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by Damanhuri Damanhuri

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Nitrogen and biodegradator application to trigger ratoon growth and production of rice (*Oryza Sativa*)

Damanhuri [1] and T W Widodo[1]

[1]Departement of Agriculture Production, Politeknik Negeri Jember, Indonesia 68124

*email: damanhuri@polije.ac.id

Abstract. Increasing the rice harvest index to 5 times a year through ratoon system was an effort to fulfill food sufficient. Currently, ratoon productivity was only 40-50% lower than it's parent plant. Utilization of rice stump biodegradator and nitrogen in the ratoon system could be applied to increase ratoon productivity. The aimed of this research was to trigger tillers formation and production of ratoon through application of biodegradator and nitrogen. The experiment arranged in split plot design. The first factor was time of biodegradator application (main plot), i.e at harvest, 3 days after harvest, and 6 days after harvest, while the second factor was time of nitrogen application (sub plot), i.e 3 days before harvest, at harvest, and 3 days after harvest. The dosage of biodegrator and nitrogen were the same for all treatments, i.e 2.2 ml.plot^{-1} and 8.3 g N.plot^{-1} respectively. Collecting data was consisted of number of tillers, number of productive tillers, number of leaves, number of grains per panicle, and weight of 1000 seeds. The results showed that all data observed were non-significantly different among treatment of biodegradator, nitrogen, as well as the combination. It was assumed that the dosage of biodegradator and nitrogen were not sufficient to trigger tillers formation of ratoon, so that the effect of application time of biodegradator and nitrogen were not significant.

1. Introduction

Food security is a major issue today. Based on data from the global hunger index in 2018, the number of Indonesians who are still experiencing hunger is around 21.9 million. The government always makes innovations to fulfill indonesian food needs. One of the innovations that can be done is to increase the productivity of food crops, especially rice. However, there are still many challenges in the implementation process. These challenges are paddy fields reduction due to land use change [1] and climate change.

The agricultural sector have to adapt to climate change. The most common of adaptation is using tolerant varieties because the adaptation is relatively easy [2]. Therefore, the adaptation that can be done to support the productivity of the agricultural sector, especially rice, is to change to ratoon rice system. Ratoon rice productivity is 40-50% lower than the parent plant, but the cultivation is very suitable for water deficit areas due to climate change [3].

Ratoon rice cultivation can increase the harvest index from 3 to 5 times a year. Although ratoon productivity decreased after the second growing period, through the application of better cultivation technology, ratoon productivity could be increased. The ratoon cultivation technology will save more money, labor, production facilities, and reduce land preparation time.

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The technology that can be applied to increase the productivity of ratoon rice is through stimulation of tillers formation. New rice tillers that grow through flushing are a major factor of productivity. The formation of tillers in the first to fourth ratoon can't be separated from the role of many factors, one of them is nutrition. Nutrients, especially nitrogen, is important factors in stimulating the formation of tillers.

Nitrogen plays a role in stimulating plant growth by increasing the number of tillers and leaf area [4]. The application of nitrogen will affect the number of tillers and then it will also increases the number of panicles in ratoon rice [5]. Increasing the number of tillers must be supported by the capacity of the plant growing space. Therefore, the remaining stump of the parent plant needs to be decomposed by biodegradator microorganisms.

The application of these two treatments will synergize with each other to stimulate flushing of rice tillers. Newly grown tillers will grow optimally if the space for growth is not limited. Degradation of the rice stump will provide an opportunity for shoots to grow optimally to form tillers. So that, this research aim is to identify the role of nitrogen and biodegradator microrganisms to stimulate flushing of rice tillers.

2. Methods

This research was conducted in State Polytechnic of Jember from May until October 2020. Materials used in this research were rice (Inpari 32 variety), Urea (source of nitrogen), biodegradator (effective microorganism), SP-36, KCl, and pesticide. The tools used in this research were electric sprayer and analytical scales.

The experiment arranged in split plot design. The first factor was time of biodegradator application (main plot), i.e at harvest, 3 days after harvest, and 6 days after harvest, while the second factor was time of nitrogen application (sub plot), i.e 3 days before harvest, at harvest, and 3 days after harvest. The dosage of biodegradator and nitrogen were the same for all treatments, i.e 2.2 $ml.plot^{-1}$ and 8.3 g $N.plot^{-1}$ respectively.

Collecting data was consisted of number of tillers, number of productive tillers, number of leaves, number of grains per panicle, and weight of 1000 seeds. All of data tested by the analysis of variance (anova) and then it was followed by the Duncan Multiple Range Test (DMRT) if the anova showed significantly different.

2.1. Planting of rice parent

Inpari 32 variety of rice was planted first. The rice was cultivated until harvest according to standard operational procedures of rice.

2.1.1. Treatment application

Rice stumps were cut along 10 cm from the soil surface before treatment application. Biodegradator treatments (2.2 $ml.plot^{-1}$) was carried out at harvest, 3 days after harvest, and 6 days after harvest, while the nitrogen treatment (8.3 g $N.plot^{-1}$) was carried out at 3 days before harvest, harvest, and 3 days after harvest.

