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The utilization of agricultural and livestock waste and the effect on new rice varieties yield on rainfed rice land of Ponjong - Gunungkidul

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Abstract. It is believed that environmentally friendly management of agricultural land through the use of liquid and fermented organic microorganisms can preserve soil fertility, increase the soil microbial population, preserve the environment, as well as increase soil productivity. This research aims to determine the application of various local microorganisms (LMO) to the growth and yield of new rice varieties on the rainfed land of Ponjong-Gunungkidul. Furthermore, it was conducted from February to May 2017, and used a Randomized Completely Block Design (RCBD) with 3 replications and 6 different treatments, namely: M_1 = Local Microorganisms of vegetable waste, M_2=Local Microorganisms of fruit waste, M_3= Local Microorganisms from banana weevils, M_4= Local Microorganisms from urine and cow manure, M_5 = Local Microorganisms from *Gliricidia sp* leaves, M_6=A mixture of the five local microorganisms ingredients. The results showed that the application of organic fertilizers produced from agricultural and livestock waste and liquid microorganisms was able to increase the total number of the microbial population about seven times on M_6 treatment compare to M_1 treatment, while the Nitrogen fixation bacteria population and Phosphate solubilizing bacteria increased about six and three times, respectively on the soil rhizosphere. The harvested dry grain yield of the variety Inpari 33 (7.78 tons ha-1) showed a higher yield than that of Inpari Sidenuk and Inpari 19, namely 6.93 tons. ha-1 or 7.13 tons ha. The observation of growth and yield components revealed that the number of tillers, the number of filled grains per panicle, the weight of 1000 grains, and plant biomass showed a significant result and higher differences of Inpari 33 variety than the other 2 varieties used in this research by applying a mixture of five agricultural and livestock wastes ingredients (M_6)

1. Introduction

The use of liquid organic fertilizer derived from chicken manure, goat manure, leaf litter, or banana weevils as a source of organic material requires an environmentally friendly decomposer in the form of local micro-organisms (LMO) as a source of microbes. Inorganic fertilizers, nutrients are mostly bound in their macromolecular compounds in such a way that they can decompose slowly in the environmental soil.

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form of local microorganisms (LMO) as the source of microbes. Inorganic fertilizers, nutrients are mostly bound in their macromolecular compounds in such a way that they can slowly be broken down in the environmental soil.

The use of decomposers for organic material should not only accelerate the decomposition process but also disinfect the compost material in such a way that the organic fertilizer or compost produced is free from pathogenic micro-organisms, ectoparasites, weed seeds and does not smell bad. However, composting with the help of organic decomposers only takes a maximum of three weeks. According to [1], the organic matter decomposer contains colonies of microorganisms that have been fixed by nature in the form of fungi and bacteria. Furthermore, the colonies of microorganisms include cellulolytic microorganisms (*Trichoderma polysporium, Trichoderma viride, Cellullomonal acidula, Bacillus cellulosa disolvens*); ligninolytic *(Clavaria dendroidea, Clitocybe alexandri, Hypoloma fascicular*); amylolytic (*Streptomyces, Micromonospora*), and non-symbiotic nitrogen-fixing micro-organisms (*Azotobacter Sp, Clostridium pasteurianum, Spirillum lipoferum).*

The decomposition process is known by the presence of an inoculum (starter/activator) such as microbes. These microbes are an important factor in the decomposition process because they will break down organic matter into organic fertilizer. Microbial decomposition of organic matter is a biological activator that grows naturally or is intentionally administered to accelerate the decomposition process and improve the quality of organic fertilizers and is commonly referred to as decomposer The number and type of decomposer microbes determine the success of the decomposition process [2]. According to [3], decomposers are living things that serve to break down relatively raw organic matter in such a way that the decomposed material can be absorbed by living plants around the area. The application of decomposer microbes can be seen from the effectiveness and efficiency of organic matter conversion, compost quality, cost, and ease of application.

