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Effect of Fish Amino Acid Application on Growth and N-uptake in Plants Rice Using The System of Rice Intensification Method

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ABSTRACT

Rice is the staple food of most Indonesians. Rice production in Indonesia cannot be separated from inorganic fertilizers which have a bad impact on the environment, so it is necessary to carry out a revolution, one of which is the System of Rice Intensification (SRI) method. The addition of FAA organic matter originating from fish sorted by fishermen which have no selling price was used as a substitute for inorganic fertilizers. This study aimseds to determine the effect of FAA application on growth and N uptake in rice plants using the SRI method and to determine the best dose. This research was conducted in December 2019 - April 2020 at a greenhouse in Agroecotechnology Department, Faculty of Agriculture, Lambung Mangkurat University, Banjarbaru. The design used was a one-factor Completely Randomized Design (CRD), with treatment f_0 (0 mL FAA L^{-1} / control), f_1 (1 mL FAA L^{-1}), f_2 (3 mL FAA L^{-1}), f_3 (5 mL FAA L^{-1}), and f_4 (7 mL FAA L^{-1}). The treatment was repeated five times, to obtain 25 experimental units. Observation parameters in the study were plant height, number of tillers, and N uptake of rice leaves. The results showed that the application of FAA with a dose of 1 mL FAA L^{-1} was able to increase the height of rice plants by 5.5%, produced an average number of tillers by 14, and was able to increase N-uptake by 9.6% in rice plant leaves.

Keywords: liquid organic fertilizer, wetland, sub-optimal, N uptake.

1. Introduction

The rice plant is one of the main crops in agriculture and the staple food of most Indonesian even Asian. This commodity needs more attention from various parties as it can shake economic, politic, and social conditions if prices are unaffordable or unavailable (Hatta, 2012).

Rice production in Indonesia cannot be separated from the use of inorganic fertilizers. The SRI method is a practice in rice farming that emphasizes the management of soil, plant, and water through group empowerment and local wisdom using environmentally friendly activities as an effort to support agriculture sustainability (Anugrah, Sumedi, & Wardana, 2016). Implemention of the method is using materials around the farm, for example, the leftover fish which are no selling price.

FAA solution is one of the organic products made from fish. (Hapsari & Welasi, 2013) reported that fish waste contains N 64.78%, P 49.39%, and K 31.16%, which are the main components of organic fertilizers needed by plants in their growth. Nitrogen has an important role for rice plants, namely encouraging rapid plant growth and improving the level of yield and quality of grain through increasing the number of tillers, developing leaf area, grain formation, and protein synthesis. N-deficient rice result in few tillers and stunted growth. (Triadiati, Pratama, & Abdulrachman, 2012) reported that the application of fertilizers with different N content had a significant effect on the height of rice. Therefore, this study is expected to find the effect of FAA application on rice growth and N uptake in the SRI method and the best dosage of FAA.

2. Materials and Methods

Materials

This research was conducted at a greenhouse of the Agroecotechnology Department, Faculty of Agriculture, Lambung Mangkurat University, Banjarbaru. The materials used were Situ Patenggang variety, rainfed lowland soil, chicken manure, fish waste, brown sugar, and water. The tools used were buckets, hoes, sacks, jars, cloths, filters, sprayers, scales, trays, rulers, stationery, cameras, plastics, plastic bottles, paper bags, and laboratory equipment.

Method

FAA was made using fish and brown sugar which has been chopped and put in a jar in alternating positions with a ratio of 1:1 without being mixed with water. The jar is covered with a cloth and tied with string and stored in the shade for one month. The fermentation process occurs aerobically. After the fermentation process, nutrient contents were analysed. The planting medium was rainfed lowland soil in a bucket of 10 kg with the addition of 45 g chicken manure (10 t ha^{-1}) (Saputra & Sari, 2021) as basic fertilizer and incubated for one week. After the incubation period is complete, an analysis of the nutrient content of the planting medium is carried out. Sowing and planting of rice seeds are carried out using the SRI method. The maintenance carried out includes replanting if the plant dies, controlling the water condition in the bucket, and controlling pests if any. FAA was applied during the vegetative phase, namely the seedlings of 7, 14, 21, 28, 35, 42, 49, and 56 days. The spray volume for one FAA application was 125 mL/application obtained from the conversion of 1 L FAA which was applied eight times with each treatment and five replicates so that the spray volume per plant for one application was 25 mL $plant^{-1}$ when spraying the closed plants so as not to spread to other plants. The observations made included plant height (cm), number of tillers (tillers), and N-uptake (%). Statistical analysis for anova and DMRT (Duncan's Multiple Range Test) was performed using IBM SPSS Statistic 21.

