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Yield Components and Productivity of SINHAS 1 Maize on the Application of Different Types and Spraying Frequency of Biofertilizer

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Abstract

The purpose of this study was to determine the effect of biofertilizer application based on the types and spraying frequencies on the yield components of maize variety SINHAS 1. The research was conducted in Tarowang Village, Galesong Selatan District, Takalar Regency from August to November 2020. Three types of biofertilizer were used applied in five different frequencies of spraying. The study employed a split plot design with types of biofertilizers as the main plot and application frequencies as the sub plots. The research was repeated 3 times, resulted in a total of 45 experimental units. The maize variety used was SINHAS 1 and observations were made on the yield components of the ear height, wet weight of peeled cobs, ear length and diameter, percentage of seed yield, weight of 1000 seeds at 15% moisture content, and productivity. The results shows that the frequency of biofertilizer application had more dominant effect than the type of biofertilizer. The type of biofertilizer used has relatively the same role in the growth of the yield components of SINHAS 1 corn. Based on the results, it is recommended to apply the biofertilizer in four times in fertilizing the SINHAS 1 maize crop

Keywords: biofertilizer, Maize SINHAS 1, Spraying frequency

A. Introduction

Maize (*Zea mays* L.) is one of the most cultivated food crops in the world, including in Indonesia and is one of the third leading cereals after rice and wheat to supply the consumption of the global population. Corn is a type of food plant that has a good economic prospect because it can be used as a source of carbohydrates, protein and raw materials for animal feed (Fadhli et al. 2020). However, increasing in population more often correlates with high demand for food and feed (Hasan, 2012), hence to address the gap in demand and production of maize in Indonesia, increasing corn production is inevitable. One of the efforts to increase productivity is fertilization technology.

Fertilization technology consists of several important components such as the type of fertilizer, fertilizer dosage, fertilization method and frequency of fertilizer application. However, at early stage in developing the fertilization technology for a new variety, the type and frequency of fertilization can be the focus of the study (Gofar, 2015). Selection of fertilizer types can be based on inorganic fertilizers, organic fertilizers and biofertilizers. The continuous use of inorganic fertilizers can deplete soil organic matter and degrade soil bio-fertility, the environment, and the balance of soil microorganisms, therefore the use of organic and biofertilizers is important in supporting plant potential. Although both fertilizers are important in supporting soil fertility, the use of biofertilizers is more effective because it involves the potential use of microorganisms in altering the environment becoming more favorable for optimal and efficient plant grow (Schmidt and Gaudin 2018; Nascimento et al. 2020). According to Roupahim et al. (2016), biofertilizers play a role in influencing the availability of macro and micro nutrients, nutrient efficiency, performance of enzyme system, increasing plant metabolism, growth and yield. In addition, the use and success of biofertilizers in increasing crop productivity have been widely reported (Kouchebagh et al. 2012; Mukhlis and Lestari 2013; Sitorus et al. 2015; Habibullah 2018; Flores 2020). Therefore, research and development of biofertilizers must continue to be developed, especially for newly released varieties. However, the potential for biofertilizers cannot be separated from the fertilizer application process. One of them is the frequency of applying the biofertilizers.

The application of biofertilizers must take into account the concentration and frequency of application to get optimal results. The application of biofertilizers with a certain concentration level and frequency of application can provide optimum results for maize. According to Bastari (2006), the frequency of fertilization, the method of application, and the form of fertilizer appropriately used are important factors in efforts to maintain nutrient availability in the soil, hence determining the correct concentration and frequency of fertilization in corn plants is important in order to increase growth and productivity. The more frequent application of the biofertilizers carried out on plants, the higher the nutrient content will be. However, giving excessive doses will actually cause wilting symptoms or reduce vigor in plants (Suwandi & Nurtika, 1987; Cheema et al. 2012). Therefore, the right frequency of administration is needed to get the most optimal plant growth.

The SINHAS 1 variety is one form of overcoming the problem of maize production, especially against drought stress and low nitrogen content (Farid et al. 2020). Several studies have reported the superiority of this variety (Ridwan et al. 2020; Padjung et al. 2020). However, the use of bio-fertilization on this variety has not been widely reported, especially for the combination of biofertilizers and the frequency of application of the fertilizers. Therefore, it is necessary to study the combination of types and frequency of application of biofertilizers. The purpose of this study was to determine the effect of bio-fertilization based on the types and frequencies of spraying on the production components of SINHAS 1 maize.

