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Increasing the Growth and Yield of Local Rice Varieties and Improving Soil Chemical Properties in Peatlands with Dolomite Application

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Abstract
Rice is a staple food crop for many people. However, rice production has been declining annually. If this decline continues, it could lead to a food crisis in Indonesia. The expansion of non-agricultural development has left the remaining agricultural land less fertile, particularly peat soils. This study was conducted on peatland in Tanah Putih District, Rokan Hilir Regency, Riau Province. A randomized complete block design (RCBD) with two factors was used. The first factor was dolomite lime dose at four levels: 0, 5, 10, and 15 tons per hectare. The second factor was rice variety, consisting of three levels: Inpari 32, Caredek, and Rotan. It resulted in 12 treatment combinations, each with three replications, for a total of 36 experimental units. Data were analyzed using ANOVA at the 5% significance level. Treatments showing significant differences were further analyzed using Duncan's New Multiple Range Test (DNMRT) at the 5% level. The results showed that the Caredek variety had the highest values for total tiller number, productive tiller number, and 1000-grain weight. The Inpari variety performed best in plant height, number of grains per panicle, and harvest age. However, dolomite application had no significant effect on any of the observed parameters. The study concluded that the Caredek variety is more adaptable to peat soils than the local Rotan variety.

Keywords: Caredek, Food, Inpari, Rattan, Rokan Hilir

1. Introduction

Rice (Oryza sativa L.) is a staple food crop for the population. Rice production reached 53.98 million tons of unhusked rice (GKG) in 2023 but decreased to 52.66 million tons in 2024 (BPS 2025). If this decline continues, it could lead to a food crisis in Indonesia. Given the importance of rice, production must be continuously increased year after year to ensure the population's needs are met.

Indonesia's rice demand increases annually in line with population growth. The use of superior varieties is a technology that can enhance both the quantity and quality of agricultural products. Efforts to develop superior varieties constitute a key policy for advancing productive rice farming. Varieties that are more adaptable to environmental conditions exhibit higher tillering potential (Mahmudi et al., 2022).

The use of rice paddy fields is declining due to non-agricultural developments, such as factory construction, roads, and housing (Erizilina et al., 2019). This increase in non-agricultural land use has led to the cultivation of less fertile soils, such as peat soil, for crops. Consequently, peatlands have become an alternative for rice cultivation. Extensification involves using land that has not been intensively farmed, including marginal lands such as peat soils.

Peat soil is a type of soil characterized by low fertility. Riau Province has extensive peatlands, but only 25% of these areas have the potential for food crop and horticultural development (Masganti et al., 2014). The use of peat soil as a planting medium faces several challenges, including high cation exchange capacity (CEC), low nutrient availability, low base saturation, and high phenolic acid content (Saukani 2015). The use of peat as a The rice planting area requires treatment to increase productivity. According to Meli Roslianti et al. (2025), the

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growing medium is a factor that needs to be considered because it can affect growth.

To achieve optimal plant growth conditions, dolomite can be added. Dolomite contains high levels of calcium, which can neutralize soil pH.. Moreover, increase nutrient availability in peatlands. Adding ameliorants, such as dolomite, can increase nutrient content in peat soil (Sasli, 2011). To address soil chemistry issues in peatland, ameliorants can be added. (Nelvia, Rosmimi, 2012). Soil chemical properties are one indicator of soil fertility (Silaban, 2014).

The Research aimed to determine the effects of dolomite doses applied to several local rice varieties on peatlands and on changes in soil chemical properties.

2. Material and Methods

2.1. Location Study

This study was conducted on land at Ujung Tanjung peat, Tanah Putih District, Regency Rokan Hulu, Riau Province, with a point coordinate of 101.035797 East Longitude and 1.626018 South Latitude (7 meters above sea level).

2.2. Tools and Materials

The tools used in this study were hoes, plowing machines, markers, labels, digital scales, analytical scales, stationery, ovens, cameras, scissors/knives, meters, rulers, sickles/machetes, folders, staplers, knapsack sprayers, nets, measuring cups, and stakes.

The materials used are Caredek rice seeds from South Solok, Rotan rice seeds from Bengkalis, Inpari 32, Urea fertilizer, SP-36, KCl, dolomite lime, seeding media (cow manure and soil), seedbed, standard poles, bamboo, plastic rope, plastic, plastic folders, paper folders, insecticides with active ingredients, fibronil 50g/l, chlorantraniliprole 50g/l, dimehipo 505g/l and adhesives with active ingredients polyethylene glycol.

