



Effect of liquid organic fertilizer on growth and yield of rice varieties in rainfed field



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ABSTRACT

Rice is a superior crop that is cultivated and increased in productivity. Increasing rice productivity is done in an efficient way, especially in rainfed land, namely the addition of Liquid Organic Fertilizer (LOF) and variety selection. The purpose of the study was to determine the effect of LOF, the effect of interaction between LOF and varieties on growth. This research is experimental using the RAK split plot method consisting of two factors. The first factor is LOF consisting of fermented banana stump, coconut fiber, bamboo shoots and maja fruit as the main plot with 2 levels of treatment, namely without LOF and with LOF. The second factor is rice varieties as subplots with 5 treatment levels. Combination of 2 levels of LOF and 5 levels of rice varieties. The number of sapling, net assimilation rate, and relative growth rate of rice with LOF were significantly different from those without LOF. The provision of LOF on the Inpari Sidenuk variety has the highest average number of sapling, which is 18 stems and is significantly different from the treatment without LOF which has an average number of tillers of 15.40 stems. So that the provision of LOF provides growth on rainfed land.

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INTRODUCTION

Rice is source of the main food for people in Indonesia. The demand for rice continues to increase, but farmers contend challenges in cultivating rice crops. One of them is agricultural land which is getting narrower due to the function of non-agricultural land. As a result, the amount of rice in Indonesia has decreased from year to year. The production of rice in Indonesia at 2021 is 54.42 million tons of GKG or a decrease of 233.91 thousand tons (0.43%) compared to 2020. West Kalimantan is one of the provinces with rice production of less than 2,000 tons of GKG with

a harvest area of 223.17 thousand hectares (BPS, 2022). Singkawang city in 2020 produced rice as big as 13.79 thousand tons of GKG and experienced an increase of 1.48 thousand tons (12.04%) compared to 2019 (BPS Singkawang city, 2021). The increase in rice production in Singkawang city until 2020 is still insufficient for the rice needs of the Singkawang population which currently numbers 260 thousand people where the annual rice consumption according to Susenas data is 116.97 kg per year per capita so that there is still a shortage of 11 thousand tons of rice. To meet these needs, it is necessary to increase rice production, one of which is the use of liquid organic fertilizer (LOF) which utilizes local technology.

The basis used in the LOF selection is made from local microorganisms, namely the use of local technology, raw materials available on the spot, the porosity level of rainfed rice field soil is quite high, the soil texture is fragile / loose, lack of soil microorganisms. LOF made from local microorganisms in the technical cultivation of sustainable plants in addition to having a relatively complete nutrient content must also be ensured sustainability in the availability of raw materials. Local microorganism that is beneficial to plants contained in raw materials does not only contain one type of microorganism, but contains several microorganisms, including *Rhizobium* sp., *Azospirillum* sp., *Azotobacter* sp., *Pseudomonas* sp., *Bacillus* sp., and phosphate solvent bacteria. The use of organic fertilizers is also able to maintain land equilibrium and increase land productivity and reduce soil environmental impacts (Supartha, 2012).

LOF solution contains macro and micro nutrients necessary for plant growth and is used as a biofertilizer for efforts to increase crop production. It also acts as a cellulolytic agent (protecting plants from disease and potentially as a biological fungicide). The use of LOF is cheaper, greener, and maintains natural balance (Syamsuddin, 2013). The main ingredient of the first is banana weevil. According to Kesumaningwati (2015), banana weevil is a decomposer of local microorganisms (MOL) which has a chemical quality pH of 8.59; C/N ratio of 31.48; N total 1.78%, P 2 O 5 0.41%; and K₂O 1.59% as well as the MOL decomposer banana weevil used to decompose had higher pH values, C/N ratios, total nitrogen, phosphorus, and potassium.

The second main ingredient is coconut husk. Coconut husk containing 10.25% potassium can be used as a choice of organic potassium sources to replace KCl fertilizer. Coconut husk contains Ca, Mg, K, Na, and P which are nutrients that are suitable as organic fertilizers. Coconut husk as a growing medium can bind and hold water strongly, has good aeration and drainage, is suitable for hot climates, and contains essential nutrients (Rahma et al., 2019).