B. Methodology

This research was conducted in Tawang Village, Galesong Selatan District, Takalar Regency from August to November 2020. The research was carried out in the form of a split plot design (SPD) experiment. The main plot was the application different types of biofertilizers (P) consisted of three levels, namely Ecofarming (p1), Microbat (p2), and Biotani Plus (p3). Sub plots were the frequency of biofertilizer application (F) consisted of five levels, namely spraying once at 50 days after sowing (DAS) (f1), spraying twice at 20 and 40 DAS (f2), spraying 3 times at 10, 30, and 50 DAS (f3), spraying 4 times at 10, 20, 30, and 40 DAS (f4), and spraying 5 times at 10, 20, 30, 40, and 50 DAS (f5). Thus, there were 15 treatment combinations that were repeated 3 times resulted in a total of 45 experimental units.

Research Implementation Procedures

Prior to planting, 90 beds, sized of 6 m x 1 m each, were made by previously clearing the land using a tractor and making the beds made manually with a hoe. The beds were set 10 cm high and 50 cm spacing between beds. SINHAS 1 maize seeds were first soaked in furadan solution for 3-5 hours. Planting was carried out by making a hole of 4 cm deep then inserting 2 corn seeds per hole and then covered with soil. Plant spacing used was 40 cm × 100 cm. At 40 DAS, soil heaping and bulking were conducted to maintain better soil aeration. Plant thinning was carried out on two weeks old plants by cutting one of the plants with the least growth, using scissors. Irrigation was done by inundating the plots to the height of the beds. The irrigation was carried out at 7 days intervals from planting to harvest.

Fertilization consisted of two types, namely basic fertilizers and fertilizers as treatment. The basic fertilizer was applied in three times during the plant growth stages. The first fertilization was carried out by providing basic fertilizers in the form of Urea 100 kg ha^{-1} and SP36 50 kg ha^{-1}. Further fertilization was carried out by mixing the fertilizers and applied as much as 6 g/plant placed next to the planting holes by means of a planning stick at 10 and 35 DAS, especially at 35 DAS, the dose of Urea given was reduced to 4 g / plant. Pest control was carried out when an attack occurs and was controlled using pesticides. Harvesting was done after the seeds on the cobs reach the harvest criteria with signs of dry leaves, yellow husks, dry and shiny seeds. Harvesting was carried out manually by twisting the corn cobs with the husk from each plant. Following harvesting, the corn was placed into plastic according to each treatment.

Biofertilizer Application

The application of Ecofarming, Microbat, and Biotany Plus biofertilizers to the plants started when the plants were 10 days old by dissolving 5 mL of each of these biofertilizers into 1 liter of water or by dissolving 75 mL of biofertilizer into a 15 liter tank pump. The application was carried out by spraying the upper and lower surfaces of the plant leaves in the morning. The time interval for applying biofertilizers is adjusted to the frequency of spraying. Spraying on the leaves of the plant is a problem in the treatment of biofertilizers, because the tools used did not function properly, so the spraying of biofertilizers may not be evenly distributed throughout the plant leaves. Plant maintenance carried out included weeding by cleaning weeds around the plants. The first and second weeding were carried out at the plant age of 7 DAS and 40 DAS, respectively.

Spraying Frequency

Spraying was carried out according to the treatment, namely by spraying 1 time (age 50 DAS), spraying 2 times (age 20 and 40 DAS), spraying 3 times (age 10, 30 and 50 DAS), spraying 4 times (age 10, 20, 30, and 40 DAS), and 5 sprays (aged 10, 20, 30, 40, and 50 DAS). For the five times spraying treatment at 10 DAS, 20 DAS, 30 DAS, 40 DAS, and 50 DAS, the volume of fertilizer application per plot was 2.1 L, 3.45 L, 4.8 L, 6.15 L, and 7 L, respectively. Based on the total number of plant per plot of 30 plants, then for the 5 L volume of spraying the average volume applied per plant was 70 mL for spraying at 10 DAS, 115 mL for spraying at 20 DAS, 160 mL for spraying at 30 DAS, 205 mL for spraying at 40 DAS, and 250 mL for spraying at 50 DAS. Spraying of biofertilizers at 30 DAS was postponed, because on that day pesticides were sprayed to cope with pests that attack the leaves of corn plants, so spraying was carried out the day after.