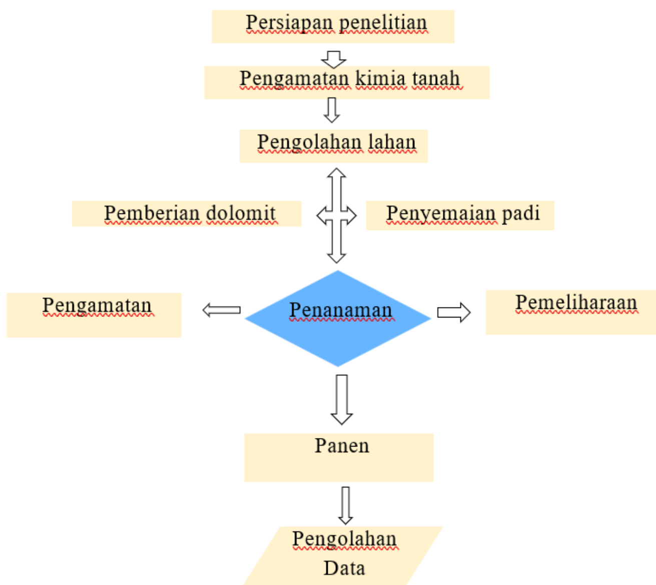

Figure 1. Research Flowchart

2.3. Observation and Data Analysis

This study used a randomized block design (CRD) method with two factors. The first factor was dolomite lime dose, with 4 levels: 0 tons/ha, 5 tons/ha, 10 tons/ha, and 15 tons/ha. And the second factor was rice varieties, consisting of 3 levels, namely the Inpari 32, Caredek, and Rotan varieties, yielding 12 treatment combinations with 3 replications; thus, there were 36 experimental units.

The data obtained were analyzed using ANOVA at the 5% level. Data with significantly different effects were further tested using Duncan's New Multiple Range. Test (DNMRT) at the 5% level. Data analysis was performed using Microsoft Excel.

Observation parameters are plant height, ILD, LAB, harvest age, total number of tillers, number of productive tillers, number of grains per panicle, and weight of 1000 grains.

Rice plant height was measured by measuring the plant from the ground surface to the tip of the tallest leaf (excluding the panicle) using a measuring ruler. Observations were made 6 days after planting.

Harvest age is determined by the number of days from planting to physiological maturity, indicated by approximately 85–90% of the panicles turning yellow. Harvest age is recorded in days after planting (DAP).

The total number of tillers is calculated by counting all the tillers that appear on each rice plant, both productive and unproductive tillers.

The number of productive tillers is calculated at harvest time by counting the tillers that produce full panicles on each rice plant.

The leaf area index (LEI) is determined by measuring the leaf area of rice plants using leaf length and width, multiplying by a correction factor, and then dividing by the area occupied by the plants. The LIA value is expressed without units.

The net assimilation rate (NAR) is calculated from the increase in dry plant weight per unit leaf area over time. Observations were made by taking plant samples at two different times and then calculating the net assimilation rate using the formula.

The number of grains per panicle was determined by counting all filled and empty grains on the rice panicle and averaging across treatments.

The weight of 1,000 grains of rice is determined by weighing 1,000 grains of dry milled rice.

3. Results and Discussion

3.1. Chemical analysis of the soil at the research site

According to the table, the soil pH is very acidic. This condition is common in peat soils, which are often highly acidic due to the accumulation of organic acids. Highly acidic pH conditions result in low availability of macronutrients (P, K, Ca, Mg). while the elements Fe, Al, and Mn are easily soluble and can be toxic to plants.

Table 1. Data analysis of the chemistry of the land peat before it is given treatment

No.	Type sample	pH - $_{H2O}$	pH-KCL	N total (%)	P- available (ppm)	K (mg/100g)	Ca (mg/100g)	Mg (mg/100g)	Fe (mg/100g)
1.	Before given treatment	3.79	3.49	0.59	72.13	0.28	1.33	0.17	729
2.	After the given treatment	5.49	5.23	0.80	31.61	0.59	5.27	1.61	631

Source: Soil Laboratory, University of Riau (UNRI)

Based on the analysis of soil chemical properties before and after dolomite treatment, several soil chemical parameters changed. Before treatment, the soil had pH values of 3.79 H_2 O and 3.49 KCl, indicating very acidic soil conditions. Very acidic soil conditions can generally inhibit plant growth by reducing the availability of essential nutrients and increasing the solubility of toxic elements, such as iron (Fe). After dolomite treatment, the soil pH value increased to 5.49 (pH H_2 O) and 5.23 (pH KCl). This increase in pH indicates that dolomite effectively neutralizes soil acidity.