The third ingredient is bamboo shoots. Bamboo shoots contain gibberellin and organic C which are used as LOF so that they can stimulate plant growth quickly (Angraeni et al., 2018). Gibberellin is a hormone that has a function in plants that will help the process of perfect formation in plants. Some of the functions of gibberellin include accelerating the growth of shoots, elevating dwarf plants to normal growth, enlarging fruits and seeds. In addition, bamboo shoots also contain local microorganisms, namely *Azotobacter* and *Azospirillum*. Both bacteria are rhizosphere bacteria that can stimulate and spur plant growth and protect plants from various pathogens (Walida et al., 2019). The last main ingredient is the maja plant. It has benefits as a natural pesticide, LOF maker or sugar substitute, and has antibacterial properties containing alkaloids, flavonoids, and tannins (Herawati, 2016).

Increasing rice productivity, either through increasing the potential or yield power of the plant as well as its tolerance and/or resistance to biotic and abiotic stress can be done with innovative technology, namely superior varieties (Rohaeni, 2012). The ability of a variety to grow and develop optimally is determined by the location or place of growth. Therefore, it is necessary to conduct a study in the form of giving LOF to several varieties of rice in rainfed rice fields to increase perfect plant growth so that it will produce optimal rice. The purpose of this study is to

determine the influence of LOF, the influence of varietal interactions between LOF and varieties in the growth and yield of rainfed rice.

RESEARCH METHODS

Research Design

The study used the split plot design of RAK consisting of two factors. The first factor is LOF (P) as the main plot with 2 levels, namely p₀= Without LOF, p₁= using LOF at a dose of 600 ml 15 liters-1 water. The second factor is the variety of paddy (V) as sub plot with 5 levels v₁=Mekongga variety, v₂= Inpari variety 32, v₃=Ciherang variety, v₄=Inpari Sidenuk variety, v₅= Diah Suci variety. The area of each plot is 34 m x 3 m 9 m².

The paddy fields that used for research are cleared of various types of woody plants or weeds by being slashed using machetes or sprayed using appropriate herbicides. The soil is treated first using a hand tractor and leveled using a rake and hoe. Plot is made according to the predetermined experimental design with size of 3 × 3 m per plot and as many as 30 plots.

Population and Samples

The research was carried out at the location of rice fields owned by farmers on Jl. Semai , Sungai Garam Hilir, North Singkawang District, Singkawang City. The materials used in the study were rice seeds of Inpari 32, Mekongga, Ciherang, Inpari Sidenuk, Diah Suci, NPK Mahkota fertilizer, non-subsidized urea, dolomite, LOF, and pesticides.

Instruments

This research used various types of tools to produce data according to the procedures. The tools used in this research were hand tractors, hoes, machetes, blades, ropes, rulers, meters, scales, ovens, moisture testers and documentation tools.

Procedures

The implementation of research begins with seedbeds of rice seeds of the Mekongga, Inpari 32, Ciherang, Inpari Sidenuk, Diah Suci varieties with sow rice seeds in accordance with research requirement. This research procedure can be seen in Figure 1. Before the seeds are soaked in water for about 36 hours then the water is removed, the seeds are drained within 24 hours. Seeds that have already opened growing eyes are sown on the site of a pre-prepared seedbed.

Planting is carried out after the age of the rice seedlings is seedbed for about 21 days. The planting pattern used is a “tandur jajar” planting pattern using a planting distance (25×25) cm. During the study, fertilization was carried out 3 (three) times, basic fertilization 7 days after planting (HST) urea 50 kg per hectare, NPK 100 kg per hectare, the first follow-up fertilization, namely 20 HST urea 50 kg per hectare and NPK 50 kg per hectare and the second follow-up fertilization, namely 35 HST NPK 50 kg per hectare

Treatment using LOF is carried out at the time of tillage by casting, then by spraying once a week starting from the 7th day of HST. LOF application is carried out at a time when the vegetative of the plant lasts a maximum. Weed control during the study, carried out 2-time weeding. The first weed control was carried out on rice plants at the age of 20 HST and the second was carried out weed control on plants aged 35 HST. Harvesting is carried out when the rice crop is ripe ± 80%. Harvesting is carried out simultaneously at one time while taking the final data of the study. This research procedure can be seen in Figure 1.