Observation Parameters and Data Analysis

Parameters observed in this study were ear height, wet weight of peeled ear (kg), ear length (cm), ear diameter (mm), seed yield (%), weight of 1000 seeds (g) on moisture content of 15%, and productivity (ton ha^{-1}). The data were collected and then tabulated in tabular form. The tabulated data was then analysed using analysis of variance (ANOVA) to test the effect of the treatment given. If there is a significant or very significant effect, then analysis was proceed with a follow-up test using the Least Significant Difference (LSD) test at the 5% level

C. Result

Results of the analysis of variance shown in table 1 indicate that the weight of 1000 seeds is the only character that was influenced by the types of biofertilizers treatment. On the other hand, the frequency of application of the biofertilizer had a significant effect on all components of SINHAS 1 yield characters, except for the weight character of 1000 seeds. Meanwhile, there was no significant interaction found between the types of biofertilizers and the frequency of application treatments on the yield component characters of the SINHAS 1 corn.

Table 1. Analysis of variance on the production component characters of SINHAS 1 Maize.

Character	Biofertilizer (P)	Frequency (F)	PxF	Cva	Cvb
Ear height	265.42	228.86*	50.1	19.76	9.45
Wet weight of peeled ear	0.54	3.36*	0.22	6.25	6.36
Ear length	0.29	2.55**	0.13	6.33	3.39
Ear diameter	1.25	5.58*	0.4	2.42	2.51
Seeds yield	2.9	20.57*	5.79	2.42	3.04
Weight of 1000 seeds	3026.14**	96.43	779.5	3.21	6.34
Productivity	0.31	1.39**	0.18	5.78	7.57

***=significant, **=highly significant**

The results of the LSD α=0.05 on the ear height (Table 2) show SINHAS1 maize applied with biofertilizer four times during plant growth resulted in the best average values on the ear height (Table 2) and wet weight of peeled cobs (Table 3). The tallest average of ear height was obtained in the treatment of 4 times spraying frequency (f4), namely 82.84 cm. On the contrary, shortest ear height of 70.58 cm was resulted from the once spraying frequency (f1). Meanwhile, for the character of wet weight of peeled cob (Table 3), the frequency of 4 times spraying (f4) show the highest value for the parameter (15.30 kg) while spraying the plants only once at 50 DAS (f1) showed the lowest average wet weight of peeled cobs of 13.67 kg.

Table 2. Average ear height (cm) of SINHAS 1 maize on different spraying frequency treatment.

Type of biofertilizer (P)	Frequency of spraying (F)					Average
	1 time (f1)	2 times (f2)	3 times (f3)	4 times (f4)	5 times (f5)	
Ecofarming (p1)	70.37	72.50	80.67	87.20	80.20	78.19
Mikrobat (p2)	67.27	81.57	78.07	74.93	77.43	75.85
Biotani plus (p3)	74.10	85.70	84.20	86.40	89.70	84.02
Ave	70.58_b	79.92_a	80.98_a	82.84_a	82.44_a	
$LSD_{0.05}$			7.30			

Numbers followed by the same letter on the row (a.b) are not significantly different in the LSD test at the confidence level of α 0.05.

Table 3. Average weight of wet weight of peeled cobs (kg) of SINHAS 1 maize on different spraying frequency treatment.

Type of biofertilizer (P)	Frequency of spraying (F)					Average
	1 time (f1)	2 kali (f2)	3 times (f3)	4 times (f4)	5 times (f5)	
Ecofarming (p1)	13.46	14.32	14.54	15.31	13.70	14.27
Mikrobat (p2)	14.04	14.54	14.45	15.24	14.62	14.55
Biotani plus (p3)	13.52	13.85	14.55	15.36	13.85	14.23
Average	13.67_b	14.24_b	14.51_{ab}	15.30_a	14.06_a	
$LSD_{0.05}$			0.88			

Numbers followed by the same letter on the row (a.b) are not significantly different in the LSD test at the confidence level of α 0.05.

The results of the LSD α=0.05 on ear length and diameter characters are shown in Table 4 and Table 5, respectively. The highest average of ear length was produced in the treatment of spraying frequency of 4 times (f4), namely 20.48 cm, but it was not significantly different from the treatment of spraying frequency of 3 times (f3). On the other hand, the frequency of spraying 1 time (f1) showed the lowest average of ear length of 19.13 cm. For the ear diameter character, use of spraying frequency of 5 times (f5) resulted in the highest value on the characters (48.78 mm), however, it was not significantly different from the spraying frequency of 3 times (f3) and 4 times (f4). On the other hand, the frequency of spraying 1 time (f1) treatment showed the lowest average ear diameter of 46.72 mm.