3. Results and Discussion

Content of FAA and rice planting media

The analysis of pH and several macronutrients of N, P, K, and organic-C in FAA and planting media are shown in Table 1.

Table 1. Characteristics of FAA and growing media

No.	Sample	pH (H_2O)	Total-N	P_2O_5	K_2O	Org-C
			----------%----------			
1.	Liquid fertilizer (FAA)	4.91	0.02	0.13	0.07	0.60
2.	Soil + chicken manure	6.11	0.13	0.19	0.21	1.43

The N, P, and K, as well as organic-C contents was classified as very low, but pH analysis had met the standard (4.91) which classified as acidic. The nutrient content in growing media (Table 1) shows a very low fertility rate. (Bustami et al., 2012) in their research stated that the N value of 0.09% was very low, P 7.18% was low, K 0.30% was low, organic-C 1.10% was low and a pH of 6.91 was classified as neutral and 5.35 was slightly acid. The nutrient content of the planting media was N 0.13% which was very low, P 0.19% was very low, K 0.21% was low, 1.43% organic-C was low and pH 6.11 was slightly acidic.

The low nutrient content in FAA and planting media increased plant height, some tillers, and N uptake. The pH in FAA and planting media were standards so that it was safe for plants, while low nutrients had an impact on plant quality. The overall nutrient content in the FAA had a complete composition, but the concentration was low. The process of making FAA in this study only from two ingredients, namely *jeblok* fish and brown sugar. Therefore, to improve the quality of nutrients other ingredients needed to be added. (Sentana, 2010) states that the low nutrient content of organic fertilizers can be increased by enriching nutrients or adding certain microbes.

Plant height

The application of the FAA with different doses, in the SRI method after eight weeks showed a very significant effect. The average effect of FAA administration on plant height is presented in Figure 1.