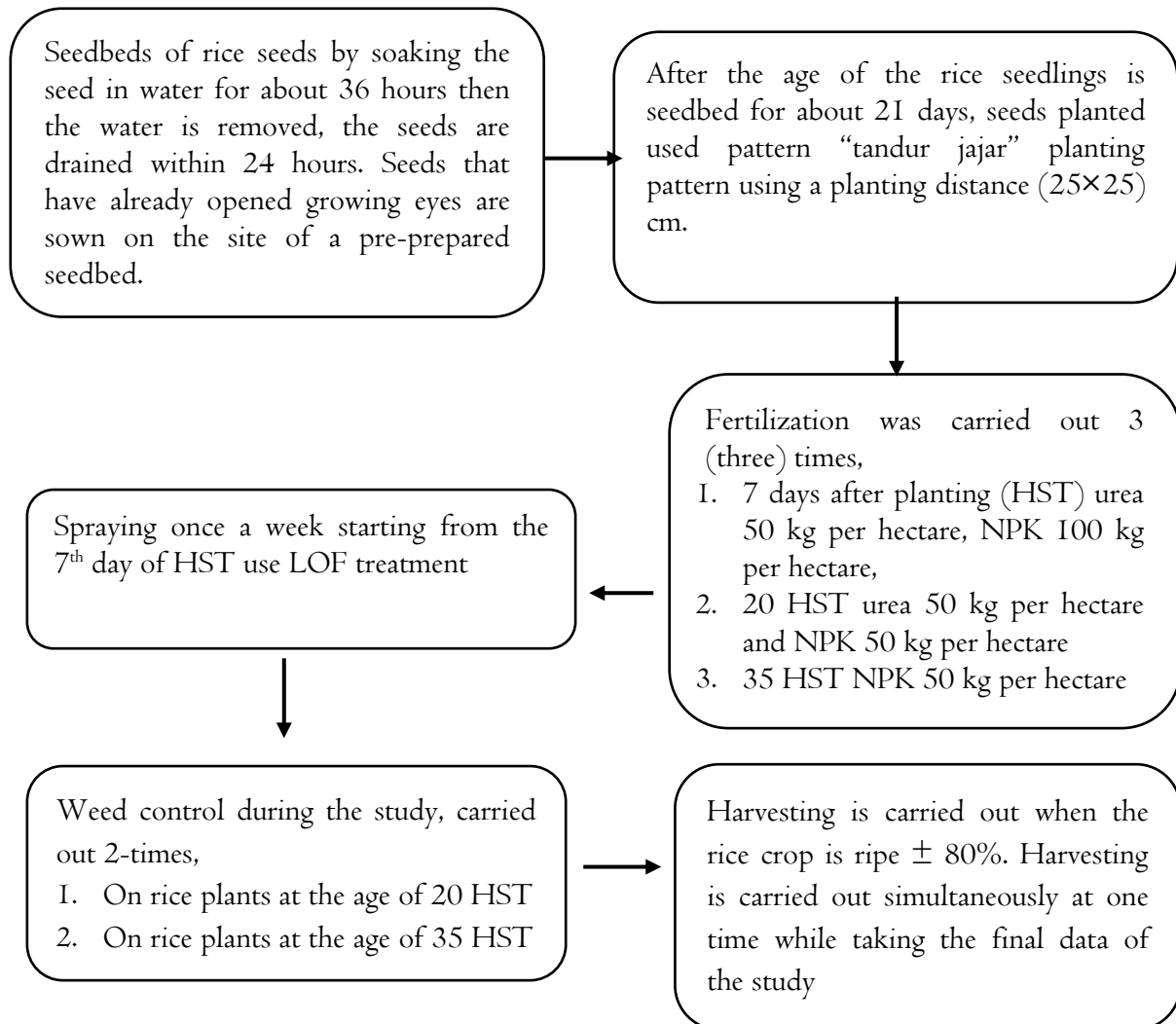


Figure 1. Procedures of research

Data Analysis

Research data were analyzed using descriptive statistics and inferential statistics. Descriptive statistics to show descriptions of critical thinking. Descriptive statistical values include average, highest average, lowest average, and difference between pre-test and post-test changes. Inferential analysis using one way ANCOVA test with a significance level of 5% was used to test the hypothesis, before the data was analyzed with the one way ANCOVA test, prerequisite tests were first carried out, namely the normality test and homogeneity test. Normality test using Kolmogorov-Smirnov One-Sample test. Homogeneity test using Levene's Test of Equality Of Error Variance (Mertler & Reinhart, 2017). Data that has been tested with one way ANCOVA followed by LSD test.