Table 4. Average ear length (cm) of maize on different spraying frequency treatment.

Type of biofertilizer (P)	Frequency of spraying (F)					Average
	1 time (f1)	2 times (f2)	3 times (f3)	4 times (f4)	5 times (f5)	
Ecofarming (p1)	19.12	19.97	20.23	20.48	19.73	19.91
Mikrobat (p2)	19.26	19.21	20.09	20.29	19.48	19.66
Biotani plus (p3)	19.00	19.31	19.91	20.67	19.45	19.67
Average	19.13_{c}	19.49_{bc}	20.08_{ab}	20.48_{a}	19.55_{bc}	
$LSD_{0.05}$			0.65			

Numbers followed by the same letter on the row (a.b) are not significantly different in the LSD test at the confidence level of α 0.05.

Table 5. Average ear diameter (mm) of SINHAS 1 maize on different spraying frequency treatment

Type of biofertilizer (P)	Frequency of spraying (F)					Average
	1 time (f1)	2 kali (f2)	3 times (f3)	4 times (f4)	5 times (f5)	
Ecofarming (p1)	46.50	46.63	47.55	47.72	49.00	47.48
Mikrobat (p2)	47.41	47.60	48.22	48.44	48.60	48.05
Biotani plus (p3)	46.26	47.56	47.88	48.13	48.73	47.71
Average	46.72_{c}	47.26_{bc}	47.88_{abc}	48.10_{ab}	48.78_{a}	
$LSD_{0.05}$			1.17			

Numbers followed by the same letter on the row (a.b) are not significantly different in the LSD test at the confidence level of α 0.05

Table 6. Average seed yield (%) of SINHAS 1 maize on different spraying frequency treatment.

Type of biofertilizer (P)	Frequency of spraying (F)					Average
	1 time (f1)	2 times (f2)	4 times (f1)	4 times (f4)	5 times (f1)	
Ecofarming (p1)	71.80	71.21	75.30	76.88	71.58	73.35
Mikrobat (p2)	73.18	73.07	73.86	75.36	75.52	74.20
Biotani plus (p3)	71.58	74.32	73.60	76.17	74.29	73.99
Average	72.19_{b}	72.86_{b}	74.26_{ab}	76.14_{a}	73.80_{b}	
$LSD_{0.05}$			2.19			

Numbers followed by the same letter on the row (a.b) are not significantly different in the LSD test at the confidence level of α 0.05.

Table 7. Average weight of 1000 seeds (g) of SINHAS 1 maize on different type of biofertilizer treatment

Type of biofertilizer (P)	Frequency of spraying (F)					Average	$LSD_{0.05}$
	1 time (f1)	2 times (f2)	3 times (f3)	4 times (f4)	5 times (f5)		
Ecofarming (p1)	376.04	368.72	381.93	380.34	395.13	380.43q	
Mikrobat (p2)	372.22	386.10	380.64	358.42	347.14	368.90q	12.45
Biotani plus (p3)	402.93	402.28	373.00	397.71	409.84	397.15p	
Average	383.73	385.70	378.52	378.82	384.04		

Numbers followed by the same letter on the column (a.b) are not significantly different in the LSD test at the confidence level of α 0.05.

The result of the LSD a 0.05 on the character of seeds yield, weight of 1000 seeds and productivity are shown in Table 6, Table 7, and Table 8, respectively. Based on Table 5, the highest average seeds yield was produced in the treatment of spraying frequency of 4 times (f4), namely 76.14%, but not significantly different from the treatment of spraying frequency of 3 times (f3).

The treatment of spraying frequency 1 time (f1) showed the lowest average seed yield, namely 72.19%. In Table 6, the highest average weight of 1000 seeds was produced in the Biotani plus (p3) biofertilizer treatment, namely 397.15 g. On the other hand, the Microbat biofertilizer treatment (p2) showed the lowest average weight of 1000 seeds of 368.90 g. As for the productivity character, the treatment frequency of spraying 4 times (f4) was the treatment with the highest productivity of 7.17 ton ha^{-1}. On the other hand, the one-time spraying treatment (f1) showed the lowest average productivity, namely 6.22 tonnes ha^{-1}.

Table 8. Average productivity (ton ha^{-1}) of SINHAS 1 maize on different spraying frequency treatment.