2.2. Ratoon rice cultivation

Ratoon was cultivated until harvest according to standard operational procedures of rice. Additional of fertilizer for ratoon using Phonska (150 $kg.ha^{-1}$) and KCl (100 $kg.ha^{-1}$) that carried out at 25 day after parent rice harvest. Spraying of pesticide, irrigation, and weeding were carried out according to the plant condition in the field.

3. Result and discussion

The rice variety planted in this research was Inpari-32 which has a 120-days harvesting age. In this study, the ratoon harvesting age is 81 days after stump cutting, it's faster than the parent plant.

Another research reported that the harvesting time of the ciherang ratoon variety was between 69-84 days after stump cutting [6]. Ratoon age was shorter than the parent plant because after the rice stalks were cut, the tillers will flowering and producing panicles [7]. Harvesting correlated with flowering time. If the ratoon plant blooms quickly, it will be harvested faster. In this study, the flowering time of ratoon was 31-42 days after stump cutting. Another research reported that the flowering time was 30- 44 days after stump cutting [6].

The study results showed that all observed data are not significantly different. It means that each treatment level, both nitrogen and biodegradator, has the same effect on all observed components. The effect of nitrogen is not significant at each level of the biodegradator and vice versa, resulting in no interaction between the two factors.

The application of nitrogen is to stimulate the formation of ratoon rice tillers. Nitrogen is an important nutrient on tillers formation because it is a component of hormones and enzymes that play a role in flushing of ratoon. In addition, nitrogen is a sizable component in all parts of the plant. The application of nitrogen can increase the accumulation of nitrogen in the leaf and stalks of ratoon [8].

The different timing of nitrogen application aims is to identify the best time to stimulate shoots, because nitrogen is a very mobile element. In addition to be absorbed by plants, nitrogen will be lost through leaching and volatilization. The absorption of nitrogen is not optimal because root formation in the ratoon is slow because the parent roots are still relatively functional, as a result the nitrogen use efficiency is low and much of nitrogen is lost.

Table 1 showed that the effect of various nitrogen application times on all observed variables. The number of tillers, number of productive tillers, number of leaves, number of grains per panicle, and weight of 1000 seeds showed non-significantly different at all times of nitrogen application. Nitrogen application 3 days before harvest tended to increase the number of tillers, but the number of productive tillers is not as much as nitrogen application 3 days after harvest. The number of late- emerging tillers usually results in lower yields and is even unproductive [9]. The number of tillers directly correlated with the number of leaves. However, only the leaves of the productive tillers that optimally in grains filling. Therefore, the number of leaves in productive tillers was closely related to the number of grains per panicle although it was not significant statistically.

Table 1. Observed data of ratoon rice based on nitrogen treatment

Nitrogen Treatment	Number of Tillers	Number of Productive Tillers	Number of Leaves	Number of Grains per Panicle	Weight of 1000 Seeds (g)
at harvest	24.39	14.86	88.56	74.86	29.67
3 days after harvest	20.97	12.07	75.56	72.56	29.89
6 days after harvest	22.36	16.90	81.33	75.03	29.83

Ratoon tillers grow from each node of the rice stump. Nitrogen is a macro nutrient that can trigger ratoon flushing. Nitrogen application with the same dose at 3 different times showed that number of tillers is not different. Nitrogen application 3 days after harvest tended to be better in triggering the number of productive tillers. Increasing the number of productive tillers can increase the number of grains per panicle. That's because nitrogen is a chlorophyll component that plays a role in the photosynthesis process to produce asimilate.

The biodegradator application aims is to trigger the decomposition of rice stumps. If the rice stump decomposes more quickly, it will increase the soil organic matter content and provide maximum growth space for rice tillers, so that it will increase the ratoon growth.

The aim of biodegradator application at different times is to identify the best time to stimulate ratoon growth by providing growth space. The results showed that all components observed (number of tillers, number of productive tillers, number of leaves, number of grains per panicle, and weight of 1000 seeds) were not significantly different (Table 2). The 6 days after harvest biodegradator application tended to be better in triggering the number of tillers, the number of productive tillers, the number of leaves, and the number of grains per panicle.

Table 2. Observed data of ratoon rice based on biodegradator treatment

Biodegradator Treatment	Number of Tillers	Number of Productive Tillers	Number of Leaves	Number of Grains per Panicle	Weight of 1000 Seeds (g)
at harvest	21.44	14.28	76.78	69.14	29.89
3 days after harvest	22.97	12.63	82.22	64.39	29.39
6 days after harvest	23.31	16.93	86.44	74.14	29.56

The number of productive tillers, the number of leaves, and the number of grains per panicle tended to be higher in the biodegradator application 6 days after harvest. It is assumed that at the beginning of harvest, the stump cells are still matabolims actively, especially for the formation of new shoots. So that the biodegradator is still not functioning optimally. However, on the 6 day after harvest, new shoots have started to form, so that it will trigger the part of non-metabolized rice stump (dead cells) to be decomposed by the biodegradator.

4. Conclusion

All data observed were non-significantly different among treatment of biodegradator, nitrogen, as well as the combination. It was assumed that the dosage of biodegradator and nitrogen were not sufficient to trigger tillers formation of ratoon, so that the effect of application time of biodegradator and nitrogen were not significant.

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