The total nitrogen (N-total) content of the soil increased from 0.59% before treatment to 0.80% after dolomite treatment. This increase is thought to be related to improved soil conditions, with higher pH, which optimizes the activity of soil microorganisms in the mineralization of organic matter. A more neutral soil pH supports decomposition and increases nitrogen availability for plants. However, most organic N is difficult for plants to access without mineralization directly. Acidic conditions often lead to low microbial activity and slow N mineralization. Therefore, high N values do not always directly correlate with plant-available N (Hermawan *et al.*, 2025). (none)

Fe levels of 729 ppm indicate high iron accumulation, a common finding in acidic peat. At low pH, Fe is more easily reduced and becomes more soluble. High concentrations can cause root damage, leaf yellowing, reduced growth, and impaired nutrient uptake. Controlling the pH (reducing acidity) and selecting tolerant varieties is crucial (Tisarum *et al*., 2023).

3.2. Plant Height

Table 2 shows that the heights of the Caredek and Rotan varieties do not differ significantly, but the Inpari variety is significantly taller at 119.88 cm. According to the Rice Standard Evaluation System, the height of rice plants is classified as medium (Suhardjadinata 2022). The difference in the height of rice plants across the studied varieties is thought to be due to genetic factors; varieties that are adaptive to the environment will provide optimal growth. According to Damanik (2015), differences in genetic composition are one of the factors that cause diverse plant appearances, in this case, plant height. According to Syahri and Somatri (2013), rice plant height can be used as a growth parameter, but high rice plant height does not guarantee high grain yields.

Dolomite application to peatlands affected rice plant height, but the differences between doses were not statistically significant. Average plant height increased with increasing dolomite dosage, but this increase was not sufficient to reach significance, possibly due to the nature of the peat soil in supplying nutrients, even with increasing dolomite dosage. Dolomite is known as a source of calcium (Ca) and magnesium (Mg), which can raise soil pH and increase nutrient availability for plants.

Varieties that adapt to peat conditions tend to be more efficient at absorbing calcium and magnesium from dolomite, so even though the dolomite dosages were not statistically significant, the adaptive varieties still showed better growth. This finding aligns with previous research showing that dolomite application can increase soil pH and support the growth of adaptive rice varieties, but its effectiveness depends heavily on the variety and land conditions (Gultom & Mardaleni, 2017).

3.3. Index Wide Leaf

Table 3 shows that several local rice varieties showed no significant differences in leaf area index. Similarly, the application of several doses of dolomite also showed no significant differences in leaf area index. Leaf area index:

The leaf area index for rice ranges from 1.14 to 1.23. This finding is because the leaf area of a plant reflects the area of the part that carries out photosynthesis, while the leaf area index reflects the amount of light absorbed by the plant. The leaf area index is the ratio of leaf area to the surface area of the land where a plant grows. The ILD value increases as the plant develops and reaches a maximum at the beginning of the generative period (Sitanggang *et al.* 2006).

Table 2. Plant height of several local rice varieties with the application of several doses of dolomite on peat land.

Dose Fertilizer	Types of Varieties			
	Inpari	Caredek	Rattan	Average
0 tons/ha	116.50±4.25	101.17±3.81	88.33±7.80	102.00±8.14
5 tons/ha	119.17±7.12	104.17±7.15	92.67±5.36	105.34±7.67
10 tons/ha	121.00±10.69	106.33±6.13	99.67±10.33	109.00±6.30
15 tons/ha	122.83±10.04	112.33±8.95	106.33±10.55	113.83±4.82
Average	119.88 ± 1.35 b	106.00 ± 2.36 a	96.75±3.96 a	
KK = 1.34				

Description: The numbers in the same row and column show no significant difference according to the DMNRT follow-up test at a 5% significance level.

