The effect of silica liquid fertilizer from straw and formulation of *bacillus* sp for rice growth (*Oryza sativa* L.) and tolerance to fungi *Pyricularia oryzae* Cav

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Abstract. Blast disease caused by *Pyricularia oryzae.*This disease which generally was caused by environmental conditions, plant age, and the level of plant resistance. One of effort to control it was used insecticides, where more used could adversely affect the environment due to toxic chemical residues. The purpose of this study was to determine the effect of the used of silica liquid fertilizer from straw and the formulation of *Bacillus* sp for the growth of rice and tolerance to diseases of blast or *Pyricularia oryzae*. The method was the factorial RAKL pattern with 2 treatment factors that were dosage formulation of *Bacillus* sp and the composition of liquid silica fertilizer with 6 repications for each treatment. Data analysis was used ANOVA with significant level of 5% and continued with the Smallest Significant Difference Test (DMRT). The results of the study showed that the added of liquid silica with a concentration of 12 ml and the formulation of *Bacillus* sp 6 grm / pot gave a significant effect on plant height, number of leaf tillers, and mean percentage of damage to rice.

1. Introduction

Rice (*Oryzae sativa*) is a national food crop whose needs continue to increase along with the increase in population. In Indonesia, the increase in population has not been followed by rice production lately which has an impact on the national food balance. This is due to the shrinking of agricultural area, inadequate irrigation flow and the presence of pests and diseases in rice. One of the diseases that attack rice is blast disease caused by the attack of *Pyricularia orizae.* Blast disease is one of the important diseases in rice throughout the world [1]. Initially blast disease in Indonesia was known to only attack rice gogo but has now been found to infect rice field. indications of blast disease in leaves are generally influenced by environmental conditions, plant age, and the level of plant resistance. Various efforts have been done to control blast disease, including using insecticides. However, more used of insecticides can adversely affect the environment due to chemical residues that are toxic and can also increase pathogenic resistance [2]. Therefore, an alternative effort is needed to control blast disease naturally without polluting the environment. One of them is by using biocontrol agents from Bacillus sp and SiO2 from straw.

Bacillus sp is one of the endophytic bacteria that lives and is associated with plant tissue without causing indication of disease in these plants. This bacterium has biological agents and is able to withstand the conditions of heat and drought, so the use of *Bacillus* sp formulation is a first step in biological control that can be done commercially. *Bacillus* sp formulation which is applied to plant roots will produce growth hormones such as auxin, cytokinin, and IAA which function in root growth and stimulate the absorption of water and nutrients that influence the growth of rice so that it can inhibit and suppress the growth of rice pathogenic fungi (*Pyricularia oryzae*) [3].

SiO_2 or what is called silica is included in the essential nutrients for plants [4]. Function of Silica in rice is a *beneficial element* [5] which plays a role to increase the oxidizing power root, ability of the roots to oxidize ferrous ions (Fe2 +) to ferries (Fe3 +) [6]. Silica also plays a role in reducing the rate of pest and disease attacks through two mechanisms, that are to be a mechanical barrier and physiological mechanism by strengthening the stems, increasing the thickness of the epidermis of stems, roots and leaves so as to protect plants from infection with *Pyricularia oryzae* [4]. In addition, the use of *Bacillus* sp formulations and silica liquid fertilizer from straw can be the first step in used reduce chemical insecticid. Therefore, this study aims to determine the effect using of silica liquid fertilizer from straw and the formulation of *Bacillus* sp in growing rice and tolerance to blast or *Pyricularia oryzae* as a challenge in this study.

2. Materials and Methods

2.1. Materials

This research was conducted in March-May 2019 which was conducted at the *Green house* and the University Samudra Laboratory. The materials used were 20% griserol solution, Nutrient Agar (NA) media, micro elements, corn flour and tapioca flour for the ingredients for the formulation of *Bacillus* sp. The materials used for liquid silica fertilizer were straw, KOH, and HCl, then the *Pyricularia oryzae* and rice.

2.2. Methods

2.2.1 Formulation *Bacillus* sp

Bacteria were cultured on NA media which were incubated for 24 hours, then was produced spore and bacterial suspension using a shaker, then dilution and re-culture were carried out on NA medium and waited for 6 days. After that, harvesting was done by centrifugation which was mixed with a mixture formulation (corn flour and tapioca flour) with a ratio of 20 ml spores for every 100 grams of carrier material, then dried and then stored in black film bottles.