Type of biofertilizer (P)	Frequency of spraying (F)					Average
	1 time (f1)	2 times (f2)	3 times (f3)	4 times (f4)	5 times (f5)	
Ecofarming (p1)	6.05	5.77	6.67	7.30	6.14	6.39
Mikrobat (p2)	6.48	6.67	6.66	6.95	6.55	6.66
Biotani plus (p3)	6.13	6.38	6.77	7.26	6.49	6.61
Average	6.22_b	6.27_b	6.70_{ab}	7.17_a	6.40_{ab}	
$LSD_{0.05}$			0.48			

Numbers followed by the same letter on the column (a.b) are not significantly different in the LSD test at the confidence level of α 0.05.

D. Discussion

Based on the ANOVA results, the frequency of biofertilizers application was the dominant treatment in determining the yield components and productivity of SINHAS 1 maize. Meanwhile, types of biofertilizers had a minor effect on the growth of these characters. The low impact of the types of biofertilizers resulted in no significant effect of the interaction between types of biofertilizers and the frequency of application. This result is different from several other studies, where the difference in the frequency of spraying dis not have a significant effect on the character of growth and yield components of corn (Sitorus et al. 2015; Habibullah 2018). Similar result was also reported by Wahyuningratri et al. (2017) on large chilies and Amalia et al. (2019) on carrots in a pot. The difference between the results of this study and the previous study was due to the presence of other treatments that were more dominant, such as the dosage of fertilizers, the combination with other types of inorganic fertilizers. Therefore, the provision of biofertilizer frequency is important the cultivation of SINHAS 1 maize.

The insignificant of the effect of types of fertilizers treatment on most of the yield component characters was due to the composition between fertilizers that was relatively similar, especially on the role of microbes in biofertilizers. However, in the weight of 1000 seeds character, different types of biofertilizers was important, which is indicated by the significant effect of the fertilizer types in the ANOVA table (Table 1). This may be due to differences in potassium content between fertilizers. Based on the macro nutrient content (N, P, K) between fertilizers, Biotani plus has a high K_2O content of 3.69, while Ecofarming is 1.47% and Microbat only focuses on microbial content and does not include potassium content. In general, potassium has a role in the photosynthesis process and seed filling, so an increase in potassium can increase seed weight (Zou et al. 2007). In addition, according to Hasanuzzaman et al. (2018) and Adnan (2020) potassium has a role in the process of transferring food material or phloem loading in seed development, so that the number of empty seeds decreases with the increase in potassium. Therefore, different types of fertilizers due to differences in K content differentiate the character of 1000 seeds weight.

Based on the frequency treatment of biofertilizers, spraying the fertilizers 4 times during the plant growth was the best treatment for yield component characters. As for the spraying frequency of 5 times, several characters experienced a decline in growth. This indicates that the optimization level of the fertilization frequency is in 4 times application. In general, the effect of fertilizer increases gradually and will stagnate or decrease when fertilization has reached the peak dose or frequency. Curve or exponential decline has also been reported by Kyveryga et al. (2007) on the application of nitrogen fertilizer to maize crops, also reported by Soro et al. (2015) on the application of organic fertilizers to maize production, and Cheema et al. (2012) on dosing potassium fertilizer on canola plants. In addition, spraying the biofertilizer 4 times up to 40 DAS means that the fertilization was carried out at the stage of vegetative optimization. During this

stage, optimal leaf growth is in progress and can alter the photosynthesis process. In contrast, at the spraying frequency of 5 times up to 50 DAS, the leaves have started to turn yellow because the plants are focused on mobilizing seed filling. This was exacerbated in the SINHAS 1 corn cultivation process, where the corn was not defoliated on the dead leaves. Defoliation has a role in efficient use of photosynthate or plant energy (Ridwan et al. 2020). Yellow leaves are not optimal in the process of photosynthesis, but the leaves still use energy (Sugito 2009). Therefore, the use of biofertilizer application of 5 times is considered less than optimal in SINHAS 1 corn production. Meanwhile, biofertilizer application with a frequency of 4 times is recommended in SINHAS 1 corn cultivation.

E. Conclusion

The frequency of biofertilizer fertilization has a more dominant effect than the type of biofertilizer. The type of biofertilizer used has relatively the same role in the growth of the yield components of SINHAS 1 corn. Application of biofertilizer with spraying frequency of 4 times is recommended in fertilizing the SINHAS 1 maize crop.

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