The aerobic composting of organic material is a process of humification of unstable organic matter (C / N ratio> 25) to stable organic material, which is characterized by the release of heat and gas from the composted substrate [4]. The duration of composting varies between 2 and 7 weeks, depending on the technique and the type of microbial decomposer used [5]**.** The level of maturity (degree of humification) and compost stability (related to microbial activity) determine the quality of the compost, which is indicated by various changes in the physical, chemical and biological properties of the compost substrate. The use of immature compost (C / N ratio> 25) or compost resulting from imperfect substrate decomposition often creates many problems [6]. In immature compost, the process of decomposition of organic matter continues, which can create an anaerobic atmosphere in the root environment (use of oxygen by microbes) and N deficiency (immobilization of N by microbes), therefore inhibiting plant growth. Incomplete composting also creates phytotoxic compounds such as phenols, which in many cases inhibit the growth of plant seeds [7] or become transient sites for pathogenic microbes. To avoid this, the socialization of appropriate composting techniques and the use of suitable decomposer microbes needs to be pursued as a strategic step in improving the quality of compost. In addition, the ease of composting and the use of microbial decomposers at relatively low cost cannot be ignored as determinants of farmers using decomposer microbes.

The composting process can be accelerated by adding an activator in the form of microorganisms, which can accelerate the decomposition process of organic waste. This activator can be obtained from local microorganisms (LMO), which are fermented liquids that use easily available local resources, including agricultural crop waste or farmer waste. One of the natural resources that can be utilized in the manufacture of LMO is the golden snail, which is primarily a pest of rice plants. This Local Microorganism (LMO) contains bacteria decomposing organic matter, plant growth stimulants, pest control agents, and nutrients needed by plants.

Organic matter decomposers can be used for the manufacture of organic fertilizers using ruminant livestock waste in the form of livestock manure, urine and feed residue or broiler cage waste in the form of chicken manure, postal / husk of the cage bed, and spilled / leftover feed, or laying chicken waste in the form of chicken manure and spilled / leftover feed. The organic material in the form of cage waste is decomposed in order to subject it to a disinfection process with local microbes in such a way that it becomes a high-quality organic fertilizer. In addition, the decomposition process with selected local microbes can be a solution for farmers to overcome the time they spend on animal waste for around 6 months, the resulting compost contains pathogenic micro-organisms, ectoparasites, weed seeds, and foul-smelling. The real result of the long composting time is the visible and frequent withering of the plants due to fresh livestock pen waste.

In general, chicken or ruminant breeders have not used their livestock waste such as faeces and urine as a source of organic fertilizer, which provides additional benefits for their maintenance. Farmers that have used their livestock manure as fertilizer only do such for personal gain and even then without any processing, this condition shows that they have not optimized the existing potential. This occurred due to various factors, including lack of knowledge of the process of making compost and farmers' lack of understanding of the negative impacts of environmental pollution by livestock manure. According to [8]. compost is the result of the decomposition of organic materials such as livestock waste or other organic waste. Furthermore, compost as an organic fertilizer has the function to improve soil structure and increase soil binding capacity for nutrients. The composting process using activators is widely available in the market including EM4, orgadec, and stardec. Activators are microorganisms that are in the liquid growing material, when the liquid containing microorganisms is dissolved in water and mixed with the material to be composted, these microorganisms grow rapidly. Similarly, this activator can be produced by an individual, namely by breeding microorganisms originating from the stomach (colon, intestine) of ruminant animals, such as cows or buffaloes [9]. If it requires a high cost, it can be carried out by making a decomposer based on Local Micro-Organisms (LMO).

This research aims to determine the application of various local microorganisms (LMO) to the growth and yield of new rice varieties in the rainfed rice fields of Ponjong District Gunungkidul Regency

2. Materials and methods

2.1 The research site

The research was carried out in Sadar Karya farmer community group, Sumberwojo hamlet, Sidorejo Village, Ponjong District, Gunungkidul from February to June 2017, and several rice varieties were planted on rainfed rice fields in Sumberwojo, Ponjong - Gunungkidul. This area has type D rain (it has 7 wet months with an average rain of over 100 mm) based on the [10]. classification and it is classified in the C2 climate (with 5–6 wet months), according to the climate classification of [11].