Table 3. Net assimilation rate of several local rice varieties with the application of several doses of dolomite on peatlands

Dose Fertilizer	Types of Varieties			
	Inpari	Caredek	Rattan	Average
0 tons/ha	1.12±0.04	1.15±0.03	1.16±0.04	1.14±0.01
5 tons/ha	1.18±0.06	1.19±0.06	1.20±0.09	1.19±0.01
10 tons/ha	1.20±0.06	1.23±0.04	1.24±0.04	1.22±0.01
15 tons/ha	1.22±0.03	1.22±0.03	1.25±0.07	1.23±0.01
Average	1.18±0.02	1.20±0.02	1.21±0.02	
KK = 0.08				

Description: The numbers in the columns and rows are not significantly different based on the F test at the 5% level.

3.4. Rate Assimilation Clean

Table 3 shows that several local rice varieties showed no significant differences in net assimilation rate. Similarly, the application of several doses of dolomite also showed no significant differences in the net assimilation rate . The net assimilation rate of rice ranged from 0.67 to 0.71. This finding is because the dry weight of the rice plant is related to the number of branches, the height of the main stem, the number of leaves, and the roots. Zulyana (2011) stated that the dry weight of the plant canopy will increase as photosynthesis increases, thereby increasing biomass absorption. This finding is supported by the opinion of Suryadi *et al.* (2013) that in plants receiving more light, the light intensity will be higher, thereby supporting the process.

Photosynthesis will run faster, and the carbohydrate supply will increase, leading to an increase in the plant's dry weight.

Net assimilation rate (NAR) is the production of dry matter per unit leaf area per unit time. This result implies that leaves and light are determining factors in the assimilation process. This finding is also supported by Roslianti et al. (2025), who stated that sunlight levels also Influence NAR. The wider the leaf area and the more light it can absorb, the greater the assimilation results. The NAR is greater when all leaves intercept light and are not shaded. This finding means that although the resulting leaf area index is high, the canopy below provides shade, reducing the number of leaves that can intercept light and thereby decreasing NAR.

Table 4. Net assimilation rate of several local rice varieties with the application of several doses of dolomite on peatlands

Dose Fertilizer	Types of Varieties			
	Inpari	Caredek	Rattan	Average
0 tons/ha	0.66±0.01	0.67±0.05	0.70±0.03	0.68±0.01
5 tons/ha	0.66±0.01	0.7±0.01	0.71±0.03	0.69±0.01
10 tons/ha	0.67±0.03	0.7±0.03	0.72±0.03	0.68±0.01
15 tons/ha	0.68±0.01	0.7±0.03	0.72±0.02	0.70±0.01
Average	0.67±0.01	0.69±0.01	0.71±0.01	
KK = 0.06				

Description: The numbers in the columns and rows are not significantly different based on the F test at the 5% level.

3.5. Amount of total offspring

In Table 5 it can be seen that the Caredek (22.42) and

Rotan (20.83) varieties have a total number of tillers more than Inpari (17.00), this finding shows that, in addition to genetic factors that influence the difference in the total number of tillers in the experiment, it is also influenced by the adaptability of the variety to peatland conditions. The ability of plants to produce tillers is influenced by nutrient availability and plant genetic factors (Mugiono *et al.* 2009). According to Cepy and Wayan (2011), the high and low growth and yield of plants are influenced by genetic factors, environmental factors such as climate and soil fertility, and biotic factors. According to Anhar *et al. (2016), differences in tiller number and plant height between varieties are due to* different genetic traits.

Dolomite functions as a soil ameliorant by raising pH and adding calcium (Ca) and magnesium (Mg), which supports vegetative rice growth. However, the effect of dolomite application on total tiller number in this study was insignificant. This result is likely due to peat soils' characteristics of high organic matter content, low cation exchange capacity, limited nutrient mobility, and redox conditions that can inhibit nutrient absorption. (Septiyana et al., 2017) emphasized that improving soil chemical properties with dolomite can increase pH and Ca–Mg availability, but this does not always translate directly into increased rice productivity on peat soils.

Table 5. Total number of tillers of several local rice varieties with the application of several doses of dolomite on peat land.

