2         | 23.77   | 23.44    |
|         | M3         | 23.09   | 23.01    |
|         | M4         | 23.4 b  | 0.6      |
| v2      | M5         | 26.64   | 24.46    |
|         | M6         | 26.44   | 26.48    |
|         |            | 26.98   | 26.51    |
|         |            | 26.59a  |          |

Note: The same letter in the same column shows no difference in the 0.05 LSD test.

Table 4 shows that the Diah Suci variety (v2) had the longest panicle length of 26.59 cm and was significantly different from the Mira-1 variety (v1) with the shortest panicle length of 23.4 cm.

3.8. Number of grains of rice per panicle (grain)
Variance analysis showed that the varieties had very significant effects, while the LM treatment and their interactions had no significant effect.

Table 5. Average number of grains per panicle (grains) of 2 rice varieties

| Variety | Type of LM | Average | LSD 0.05 |
|---------|------------|---------|----------|
| v1      | M1         | 119.72  | 123.19   |
|         | M2         | 113.14  | 121.47   |
|         | M3         | 120.25  | 114.33   |
|         | M4         | 118.69 b| 17.09    |
| v2      | M5         | 166.75  | 158.69   |
|         | M6         | 163.97  | 157.42   |
|         |            | 166.53  | 151.31   |
|         |            | 160.78 a|          |

Note: The same letter in the same column shows no difference in the 0.05 LSD test.

Table 5 shows that the Diah Suci variety (v2) had a total of 160.78 grains that differed significantly from the Mira-1 variety (v1) which only had 118.69 grains.

3.9. Percentage of filled rice per panicle (%)
The variance analysis showed that the variety had a very significant effect, while LM and its interaction had no significant effect on the percentage of filled rice per panicle.

Table 6. Average percentage of filled grains per panicle (%) of 2 rice varieties

| Variety | Type of LM | Average | LSD 0.05 |
|---------|------------|---------|----------|
| v1      | M1         | 87.11   | 87.81    |
|         | M2         | 88.20   | 84.94    |
|         | M3         | 88.68   | 90.24    |
|         | M4         | 87.83 a | 3.53     |
| v2      | M5         | 70.10   | 72.13    |
|         | M6         | 73.14   | 71.15    |
|         |            | 72.54   | 73.93    |
|         |            | 72.16 b |          |

Note: The same letter in the same column shows no difference in the 0.05 LSD test.

Table 6 shows that the average percentage of filled grain per panicle was found in the Mira-1 variety (v1), which was 87.83%, which was significantly different from the Diah Suci variety (v2), namely 72.16% filled grain per panicle.

3.10. Weight of 1000 grains (g)
The variance analysis showed that the varieties had a very significant effect while LM and its interactions had no effect on the weight of 1000 seeds.

Table 7. Average weights of 1000 grains (g) of 2 rice varieties

| Variety | Type of LM | Average | LSD 0.05 |
|---------|------------|---------|----------|
| v1      | M1         | 26.37   | 26.77    |
|         | M2         | 26.90   | 26.17    |
|         | M3         | 26.17   | 26.17    |
|         | M4         | 26.44 b | 0.85     |
| v2      | M5         | 29.00   | 27.87    |
|         | M6         | 28.83   | 28.83    |
|         |            | 28.43 a |          |

Note: The same letter in the same column shows no difference in the 0.05 LSD test.
Table 7 shows the highest weight of 1000 grains found in the Diah Suci variety (v2) that was 28.43 g which was significantly different from the Mira-1 variety (v1) with the lowest value of 26.44 g.

3.11. Production per hectare (ton)
The variance analysis showed that the variety had a very significant effect while LM and its interaction had no significant effect on grain production per hectare.

Table 8. Average grain production per hectare (ton) in 2 rice varieties

| Variety | Type of LM | M1  | M2  | M3  | M4  | M5  | M6  | Average |
|---------|------------|-----|-----|-----|-----|-----|-----|---------|
| v1      |            | 9.92| 10.25| 9.59| 9.92| 9.92| 10.19| 9.96 b  |
| v2      |            | 11.57| 11.57| 11.57| 11.64| 10.58| 11.57| 11.42 a |

Note: The same letter in the same column shows no difference in the 0.05 LSD test.

Table 8 shows that the highest production per hectare was achieved by the Diah Suci variety (v2) i.e. 11.42 tons which was significantly different from the Mira-1 variety (v1) which produced the lowest production per hectare which was 9.96 tons.

4. Conclusion
Variety Diah Suci gave higher yields than the Mira-1 variety on plant height, panicle length, number of grains, weight of 1000 grains, and production per hectare. The application of a mixture of the five types of local microorganism (LM) resulted in a shorter flowering time and a shorter harvest time. There were no results that indicate interactions between varieties and types of local microorganism (LM).

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