2.2 Research Material and Equipment

The tools used are tractor, hoe, scissors, hand sprayer volume 14 liters, analytical weight balance, watering can, plastic bucket, ruler, funnel, aqua bottle, hose, blender, filter, stationery, ticks, plastic bucket with capacity volume 20 liters.

The materials used are Inpari 19, Inpari Sidenuk and Inpari 33 varieties, Decis 25-EC, Dithane M-45, livestock manure, cow urine, Urea fertilizer, TSP, KCl, brown sugar, rice

washing water, fruit waste, vegetable waste, banana stem weevil, *Gliricidia sepium* leaves. This research used a completely randomized block design (RCBD) with a combination of LMO treatment of agricultural and livestock waste materials. The agricultural and livestock waste materials are in accordance with the following treatment: M1 = LMO vegetable waste, M2 = LMO fruit waste, M3 = LMO from banana weevil, M4 = LMO from urine and cow manure, M5 = LMO from *Gliricidia sepium* leaves, M6 = a mixture of the five LMO ingredients. While the rice varieties tested, namely Inpari 19, Inpari Sidenuk, and Inpari 33 in such a way that there were 18 treatment combinations with 3 replications. All treatments were placed in plots, which were randomly assigned to the farmer's rice field.
The spacing for rice follows the Tajarwo system 2: 1, namely 40 x 12.5 x 25 cm. Basic fertilization in the form of manure of about 4 tons/ha was applied 7 days before planting, while inorganic fertilization with Phonska fertilizer (15:15:15) of about 250 kg /ha, Urea 150 kg /ha, SP-36 75 kg/ ha, and KCl 100 kg/ha was also applied.
The solution of local microorganisms was carried out by mixing the basic ingredients of agricultural and livestock waste, which were 4 kg of agricultural and livestock waste material mixed with 4 liters of water, 1000 ml of rice washing water, 100 grams of livestock rumen (as the microbial starter) and 100 grams of Java sugar, and placed in a bucket of 20-liter volume and close tightly and ripen for 10 days. Spraying the LMO solution evenly to the roots and leaves of rice plants 3 times, namely when the plants were aged 15 DAP, 30 DAP, and 40 DAP with a dose of 200 ml / 10 liters of water in a sprayer tank.
The parameters observed were the total population of microbes, the amount of Nitrogen fixation bacteria and Phosphate solubilizing bacteria, the content of macro and microelements in various LMO liquids from agricultural and livestock waste materials, number of rice tillers, the number of filled grains per panicle, the weight of 1000 grains, plant biomass and the yield of harvested dry grain.

2.3 Data analysis

The data analysis was used with the SAS version 9.0 program to determine the treatment response to growth and yield of several new rice varieties performed by analysis of variance (ANOVA) and to differentiate the significance between the mean of each treatment, the process was continued by the DMRT test at a 5% level.

3. Result and Discussion

The total population of microbes and other observations of species microbes are presented in Table 1 below.
As shown in Table 1, the total population of microbes in treatment M_6 (LMO from the mixture of the five ingredients) was significantly higher than in other treatments. While the highest populations of Nitrogen fixation bacteria in the soil were achieved by the M_5 treatment (Local Microorganisms from *Gliricidia* sp leaves) and the other treatments have a lower value. Moreover, the treatment M_3 (Local Microorganisms from banana weevils) achieved a significantly higher population of Phosphate solubilizing bacteria, and the lowest was M_5 treatment (Local Microorganisms from *Gliricidia* sp leaves).

Table 1. The total population of microbes, nitrogen fixation bacteria, phosphate solubilizing bacteria, cellulolytic microbes population on the various liquid LMO

Types of LMO (Treatments)	Total population mikrobes (10^7cfu ml $^{-1}$)	Nitrogen fixation bacteria (10^3 cfu ml $^{-1}$)	Phosphate solubilizing bacteria (10^4 cfu ml $^{-1}$)	Selulolitic mibrobes (10^4 cfu ml $^{-1}$)
Local Microorganisms of vegetable waste (M_1)	11.8 a	2.1 a	18.3 a	1.8 b
Local Microorganisms of fruit waste (M_2)	26.7 ab	2.9 a	22.9 b	0.7 a
Local Microorganisms from banana weevils (M_3)	21.4 a	2.3 a	42.9 c	1.9 b
Local Microorganisms from urine and cow manure (M_4)	64.2 c	11.2 b	28.3 b	2.8 bc
Local Microorganisms from *Gliricidia* sp leaves (M_5)	30.7 b	20.5 c	11.6 a	1.3 a
LMO from a mixture of the five ingredients (M_6)	85.3 d	13.4 b	34.7 bc	3.5 c