Dose Fertilizer	Types of Varieties			
	Inpari	Caredek	Rattan	Average
0 tons/ha	15.67±2.73	21.00±0.57	19.33±0.67	18.67±1.57
5 tons/ha	17.00±2.08	22.33±1.76	20.00±0.57	19.78±1.54
10 tons/ha	17.33±1.85	22.67±0.88	21.67±0.88	20.56±1.63
15 tons/ha	18.00±1.53	23.67±1.85	22.33±1.20	21.33±1.71
Average	17.00± 0.48a	22.42±0.55b	20.83±0.70 b	
KK= 0.59				

Description: The numbers in the same row and column show no significant difference according to the DMNRT test at a significance level of 5%.

3.6. Number of productive offspring

In Table 6, it can be seen that the number of productive tillers in the inparidan variety and the rattan variety does not show a significant difference, whereas the caredek variety shows a significant difference, namely 16.25 stems. According to Perwira *et al* . (2022), tillers in rice plants are divided into five groups: (<5) very few categories, (5-9) few categories, (10-19) moderate categories, (20-25) many categories, and (>25) very many categories. Based on these categories, the number of productive tillers in several local rice varieties falls within the moderate tiller type.

Good rice tiller growth will affect rice production. Rice tillers will grow into panicles that produce rice grains. The number of productive tillers is directly proportional to the total number of tillers. Based on the results of this study, the highest number of productive tillers was observed in the Caredek variety, with a total of 22.42 tillers and 16.25 productive tillers. This finding aligns with Makmur et al. (2020), who found that the number of productive plant shoots is influenced by the total number of shoots per clump; the more shoots there are, the more productive the shoots are. According to Yulina N et al. (2021), the number of offspring will be maximized if the plant has good genetic characteristics and environmental conditions suitable for plant growth and development.

Table 6. Number of productive tillers of several local rice varieties with the application of several doses of dolomite on peat land.

Dose Fertilizer	Types of Varieties			
	Inpari	Caredek	Rattan	Average
0 tons/ha	10±0.57	17.67±0.33	12.67±0.88	13.44±2.25
5 tons/ha	13.67±2.02	15.67±0.88	14.33±0.88	14.56±0.58
10 tons/ha	13.33±1.45	15.00±0.57	13.67±1.45	14.00±0.51
15 tons/ha	14.67±1.45	16.67±0.88	16.67±0.67	16.00±0.66
Average	12.92±1.01 a	16.25± 0.58 b	14.33± 0.85a	
KK = 0.50				

Description: The numbers in the same row and column show no significant difference according to the DMNRT test at a significance level of 5%.

3.7. Harvest age

Data show that variety differences Influence rice harvest time, but dolomite dosage does not. A faster harvest time is found when dolomite is applied at 15 tons/ha (D4), namely 133.78 days after planting. Dolomite can improve soil pH and the availability of Ca and Mg, allowing plants to grow more efficiently. On peat soils, improving soil pH and nutrient levels with dolomite can support growth, but it is not strong enough to change the basic characteristics of varieties regarding harvest time. However, harvest time is also influenced by genetic factors. The Inpari variety shows a faster harvest time, namely 106.50 days after planting.

Caredek and Rotan rice varieties take longer to form panicles and fill grains. According to Faridah and Cahyono (2022), increasing soil pH through dolomite liming can accelerate flowering and rice grain ripening due to healthy root conditions and more optimal nutrient absorption. This finding is also in accordance with Rahman et al. (2021), who found that dolomite can improve the root environment, enabling efficient grain formation and slightly shortening the harvest period.

Table 7. Harvest age of several local rice varieties with the application of several doses of dolomite on peat land.

Dose Fertilizer	Types of Varieties			
	Inpari	Caredek	Rattan	Average
0 tons/ha	108.67±3.67	148.00±3.60	159.67±4.05	138.78±15.42
5 tons/ha	106.67±2.18	145.00±6.55	159.00±3.78	136.89±15.64
10 tons/ha	106.00±3.05	142.33±10.17	155.33±6.93	134.55±14.76
15 tons/ha	104.67±4.41	142.00±1.73	154.67±4.97	133.78±15.00
Average	106.50±0.83 a	144.33±1.39 b	157.17±1.26 b	
KK = 0.76				

Description: The numbers in the same row and column show no significant difference according to the DMNRT test at a significance level of 5%.