RESULTS

Results Analysis of the diversity of the number of saplings on plants aged 28 days after planting LOF treatment and variety had a significant effect on the number of saplings. On plants aged 14, 42 and 56 HST, it was shown that LOF treatment and varieties had no significant effect on the number of saplings, and the interaction between LOF and varieties had a significant effect on the number of saplings on plants aged 14 HST. Then a 5% BNJ test was carried out to find

out the differences in each of the resulting treatments which can be seen in Table 1 and Table 2. The results of the 5% BNJ test in Table 1 show that at plant age 28 HST the LOF treatment had a significant effect on the number of saplings, while at plant ages 14, 42 and 56 HST the LOF treatment had no significant effect on the number of saplings.

Table 1. BNJ test of 5% influence liquid organic fertilizer against the average number of saplings

Treatment	Average Number of saplings (stems)			
	14 HST	28 HST	42 HST	56 HST
Without LOF	15.56 a	22.73 a	28.93 a	36.85 a
With LOF	15.76 a	25.25 b	32.00 a	32.04 a
BNJ 5%	0.49	1.27	12.31	4.96

Source: Results of research data analysis 2021

Description:

The numbers followed by the same letter in the same column do not differ markedly according to the BNJ test at a level of $\alpha=5\%$

The results in Table 2 show the interaction between LOF and rice varieties on the number of saplings in plants aged 14 HST. The application of LOF in the Inpari Sidenuk variety had the highest average number of saplings, which was 18 stems. This was significantly different from the treatment without LOF on the Inpari Sidenuk variety had an average number of saplings of 15.40 stems. The lowest value of the average number of saplings in the treatment of LOF application in varieties, namely the Diah Suci variety was 15.13 stems as well as in the treatment without LOF occurred in the Diah Suci variety, which was 14.06 stems.

Table 2. BNJ test 5% influence interaction of liquid and varietal organic fertilizers against the average number of saplings (stems)

Treatment	Average number of saplings 14 HST
Without LOF + Mekongga	14.40 ab
Without LOF + Inpari 32	14.90 ab
Without LOF + Ciherang	15.60 ab
Without LOF + Inpari Sidenuk	15.40 ab
Without LOF + Diah Suci	14.06 b
LOF + Mekongga	16.87 ab
LOF + Inpari 32	15.80 ab
LOF + Ciherang	16.40 ab
LOF + Inpari Sidenuk	15.40 ab
LOF + Diah Suci	15.13 ab
BNJ 5%	3.91

Source: Results of research data analysis 2021

Description:

The numbers followed by the same letter in the same column do not differ markedly according to the BNJ test at the level of $\alpha=5\%$

The results of analysis of diversity against the mean net assimilation rate were found that LOF treatment had a significant effect on 14-28 HST and 42-56 HST. The result can be seen in Table 3.

Table 3. BNJ test 5% effect of LOF on average net assimilation rate

Treatment	Average Net Assimilation Rate		
	14-28 HST	28-42 HST	42-56 HST
P0	0.0034 a	0.000965 a	0.000523 b
PI	0.0024 b	0.000920 a	0.000689 a
BNJ 5%	0.000233	0.000233	0.000149

Source: Results of research data analysis 2021

Description:

The numbers followed by the same letter in the same column do not differ markedly according to the BNJ test at a level of $\alpha=5\%$

In addition, there was an interaction between LOF treatment and variety, where the net assimilation rate of plants aged 14-28 HST, 28-42 HST and 42-56 HST had a noticeable effect. Furthermore, 5% BNJ follow up test was carried out to see the difference in the average net assimilation rate in the LOF treatment and the varieties that can be seen in Table 4.