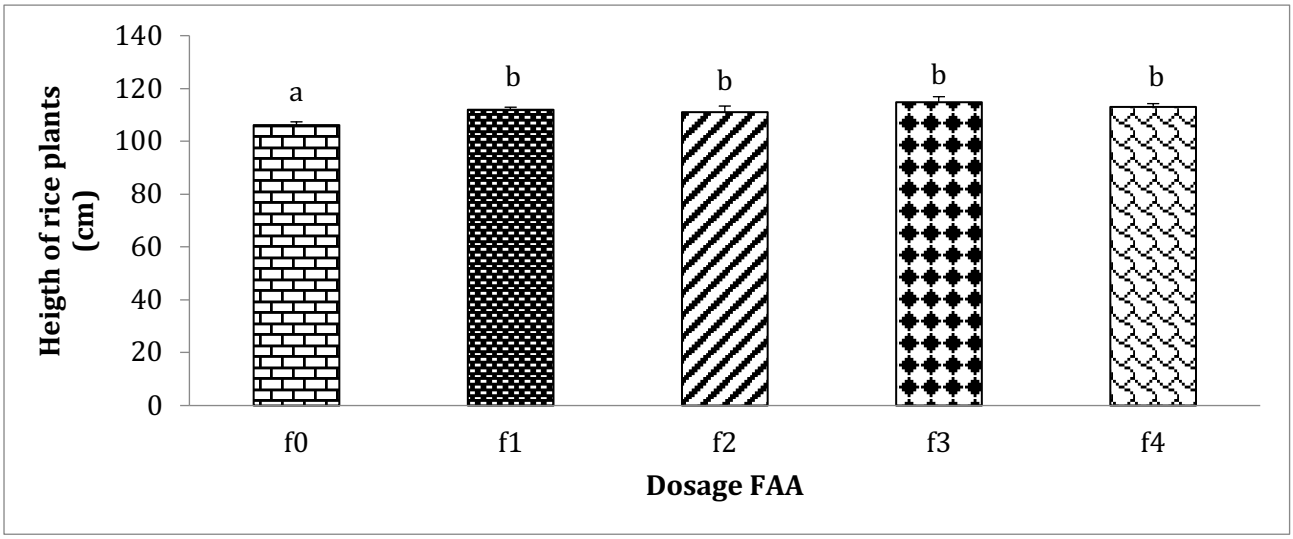

Figure 1. Height of rice plants using the SRI method with FAA application. f_0 = control, f_1 = 1 mL FAA L^{-1}, f_2 = 3 mL FAA L^{-1}, f_3 = 5 mL FAA L^{-1}, f_4 = 7 mL FAA L^{-1}. The line above the bar represents the standard error of the treatment (n=5). The same letter above the line indicates that the treatment has no different effect based on DMRT (0.5%).

The application variety of FAA with different doses in the SRI method had a very significant effect on the height of rice plants and was not significantly different between treatments. Treatment f_1 1 mL FAA L^{-1} was not significantly different from treatment f_2 3 mL FAA L^{-1}, f_3 5 mL FAA L^{-1}, and f_4 7 mL FAA L^{-1}. Treatment f_1 1 mL FAA L^{-1}, f_2 3 mL FAA L^{-1}, f_3 5 mL FAA L^{-1}, and f_4 7 mL FAA L^{-1} were significantly different from treatment without FAA (control), so that the best treatment was at f_1 1 mL FAA L^{-1} because with this dose can provide the same effect with the highest dose, namely f_4 7 mL FAA L^{-1}. This was due to the difference in the administration of the FAA dosage which was not too far from the recommended dosage in the Agricultural Service (El-Shafie, 2012) which uses a dose of 10 mL FAA for 10 L of water.

Different FAA doses did not provide a significant difference in the height of rice plants. According to (Yasin, 2016), the high and low dose does not determine the plant height and the best number of tillers in rice plants, because plant growth is also influenced by environmental factors. Based on observational data, rice plants positioned to the north or adjacent to the greenhouse wall did not get the optimal lighting time so that rice plants in that area has a higher height than rice plants that are towards the south. Hence, the placement in the greenhouse also affects plant height. Also, the SRI planting method used affects plant height growth, such as using a planting pattern of one seed per planting hole, young seeds, irrigation, and fertilizing with organic matter. This is by (Pratiwi, 2016) which states that in the SRI method, rice plants will get optimal light, while plant elongation will be spurred if the light intensity is low (etiolation).

(Misran, 2013) states that the longer the seedlings are planted, the higher the plants are, whereas, in the SRI method, the rice plant seeds used are young so that this can be a factor in the height of the rice plants in the treatment, which does not show much difference. Usman et al. 2014 reported that the faster the seedlings were transferred, the shorter the stagnation period of the seeds was. The shorter the stagnation period of the seedlings, the higher the growth of the rice plants, because the plant's dormancy period is shorter, so the growing period will be longer

Number of tillers

Number of tillers for eight weeks after the application of the FAA in the SRI method showed significant results. The average effect of FAA administration with different doses of the SRI method can be seen in Figure 2.