Similar observations were reported by [12], where the application of organic matter to the soil resulted in an increase in soil microbial populations and the biological activity of the soil, and [13], also reported that the number of CFU bacteria and fungi increased, when livestock compost was added to the soil. Furthermore, the application of wastewater containing organic matter and nutrients has been reported to increase total soil microbial biomass [14], and the total population of bacteria, fungi, and actinomycetes will be increased in the soil rhizosphere [15].

The results of the analysis of the content of macroelements of various LMO materials derived from agricultural and livestock waste are shown in Table 2. The table shows that the highest N content was obtained in liquid LMO derived from *Gliricidia sp* leaves waste, namely 3,65%, while the lowest was obtained from banana weevil waste, namely 0.89%. This condition conforms to the statement [16], that the use of *Gliricidia sepium* leaves as raw material for making local microorganisms has become common since this plant is a type of legume plant with high nutrient content. One-year-old *Gliricidia sepium* contains 3- 6% N; 0.31% P; 0.77% K; 15-30% crude fiber; and 10% of Potassium. Subsequently, the highest P element content was obtained from the liquid LMO of banana weevil waste, which was 77.62 ppm and the smallest nutrient content of P was obtained from the liquid LMO of *Gliricidia sp.* leaves. The results of the analysis of the highest K content were obtained from liquid LMO of manure and cow urine, which was 173.42 ppm and the smallest was obtained from liquid LMO of banana weevil waste which was 47.52ppm.

Table 2. Macro elemental content of liquid LMO derived from agricultural and livestock waste materials

Parameters	Unit	arious Local Microorganism (LMO)					
		M_1	M_2	M_3	M_4	M_5	M_6
pH		5.6	5.3	5.8	4.8	5.3	5.0
Nitrogen (N) total	%	1.77	1.14	0.89	1.73	3.65	2.34
Phosphor (P_2O_5) available	ppm	43.27	61.45	77.62	23.94	21.86	38.49
Kalium (K_2O) available	ppm	105.98	92.37	47.52	173.42	77.65	135.24

Analysis of the micronutrient content of liquid LMO from agricultural and livestock waste is shown in Table 3 below. The types of microelements are Calcium, Magnesium, iron, Manganese, and Zinc. The highest calcium content was reported in liquid LMO from a mixture of vegetables + fruits, banana weevil + cow urine + *Gliricidia sp* leaves, which is 9.29 ppm and the smallest is liquid LMO from manure and cow urine. The highest content of iron was obtained from fruit LMO and the lowest in LMO derived from *Gliricidia sp* leaves. While the highest zinc content was obtained in liquid LMO from manure and cow urine waste, namely 1.85 ppm and the lowest was from banana weevils of 0.32 ppm.

Table 3. Micro elemental content of liquid LMO derived from agricultural and livestock waste materials

Parameters	Unit	Various Local microorganisms (LMO)					
		M_1	M_2	M_3	M_4	M_5	M_6
Calcium (Ca)	ppm	3,16	3,34	5,62	2,73	2,05	9,29
Magnesium (Mg)	ppm	15,42	22,75	35,46	32,57	19,45	37,
Iron (Fe)	ppm	1,04	1,67	0,83	0,92	0,65	1,27
Mangan (Mn)	ppm	0,72	0,63	0,46	0,28	0,39	0,14
Zinc (Zn)	ppm	0,51	1,34	0,32	1,85	0,43	1,28