Table 4. BNJ test 5% effect of LOF and varieties interactions on average net assimilation rate

Treatment	Average Net Assimilation Rate		
	14-28 HST	28-42 HST	42-56 HST
Without LOF + Mekongga	0.0032 bc	0.00068 ab	0.00081 e
Without LOF + Inpari 32	0.0041 d	0.00090 abc	0.00053 abcd
Without LOF + Ciherang	0.0030 bc	0.00069 abc	0.00035 a
Without LOF + Inpari Sidenuk	0.0038 c	0.00085 abc	0.00049 abcd
Without LOF + Diah Suci	0.0031 bc	0.00101 abc	0.00044 ab
LOF + Mekongga	0.0029 ab	0.00114 bc	0.00046 abc
LOF + Inpari 32	0.0022 a	0.00112 bc	0.00066 bcde
LOF + Ciherang	0.0023 a	0.00139 c	0.00069 cde
LOF + Inpari Sidenuk	0.0024 a	0.00056 a	0.00076 de
LOF + Diah Suci	0.0022 a	0.00101 abc	0.00088 e
BNJ 5%	0.00074	0.00053	0.00024

Source: Results of research data analysis 2021

Description:

The numbers followed by the same letter in the same column do not differ markedly according to the BNJ test at a level of $\alpha=5\%$

The application of LOF and without LOF on plants showed that the average relative growth rate when giving LOF planting age of 14-28 HST had a lower yield than the yield without LOF. Result can be seen in Table 5.

Table 5. BNJ test 5% effect of LOF on average relative growth rate

Treatment	Average relative growth rate		
	14-28 HST	28-42 HST	42-56 HST
P0	0.2282 a	0.0992 a	0.0645 b
PI	0.1783 b	0.1004 a	0.0645 a
BNJ 5%	0.0208	0.0510	0.0103

Source: Results of research data analysis 2021

Description:

The numbers followed by the same letter in the same column do not differ markedly according to the BNJ test at the level of $\alpha=5\%$

At the age of 28-42 HST, the relative growth rate of LOF application is higher than the yield without LOF while at planting age 42-56 HST the relative growth rate shows the same result (LOF does not affect the relative growth of plants). Differences in varieties at the time of LOF application and without LOF on Table 6 showed diversity of change in all treatments. Varieties without LOF have a relatively higher growth rate yield at a planting age of 14-28 HST, while at the age of 28-42 HST the Mekongga and Inpari 32 varieties have a relatively higher growth rate than 3 other varieties, namely Ciherang, Inpari Sidenuk, and Diah Suci. Plant age 42-56 HST shows that LOF application in 4 rice varieties has a relatively higher growth rate value than without LOF in one variety, namely Inpari 32.

Table 6. BNJ test 5% effect of LOF and variety interactions on average relative growth rate

Treatment	Rata-average relative growth rate		
	14-28 HST	28-42 HST	42-56 HST
Without LOF + Mekongga	0.219 defg	0.070 a	0.094 de
Without LOF + Inpari 32	0.250 g	0.091 ab	0.066 abcd
Without LOF + Ciherang	0.198 bcde	0.121 b	0.039 a
Without LOF + Inpari Sidenuk	0.236 efg	0.090 ab	0.061 ab
Without LOF + Diah Suci	0.238 fg	0.123 b	0.062 abc
LOF + Mekongga	0.206 cdef	0.127 b	0.062 abc
LOF + Inpari 32	0.166 ab	0.116 ab	0.083 bcde
LOF + Ciherang	0.177 abc	0.081 ab	0.091 cde
LOF + Inpari Sidenuk	0.189 abcd	0.068 a	0.103 e
LOF + Diah Suci	0.154 a	0.111 ab	0.117 e
BNJ 5%	0.039	0.049	0.030

Source: Results of research data analysis 2021

Description:

The numbers followed by the same letter in the same column do not differ markedly according to the BNJ test at the level of $\alpha=5\%$

DISCUSSION

Application of liquid organic fertilizer (LOF) enriched with micronutrients, including growth-promoting bacteria and macronutrients at a dose of 600 ml 15 liters⁻¹ of water can increase the number of saplings in plants aged 28 days after planting (HST) Table 1. Purwanto et al. (2019) states that microbes are used as growth promoters that can help nitrogen fixation so that nitrogen nutrients are available and useful for supporting plant height growth and the number of saplings.