3.8. Number of grains per panicle

The table above shows that the Inpari variety had the highest number of grains per panicle, averaging 145.38. All varieties showed an increase in the number of grains per panicle with increasing dolomite dosage, but the Inpari variety responded more strongly. Inpari is a superior variety released by the Ministry of Agriculture, making it more adaptable to peatlands. According to Widodo and Lestari (2020), the number of grains per panicle is a quantitative trait influenced by genetic and environmental factors. This superior variety has better panicles than the local varieties Caredek and Rotan.

Furthermore, higher dolomite doses were also associated with higher average grain yields. The highest grain yield per panicle was achieved with a dolomite dose of 15 tons/ha (D4), at 142.5g. This finding is due to dolomite's ability to improve peat soil conditions, thereby supporting optimal panicle formation. According to Faridah and Cahyono (2022), dolomite application increases peat soil pH and reduces Al toxicity, resulting in a more complete grain filling process. This increase in grain yield per panicle aligns with research by Kusuma and Anwar (2023), who reported that application of 1-4 tons of dolomite/ha can increase the number of grains per panicle in local rice on acidic soils.

Table 8. Number of grains per panicle of several local rice varieties with the application of several doses of dolomite on peat land.

Dose Fertilizer	Types of Varieties			
	Inpari	Caredek	Rattan	Average
0 tons/ha	136.60±4.30	128.82±6.33	133.55±3.21	132.99±2.26
5 tons/ha	142.51±7.60	129.19±2.68	134.54±1.78	135.41±3.87
10 tons/ha	148.16±1.98	130.14±0.67	136.1±0.41	138.13±5.30
15 tons/ha	154.26±15.99	133.15±1.65	140.37±2.05	142.59±6.19
Average	145.38±3.78 a	130.33±0.98 a	136.14± 1.50a	
KK = 0.86				

Description: The numbers in the same row and column show no significant difference according to the DMNRT test at a significance level of 5%.

3.9. Weight of 1000 grains

The table shows that the weight of 1000 grains increases with increasing dolomite dose, with the highest value at 21.97. This finding shows that applying dolomite at 15 tons/ha can improve soil chemical properties, increasing pH, Ca, and Mg and decreasing Al/Fe, thereby supporting more optimal grain filling and heavier grain. This finding aligns with the results of research by Utami et al. (2012), which found that applying dolomite to peat soil can increase pH and Ca levels and affect components of rice yield. (Septiyana et al., 2017) added that the application of ameliorants to the soil can increase the weight of rice grain.

The highest 1000-grain weight recorded for the Caredek variety was 23.10 grams, although this was not significantly different from the other varieties. Inpari and Caredek exhibit larger, fuller grains than the Rotan variety. While the Rotan variety has smaller grain sizes, it demonstrates greater tolerance to peatland conditions. This difference is likely influenced primarily by the plant's genetics. Each variety displays distinct adaptive traits and responses to fertilizer dosages, resulting in variations in grain weight. This finding aligns with the findings of Widodo and Lestari (2020), who stated that 1000-grain weight is primarily determined by genetic factors and the plant's ability to adapt to environmental conditions during the growing period. Additionally,. (Madani et al., 2025) suggested that the combined application of genopite and dolomite can be an effective strategy to increase grain weight and rice yield, particularly in acidic soils such as peat.

Table 9. Number of grains per panicle of several local rice varieties with the application of several doses of dolomite on peat land.

Dose Fertilizer	Types of Varieties			
	Inpari	**Caredek**	**Rattan**	**Average**
0 tons/ha	22.18±0.37	22.91±0.12	17.84±1.55	20.98±1.58
5 tons/ha	22.16±2.16	22.85±2.25	17.9±1.50	20.97±1.55
10 tons/ha	22.71±2.78	22.95±3.01	17.92±1.03	21.19±1.64
15 tons/ha	23.36±3.52	23.69±3.09	18.86±4.97	21.97±1.55
Average	22.60±0.28 a	23.10±0.15 a	18.13±0.24a	
KK = 0.96				

Description: The numbers in the same row and column show no significant difference according to the DMNRT test at a significance level of 5%.

Figure 2. Rice varieties (left) Inpari; (center) Caredek; (right) Rotan

4. Conclusion

This study concluded that the Caredek variety is more adaptable to peat soils than the local Rotan variety. It exhibits a higher total tiller count, greater productivity, and increased 1,000-grain weight. Further research is recommended on peat soils using different ameliorants to better their effects on the growth and yield of local rice varieties.

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