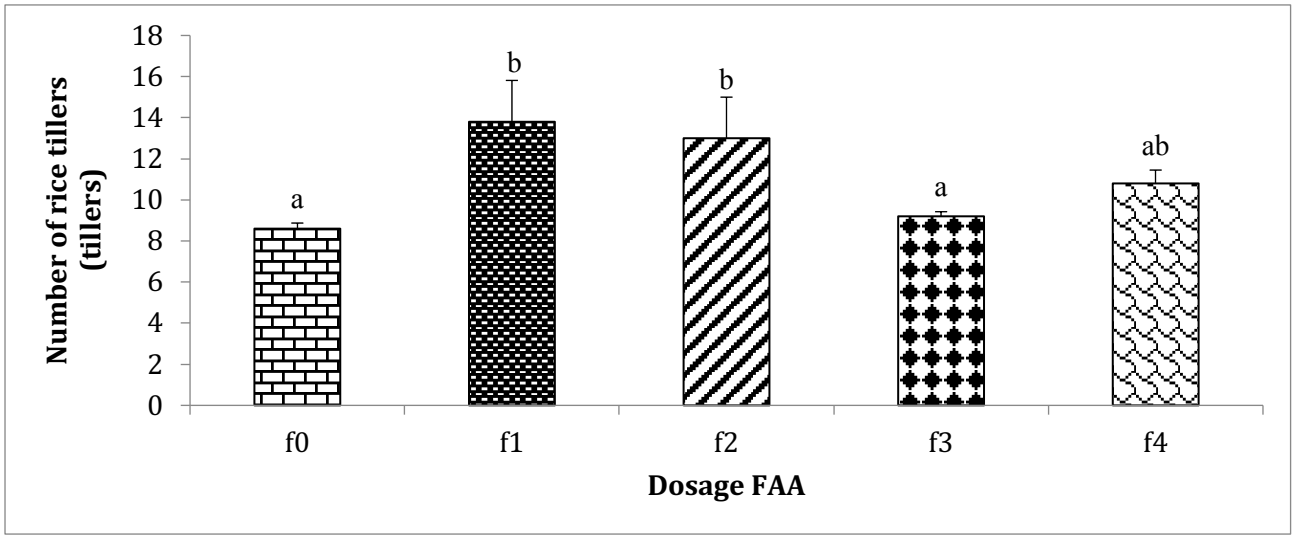

Figure 2. The number of rice tillers using the SRI method with the FAA application. f_0 = control, f_1 = 1 mL FAA L^{-1}, f_2 = 3 mL FAA L^{-1}, f_3 = 5 mL FAA L^{-1}, f_4 = 7 mL FAA L^{-1}. The line above the bar represents the standard error of the treatment (n=5). The same letter above the line indicates that the treatment has no different effect based on DMRT (0.5%).

The application variety of FAA with different doses in the SRI method, it had a significant effect on the number of tillers of rice plants. Treatment f_1 1 mL FAA L^{-1} was significantly different from f_3 5 mL FAA L^{-1} and treatment without FAA administration (control), but not significantly different from treatment f_2 3 mL FAA L^{-1} and f_4 7 mL FAA L^{-1}. The best treatment for FAA in the SRI method was in the f_1 1 mL FAA L^{-1} treatment with the highest number of tillers, which was 13.8 tillers.

FAA at a dose of 1 mL FAA L^{-1} had been able to meet the needs of rice plants in increasing the number of tillers. This indicates that the difference in dosage was not always directly proportional to the growth in the number of tillers. The results of the research by (Triadiati et al., 2012) stated that giving fertilizer doses by plant needs can increase growth. (Zheng et al., 2007) states that excessive doses of fertilizer will be toxic to plants and interfere with the vegetative and generative stages. Based on the results of the observations, it was concluded that plants did not require a high dose but rather the correct dosage.

The response to increasing the number of tillers is also supported by the SRI method with the principle of planting one seed per plant so that the plants are more flexible to develop, receiving light and absorbing nutrients. (Pratiwi, 2016) states that SRI planting tends to form the number of tillers due to the adequacy of the light intensity received. The SRI planting method applies several provisions, one of which is the use of young seeds. This study used 10-day old rice seeds to produce the maximum number of tillers. This is in line with the research results of (Anditya, Aditama, Hidayat, & Ikhwani, 2021) which states that younger seedlings will produce more tillers. (Usman et al., 2014) stated that rice plants planted at older seedlings caused less ability to form tillers. An older nursery will result in the risk of damage to the roots during transplanting because the condition of the plants in the nursery is getting stronger, so the ability of rice plants to absorb nutrients will be disturbed. (Thakur at al., 2010) reported that tillers on the SRI method have the potential to produce panicles of productive tillers. Management in the SRI planting method deviates a lot from conventional planting patterns. It aims to provide optimal growth conditions for plants for better yields and productivity.

N-uptake

The application of the FAA with different doses in the SRI method showed that the treatment did not significantly affect the N-uptake. The difference in N-uptake in each treatment ranged from 0.01-0.08%. The data on the average N uptake in rice can be seen in Figure 3.