There is an interaction between LOF and rice varieties on the number of tillers shown in Table 2. This shows that the diversity of plants of each different variety is also influenced by the genetic traits of each plant and the application of fertilizers (Alavan et al., 2015). According to Adwiyani et al. (2022), application of microbial-enriched organic fertilizers compared to treatment without fertilization can increase plant height, number of saplings, dry weight of roots and headers, greenness of leaves, total grain amount per panicle, and productive saplings.

The enhancement of saplings number can be influenced by the nutrients given, element N can increase the maximum saplings, where by LOF application that contains nitrogen and the content of binding bacteria N 15x10¹ ml⁻¹ solution applied after tillage and every week the treatment is able to increase the availability of N nutrients in the soil, so that the amount of N nutrients in the leaves, especially chlorophyll increases. Increased chlorophyll will cause an increasing in the rate of plants photosynthesis and the content of Photosynth produced so that the growth and number of

saplings increases (Putri et al., 2017). According to Tando (2018), the nutrient nitrogen is an integral part of the chlorophyll molecule that affects the vegetative growth of plants and stimulates an increase in the number of rice saplings if given in sufficient quantities. Tall plants and more saplings can produce more than short plants and few saplings. LOF also contains P and bacteria solvent P $10 \times 10^1 \text{ ml}^{-1}$ solution which can increase saplings. Solvent P bacteria in LOF is able to dissolve P present in soil colloids into compounds that are easily absorbed by plant roots and P element also has a role in increasing the number of productive saplings of rice, root development, early flowering and ripening.

The results showed that other factors that could affect the high increment of plants and the number of saplings were the condition of the land, light, weather and climate at the study site, and the genes of the rice varieties grown. This is in accordance with Donggulo et al. (2017) which states that genetic traits and a good environment for plant growth and development can affect the number of saplings.

The net assimilation rate variable showed a significant influence on LOF treatment and no significant effect on varietal treatment but there was an interaction in both treatments shown on Table 3 and Table 4. The rate of net assimilation relates to the area of leaves and dry matter resulting from a given period. Inhibited leaf breadth will have an impact on decreasing the leaf's capacity to absorb light. Leaves are closely related to photosynthetic activity, because they contain chlorophyll needed by plants in the process of photosynthesis, the more the number of leaves, the higher the photosynthesis yield, so that the plant grows well. Chlorophyll formed in the process of photosynthesis can spur vegetative growth such as plant height, number of leaves, leaf area, and stem diameter (Asra et al., 2016). From the results of the study, it is stated that LOF application increases macro and micronutrients related to plant photosynthesis. Photosynthesis results are processed through a respiration process, allowing cells to produce the energy needed for cell division and leaves to grow longer and wider. The more leaf surface area, the higher the rate of photosynthesis due to the intensity of sunlight so that more carbohydrates are produced for cell division and leaf growth are larger and wider (Uminawar et al., 2013). The process of cell division and enlargement that causes young leaves to reach their perfect shape more quickly is influenced by the elements N, P, and K contained in the growth medium (Leonardo et al., 2016).

The addition of LOF based on the result (Table 5 & 6) can increase the relative growth of a plant expressed in biomass, because there is a maximum photosynthesis process and the roots are more active in absorbing nutrients and water. This corresponds to Afriza et al. (2015) which states that growth rate is relatively slow after germination increases rapidly after planting and decreases as the plant progresses. The relative growth rate indicates an increase in dry weight over time. High dry weight does not necessarily result in rapid growth. The growth rate is high if the yield difference is large and highly dependent on the previous week and does not necessarily correlate with the final dry weight. According to Rahmah et al. (2014), biomass increases as plants absorb more water and nutrients, this results in increased photosynthetic activity and affects the increase in wet weight and dry weight. Doses with an increased amount of LOF affect the nutrients that bind to microbes, resulting in a higher nutrient content. One of the soil components that are important for soil ecosystems is organic matter which is a source of nutrients and nutrient binders and as a substrate for soil microbes (Setiawati et al., 2020).

CONCLUSION

The treatment of LOF application at a dose of 600 ml 15 liters^{-1} has significant influence on the number of saplings, net assimilation rate, and relative growth rate and tends to increase vegetative and generative growth. The number of saplings, net assimilation rate and relative growth rate there is an interaction between LOF treatment and varietal diversity.



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