POTENTIAL OF CARRAGEENAN PGP AND SYNTHETIC FERTILIZER IN IMPROVING GROWTH AND YIELD OF AEROBIC RICE

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ABSTRACT

This study assessed the impact of carrageenan and synthetic fertilizer on rice production by examining various parameters including plant height, number of tillers, panicle length, moisture content, and rice yield. Field experiments were conducted, and data were collected from five different treatment groups. Statistical analysis revealed non-significant effects across all parameters, with p-values ranging from 0.81 to 0.99, indicating that neither carrageenan nor synthetic fertilizer led to statistically significant differences in rice growth and productivity. Despite the absence of significant effects, the study contributes valuable insights to agricultural research by challenging existing assumptions about the efficacy of these treatments. It underscores the necessity for empirical validation of agricultural practices and emphasizes the ongoing need for exploration and refinement of agricultural technologies. Future research directions include exploring alternative application rates, timings, or formulations of carrageenan and synthetic fertilizer to uncover optimal conditions for enhancing rice production. Additionally, conducting field trials across diverse environments and adopting integrated approaches that combine various agricultural practices may offer new insights into improving crop performance. Comprehensive economic analyses will also aid in assessing the cost-effectiveness of these treatments and informing farmers' decisions regarding their adoption. This study sets the stage for further investigations aimed at optimizing rice production practices and addressing the challenges faced by farmers in the agricultural sector.

Keywords: Aerobic Rice, Carrageenan, Plant growth, Rice production, Synthetic fertilizer

1. INTRODUCTION

Although rice is a staple meal throughout Asia, its high-water requirement presents a problem in light of the region's diminishing water supplies. The decreasing availability of water poses a danger to the traditional practice of irrigated rice farming. An inventive method that offers a water-saving substitute is called aerobic rice technology. Aerobic rice is produced with additional irrigation, just like other upland cereal crops, as opposed to conventional flooded rice fields. With this technique, high-yielding rice may be grown in aerobic soil that is neither flooded nor puddled (Sudhakara et al., 2020).

Farmers and researchers highlight numerous advantages of aerobic rice technology compared to traditional methods. These include reduced input requirements, ease of crop management, competitive yields, improved profitability, early establishment enhancing water and land productivity, resistance to pests and diseases, and weed competitiveness. Recognizing these potentials, there is a call to further develop, promote, and disseminate aerobic rice technology in rainfed areas. Moreover, there is a need for comprehensive research to refine specific management practices, particularly during the dry season (Dayag et al., 2014).

However, despite varietal improvements, aerobic rice yields remain low, largely attributed to faulty fertilizer practices. Nitrogen, in particular, plays a crucial role in rice yield enhancement, influencing tiller production, leaf area development, and canopy photosynthesis. A significant increase in Asian rice production from 1965 to 1980 was linked to fertilizer use, notably nitrogen. Poor nitrogen management leads to inadequate soil nutrient supply and low fertilizer use efficiency. Hence, appropriate nitrogen management is imperative for aerobic rice cultivation (Amrutha et al., 2016).

Several studies have demonstrated the positive impact of bio and organic fertilizers on rice growth and yield, often resulting in reduced mineral fertilizer usage. Integrating organic fertilizers with chemical fertilizers presents a promising agronomic option to minimize chemical fertilizer dependency. Thus, this study aims to evaluate the effects of integrated fertilizer using carrageenan and synthetic fertilizer on the growth and yield of aerobic rice.

The main objective of the study aimed to assess the growth and yield of aerobic rice under integrated fertilizer management using carrageenan PGP and synthetic fertilizer.

Specifically, the study aimed to: determine the effect of carrageenan and synthetic fertilizer on the growth of rice in terms of plant height; assess the effect of carrageenan and synthetic fertilizer on the yield and yield components of rice in terms of: number of productive and unproductive tillers; length of panicle; weight of 1000 grains; moisture content; and total yield.

2. RESEARCH METHODOLOGY

Research Design

The experiment employed the Randomized Complete Block Design (RCBD) with five (5) treatments and replicated three (3) times with the following treatments: Treatment 1 - Control (Farmer's Practice using 100% Synthetic Fertilizer); Treatment 2 - 25% Carrageenan - 75% Synthetic Fertilizer Treatment 3-50% Synthetic Fertilizer - 50% Carrageenan Treatment 4 -75% Carrageenan -25% Synthetic Fertilizer and Treatment 5-100% Carrageenan

Land Preparation

The soil was dug up over time, and then the field was leveled. After the land preparation, construction of bunds in all experimental plots was undertaken to ensure that no leakage of treatments took place. The bunds that were constructed were made sure to be compacted and properly sealed to eliminate leakage through seepage. A total of 15 experimental plots were established with a size of 3m x 4m.