In Table 4, it can be seen that the highest number of tillers was achieved with the M6 treatment in all tested superior Inpari varieties, and the highest yield was achieved in the Inpari 33 variety, which comprised of 23 tillers and was significantly different from other treatments but not different from the M4 treatment. This shows that when liquid LMO is administered in the M_6 treatment, the nutrient content is relatively homogeneous compared to the application of the M_1 to M_5 treatment. Furthermore, the addition of cow urine and livestock waste in the M_4 and M_6 treatments can increase macro and micronutrients and contain bacteria that have the potential to remodel organic matter and stimulate the growth of rice plants. This condition is in accordance with the results of the research by [17], which stated that administering liquid LMO plus livestock urine was able to show a higher number of tillers than liquid LMO from banana weevils alone. This shows that mixing LMO with livestock urine can support the vegetative and generative growth of rice plants.

Table 4. The Number of tillers affected by application various of LOM derived from Agriculture and Livestock waste

Number treatment	LMO	New Rice varieties		
		Inpari 19	Inpari Sidenuk	Inpari 33
1	M1	16 ab	15 a	18 b
2	M2	17 b	14 a	18 b
3	M3	18 b	14 a	19 bc
4	M4	19 bc	16 ab	20 c
5	M5	18 b	15 a	17 b
6	M6	20 c	18 b	23 c

The numbers accompanied by the same letter are not significantly different from the DMRT on 5% level

Table 5 shows that the number of filled grains per panicle varies with various LMO treatments of agricultural and livestock waste, namely in the range of 162 to 210 grains per panicle. The highest yield of filled grain was achieved with the M_6 application by totaling 210 grains, and significantly different from the M_1-M_3 application but not significantly different from the M_4. This is consistent with the results of [18] research, which showed that LMO derived from livestock waste (urine) contains macro elements N, P. K, and microelements Ca, Mg, Cu, Zn, and Fe were higher than agricultural waste (banana weevil). When the LMO mixture of cow urine + vegetable and fruit waste is applied to rice plants, it will be able to provide a higher amount of filled grain per panicle than LMO from banana weevils and LMO from other agricultural wastes

Table 5. The Number of filled grains per panicle by the affected of various LMO of derived from Agriculture and Livestock waste

Number	LMO	Rice varieties		
		Inpari 19	Inpari Sidenuk	Inpari 33
1	M1	178 b	170 a	187 cd
2	M2	181 c	162 a	189 d
3	M3	179 bc	171 ab	185 c
4	M4	185 cd	172 b	205 e
5	M5	180 c	165 a	186 cd
6	M6	188 d	175 b	210 e

The numbers accompanied by the same letter are not significantly different from the DMRT 5% level

Table 6 shows that the application of liquid LMO from a mixture of vegetables, fruit, banana weevil, gamal leaves, and cow urine (treatment M6) has the highest value but these results do not show a significant difference with M_4 treatment (MOL manure and cow urine). The lowest results were obtained in the M_1 treatment (LMO vegetable waste) and M_2 (LMO fruit waste) on the 3 superior varieties tested, namely Inpari 19, Inpari Sidenuk, and Inpari 33. This is in accordance with the statement of [19], which showed that application of liquid LMO from a mixture of vegetable and fruit waste as well as cow manure and urine can increase the availability of macroelements (nitrogen, phosphorus, potassium, calcium, and sulfur) and microelements (iron, zinc, boron, cobalt), improve physical, chemical properties, and soil biology, improve soil structure, increase permeability and soil organic matter content in such a way that rice plant growth increases.

Table 6. The weight of 1000 rice by the affected of various LMO a derived from Agriculture and Livestock waste

Number	LMO	New Rice varieties		
		Inpari 19	Inpari Sidenuk	Inpari 33
1	M1	24,3 a	23,7 a	25,4 b
2	M2	23,9 a	23,4 a	24,9 ab
3	M3	24,8 ab	24,7 ab	26,2 c
4	M4	25,9 b	25,2 b	27,5 d
5	M5	24,9 ab	24,2 a	26,7 c
6	M6	26,4 b	25,8 b	27,9 d

The number accompanied by the same letter are not significantly different from the DMRT 5% level