2.2.2 Making SiO2 from Straw

The stages of making liquid SiO2 from straw were: Waste of dried straw is burned until it becomes ash. White ash from combustion is taken, then was mashed and added with KOH solution, then was heated on hot plate for 15 minutes (85^0C), stirred with magnet stirrez. The mixture of straw ash and KOH solution was filtered to produce filtrate and residue. Filtrate is stored, while the Residue r is added with KOH, heated and stirred again as before. The mixture of straw ash and KOH is filtered again to produce filtrate and residue. The filtrate obtained from the filtration is poured in the baker glass, and then HCl is added slowly through the glass wall so that the final results obtained are KCl and silica.

2.2.3 Experimental design

The design in this study was a factorial randomized complete block design (RAKL), with 2 treatment factors that were dosage formulation of *Bacillus* sp and the composition of liquid silica fertilizer with 6 repications for each treatment. With sample total was 96 samples of rice. Challenges of *P.oryzae* where on rice that was 4 and 6 weeks old after transplanting. This was because at the age of 4 and 6 weeks the rice were in the vegetative phase to generative. *Pyricularia oryzae* was taken from rice that had been infected by the virus. Then cut and finely ground. Then mixed with water and injected into the experimental rice.

2.2.4 Data analysis

Data analysis was used ANOVA with significant level of 5% and continued with the Smallest Significant Difference Test (DMRT). Creteria of tes were as follows: if the value of $F_{count} > F_{table}$, then H1 is accepted and Ho is rejected, If the value of $F_{count} < F_{table}$, then Ho is accepted and H1 is rejected [7].

3. Results and Discussions

Observation of Rice Morphology

The average stem height, number of leaves and number of tillers, 6, 8 and 10 weeks after transplanting are presented in the table below:

Table 1. The mean height of rice stems after treatment

The volume of SiO2 liquid fertilizer		The dosage of *Bacillus* sp (gr / pot)				Average
		0	2	4	6	
6 weeks	0	74,48	77,52	77,52	78,83	77,1[d]
	4	82,18	83,98	83,98	83,38	83,4[c]
	8	88,38	89,8	90,58	91,1	89,9[b]
	12	95,7	96,6	96,82	96,8	96,4[a]
Average		85,2[b]	86,9[b]	87,2[b]	91,5[a]	+
8 weeks	0	105,58	106,56	106,98	115,94	109,8d
	4	113,94	114,54	114,74	117,16	117,5[c]
	8	120,6	120,7	120,92	122,98	121,5[b]
	12	129,72[b]	130,28	130,6	136,6	132,4[a]
Average		117,7[b]	118,0[b]	118,3[b]	123,7[a]	+
10 weeks	0	121,16	127,02	128,1	123,4	126,2[c]
	4	131,4	132,64	132,26	133,4	132,8[b]
	8	134,25	133,4	135,2	137,6	135,4[b]
	12	141,8	143,78	145,84	147,66	145,8[a]
Average		132,09[ab]	134,21[ab]	135,35[a]	135,52[a]	

Explanation: the numbers in the column followed by the same letters show no significant difference based on the smallest difference test at the level of 5 per cent.

Based on Table 1 the application of liquid silica fertilizer and the formulation of *Bacillus* sp gave a significant effect on the height of paddy rice plants at a concentration of 12 ml and 6 grm / pot with plant height reaching 147.66 cm because silica (Si) was a beneficial element for rice [5]. Silica was absorbed by the roots and will accumulate in the leaf epidermis, caused the leaves to become more erect and stretch well. This results was caused leaf surfaces getting more sunlight so that the absorption of sunlight for photosynthesis becomes more optimal. Photosynthates which was produced from photosynthesis will be used to process stem growth and elongation [8]. In addition, *Bacillus* sp, which was applied to the growing media, was possible to trigger the formation of hormones auxin, cytokinins, and gibberellins which function in cell division and elongation. This was because Basilus sp belongs to the group of bacteria PGPR (*Plant Growt Promoting Rhizobacteria*) which was able to stimulate plant growth by stimulating lateral growth, so that water absorption and nutrients are more optimal.