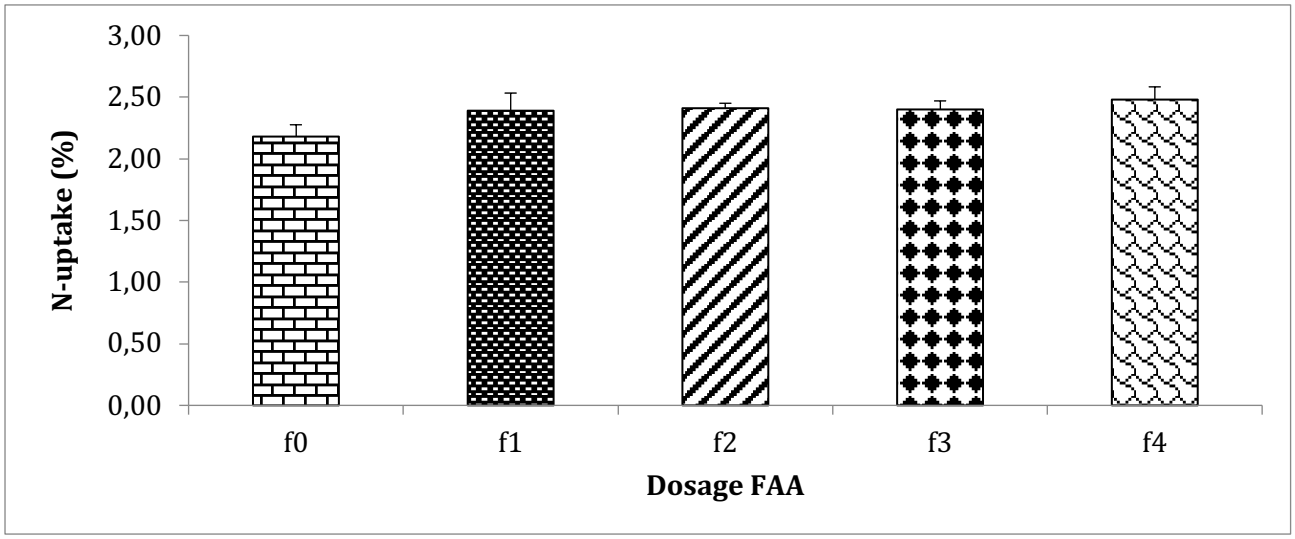

Figure 3. The nitrogen uptake with the SRI method with the FAA application. f_0 = control, f_1 = 1 mL FAA L^{-1}, f_2 = 3 mL FAA L^{-1}, f_3 = 5 mL FAA L^{-1}, f_4 = 7 mL FAA L^{-1}. The line above the bar represents the standard error of the treatment (n=5). The same letter above the line indicates that the treatment has no different effect based on DMRT (0.5%).

Based on the analysis of variance, it showed that the FAA treatment with different doses in the SRI method did not show a significant difference between treatments for N uptake in the leaves of rice plants. The highest N uptake in the leaves of rice plants was shown in the f_4 treatment of 7 mL FAA L^{-1}, namely 2.48%.

Nitrogen is an essential macronutrient for plants because its presence is needed for the plant growth process. The sampling analysis was carried out at the end of the vegetative period of the plant because the element N was absorbed maximally in the growth process. This statement is supported by (Supartha et al., 2012) which states that N nutrient plays an important role in the vegetative and generative phases of plants.

The average rice plant leaves were able to absorb more than 2% of the N nutrient obtained from FAA and planting media. According to research by (Patti et al., 2018), the average N content in plant tissue is 2-4%. Less than optimal N fertilization will result in plants deficient in N elements. For plants deficient in N, their growth will be inhibited, the leaves turn light green so that they can slow down the photosynthesis (Setyanti et al., 2013). (Yasin, 2016) in his research conveyed that N contained in liquid organic fertilizer is slowly available to plants.

The relationship between the N absorption value and the growth of rice plants using the SRI method can be seen from the increase in the height of the rice plants and the number of tillers formed. The highest N uptake did not determine the increase in plant height growth and the number of tillers of rice plants using the SRI method. According to research (Razie et al., 2013), nutrient uptake in SRI cultivation is higher than conventional cultivation. (Barison & Uphoff, 2011) added that deep root systems and a lot of SRI cultivation contribute to increased nutrient uptake. Applying high and appropriate N fertilizer to plants will affect N uptake (Soplanit et al., 2018). According to Patti et al. (2013), the main factors that influence the presence of N in plant structure are nutrients in the soil, especially N and plant water availability.

4. Conclusion

The application of FAA effected plant height and the number 1 mL FAA L^{-1} (f_1) increased the height of rice by 5.5%, produce an average number of 14 tillers, and increased N uptake by 9.6% on rice leaves.

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