Table 7 shows that the highest biomass weight was achieved with the treatment of M_6 liquid MOL and was not significantly different from the M_2 treatment, namely 10.17 ton.ha^{-1} and 10.04 ton.ha^{-1}, respectively. This shows that the nutrient content derived from the LMO of fruit waste and a mixture of vegetable + fruit + banana weevil + cow urine is quite complete and the percentage is quite high compared to LMO from other waste materials. In addition, the content of N and K elements in the LMO of the M_6 solution is quite high in such a way that it can support the development and yield of rice biomass for 3 different varieties. According to [20], nitrogen (N) is needed in large quantities at every stage of plant growth, especially shoot formation, stem development, and leaves. In M_6 and M_2 treatment, it is possible to obtain optimal N requirements, which can increase photosynthetic activity in such a way that it can increase plant photosynthate. Furthermore, photosynthate will then be translocated to the meristem, and in the meristem, cell division and elongation will occur in such a way that it will cause the plant to grow taller and have enough nutrients for generative growth, resulting in high yield biomass

Table 7. The weight of harvested biomass by the affected of various LMO derived from Agriculture and livestock waste

Number	LMO	New Rice varieties		
		Inpari 19	Inpari Sidenuk	Inpari 33
1	M1	8,35 b	7,94 a	9,38 cd
2	M2	8,17 a	8,12 a	9,12 cd
3	M3	8,86 c	8,05 a	9,51 d
4	M4	9.53 d	8,61 bc	10,04 e
5	M5	8.42 b	8,14 a	9,08 cd
6	M6	9,79 d	8,89 c	10,17 e

The number accompanied by the same letter are not significantly different from the DMRT 5% level

Table 8. The weight of Harvested rice by the affected of various LMO of derived from Agriculture and Livestock waste

Number	LMO	New Rice varieties		
		Inpari 19	Inpari Sidenuk	Inpari 33
1	M1	7,42 b	6,69 a	8,02 d
2	M**2**	6,83 a	6,34 a	7,96 cd
3	M3	7,59 c	6.83 ab	7,88 c
4	M4	7,94 cd	7,38 b	8,79 e
5	M5	6,91 ab	6, 74 a	7,80 c
6	M6	8,05 d	7,42 bc	8,92 e

The numbers accompanied by the same letter are not significantly different from the DMRT

In Table 8, it can be seen that the variety that produced the highest grain was Inpari 33 with a yield of around 8.79 - 8.92 tonnes/ha with the application of M4 and M6 treatments. While the MOL liquid application treatment, which had no effect on increasing rice yield, was M_1 and M_2, both of which produced the lowest GKP weight in each of the superior rice varieties. The results of [21] research, showed that the decrease in the number of empty unhulled rice and the increase in the weight of harvested dry grain is believed to be due to the influence of MOL enriched microbial raw materials. Furthermore [22], stated that the LOM banana weevil contains the hormone gibberellin, which collaborates with the hormone auxin in determining stem elongation, flowering, and seed development. In addition, the use of chemical fertilizers alone does not sustain productivity under continuous intensive cropping, while the inclusion of organic materials improves physical soil properties [23], builds up soil fertility and it can increase the rice yield [24]. Other research by [25], also stated that the use of manure integrated with chemical fertilizer increased the growth and yield of rice significantly compared to the sole use of chemical fertilizer.

4. Conclusions

The percentage of macro and micronutrient content changes when the LMO liquid fertilizer is produced from a mixture of agricultural and livestock waste with high levels of each macronutrient. The highest content of macro nitrogen (N) elements was reported in liquid MOL from gamal leaf waste material, namely 2.65%, the highest Phosphate (P) was reported in MOL with banana weevil waste material which was 77.62 and the highest K content was obtained from MOL with manure and cow urine of about 173.42 ppm. The application of liquid LMO derived from mixed fermentation of agricultural and livestock waste (vegetable waste, fruit, banana weevil waste, Gliricidia leaves, and cow urine) is to be recommended to apply and gives the filled grains per panicle, the weight of 1000 grains, and the yield of harvested dry grains on Inpari 33 variety higher yield (7.78 $ton.ha^{-1}$) than Inpari Sidenuk and Inpari 19, namely 6.93 tons. ha^{-1} and 7.13 $tons.ha^{-1}$, respectively.

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