Table 2. Average number of tillers after treatment

The volume of SiO2 liquid fertilizer		The dosage of *Bacillus* sp (gr / pot)				Average
		0	**2**	**4**	**6**	
6 weeks	0	3,2	4	4,2	5,4	4,2[c]
	4	4,4	5,0	6	7,3	6,7[b]
	8	5,4	6,2	7,6	8,6	6,9[b]
	12	7	8,6	9,2	13,8	9,6[a]
Average		5[b]	5,9[b]	6,7[b]	8,7[a]	+
8 weeks	0	6,8	8,6	9	9,6	9,0[d]
	4	11,2	11,4	12,8	13,4	12,5[c]
	8	14	14,2	15,4	16,8	15,4[b]
	12	17	20	21,8	24,8	22,2[a]
Average		12,2[c]	13,5[b]	14,7[b]	16,1[a]	+
10 weeks	0	12,8	14,6	15	16,6	15,4[d]
	4	17,4	19,6	22	20,6	20,7[c]
	8	22,6	23,6	24,8	26	24,8[b]
	12	27,6	28,6	28,4	28,4	28,5[a]
Average		20,1[ab]	23,6[a]	22,5[a]	22,9[a]	+

Explanation: the numbers in the column followed by the same letters show no significant difference based on the smallest difference test at the level of 5 per cent.

Based on Table 2 liquid silica fertilizer and the formulation of *Bacillus* sp were showed could to increase the number of tillers at the age of 6, 8, and 10 weeks. The average number of rice tillers produced was 4-28, with the highest number of rice tillers being 28.4 with a concentration of 12 ml silica and a Bacillus 6 grm / pot formulation because added of silica could to increase nutrient uptake by the roots, especially P elements which function in cell division so that it can spur the formation of saplings. Increased nutrient uptake occurs because the presence of silica in plants making the root system was better, roots become stronger and longer so it was more effective in absorbing nutrients. The results of Zulputra's research (2018) showed that the number of paddy seedlings increased with increasing P uptake due to added silica because phosphorus was needed by plants in the process of cell division and as energy in each plant's metabolic processes [9]. In addition, the application of *Bacillus* sp can increase to growth of rice from the vegetative to the generative phase. This is due to the interaction between *Bacillus* sp with a mutually beneficial root system. *Bacillus* sp. Colonizes the root system by utilizing secondary metabolites produced by plants as nutrients so that ZPT is produced which is able to induce the rice root system well. With a good root system, the absorption of nutrients becomes better so that the number of productive tillers increases [10].

3.2 Observation of Rice Damage

The average data on the percentage of damage to rice after being challenged with *Phycularia oryzae* is presented in the table below:

Table 3. The average percentage of damage to rice plants after treatment

The volume of SiO2 liquid fertilizer	The dosage of *Bacillus* sp (gr / pot)				Average
	0	2	4	6	
0	50%	33%	17%	0	25%
4	33%	17%	0	0	12,5%
8	17%	17%	0	0	8,5%
12	0	0	0	0	0
Average	25%	16,75%	4,25%	0	11,5

Explanation: the numbers in the column followed by the same letters show no significant difference based on the smallest difference test at the level of 5 percent

Based on Table 3 was showed application of silica 12 ml with Basil sp 6 grm / pot could descend of attacked *Pyricularia oryzae* on rice. This could be seen from the larger doses given, the average percentage of damage to paddy plants was decreasing, in the treatment of B3S3 with a damage rate of 0% and the highest level of damage is in treatment B0S0 with the level of damage to rice by 50%. This was due to add *Bacillus* subtilus could to decrease pathogen development in roots through association and competition with pathogens [10]. In addition, silica also function in the percentage of damage to rice caused by blast disease, that silica was not much dissolved by water causes only a small amount to be absorbed by plants so that the cell wall is easily penetrated by the *P.oryzae*. So that high levels of silica were more could to increase rice resistance to blast disease by: silica deposited in epidermal tissue mechanically protects invasion of hyphae and silica increases assimilation of ammonium and controls the increase in nitrogen component solutions, including amino acids and amides which are developmental ingredients hyphae [11].

4. Conclusion

From the results of the study of silica fertilizer with a concentration of 12 ml and *Bacillus* formulation 6 grm / pt gave a significant effect on the growth of rice and the percentage of damage to rice caused by blast disease. This was because the silica content deposited in epidermal tissue mechanically protects invasion of hyphae and silica increased the assimilation of ammonium and controls the increase in nitrogen component solutions, including amino acids, and amides which are the ingredients of hyphal development. In addition, silica also made the leaves of the plant erect, making it easier to get sunlight that worked in the photosynthate process and scribbling the process of cleavage and elevation of the stem. *Bacillus* sp also played an important role in triggering the formation of hormones auxin, cytokinins, and gibberellins which had function in cell division and elongation.

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