Seed Sowing

Seeds were directly sown in the field using drilling method following the distance of 20cm x 20cm. Three (3) seeds of rice were placed in a hole using bamboo stick.

Fertilizer Management

Application of fertilizer was done through foliar application following the recommended rate.

Table1. Application of fertilizer following farmer’s practice

Fertilizer	Dosage	Time Application	Stage of Crop
Complete Fertilizer	120g	1st application 15 DAT	After transplanting
Urea + Ammonium Sulphate	240g + 120G	2nd application 30 DAT	Vegetative stage

Table 2. Application of fertilizer 75% of synthetic and 25% of carrageenan

Fertilizer	Dosage	Time Application	Stage of Crop
Complete Fertilizer + Carrageenan	90g + 80ml/L	1st application 15 DAT	After transplanting
Urea + Ammonium Sulphate + Carrageenan	180g + 90g + 80ml/L	2nd application 30 DAT	Vegetative stage

Table 3. Application of fertilizer 50% of synthetic and 50% of carrageenan

Fertilizer	Dosage	Time Application	Stage of Crop
Complete Fertilizer + Carrageenan	60 + 160ml/L	1st application 15 DAT	After transplanting
Urea + Ammonium Sulphate + Carrageenan	120g + 60g + 160ml/L	2nd application 30 DAT	Vegetative stage

Table 4. Application of fertilizer 25% of synthetic and 75% of carrageenan

Fertilizer	Dosage	Time Application	Stage of Crop
Complete Fertilizer + Carrageenan	30 + 240ml/L	1st application 15 DAT	After transplanting
Urea + Ammonium Sulphate + Carrageenan	60g + 30g + 240ml/L	2nd application 30 DAT	Vegetative stage

Table 5. Application of carrageenan

Fertilizer	Dosage	Time Application	Stage of Crop
Carrageenan	320ml/L	1st application 14 DAT 2nd application 30 DAT 3rd application 45 DAT	After transplanting Vegetative Stage Panicle initiation

Water Management

Flash irrigation was employed as the irrigation scheme wherein the experimental plots were done weekly at 2 – 5 cm water depth. However, during the flowering stage of the plants, flood irrigation was employed wherein 5-7 cm water depth.

3. RELATED RESEARCH/LITERATURE REVIEW

In a study by Naeem et al. (2020), the effects of foliar application of radiation-modified carrageenan on rice yield were examined. Results showed that test plants treated with 200ppm carrageenan exhibited a 34.8% increase in grain yield compared to untreated controls. Additionally, the addition of inorganic fertilizer at varying rates resulted in yield increases of 15% to 25.6% compared to treatments with fertilizer alone. Moreover, plant height increments were observed at different carrageenan concentrations, with the highest increments seen at 100 ppm and 200 ppm. Further application of carrageenan at the milking stage also showed positive effects on grain filling and yield. The study concluded that radiated carrageenan effectively enhanced grain yield, yield components, and plant growth.

Another study by Kirchmann (2019) focused on organic farming, aiming to address the rising costs of inorganic fertilizers by evaluating seaweed emulsion (carrageenan) as a nutrient supplement for glutinous corn production. The experiment, conducted at Cagayan State University, revealed that seaweed emulsion application did not significantly affect plant height but positively influenced grain development, resulting in longer and heavier corn ears. Higher seaweed emulsion rates (3-6 liters/ha) were found to be more efficient, leading to larger ears, higher yields, and a remarkable return on investment of 909.62%. The study concluded that the combination of organic fertilizer with seaweed emulsion improved glutinous corn production, offering a promising alternative for farmers.

These studies highlight the potential of carrageenan as a beneficial supplement in agricultural practices, contributing to increased yield and productivity in rice and corn cultivation. They emphasize the importance of exploring natural organic inputs to enhance crop production and sustainability, particularly in the face of challenges such as rising fertilizer costs and water scarcity. Through continued research and adoption of innovative techniques, farmers can optimize their farming practices and mitigate challenges while promoting environmental stewardship and economic viability.

4. RESULTS AND DISCUSSION

Effect of Carrageenan and Synthetic Fertilizer on the Growth of Rice in terms of Plant Height

The effect of carrageenan and synthetic fertilizer on the growth of rice in terms of plant height was assessed. The analysis of variance (ANOVA) results indicated a p-value of 0.94, suggesting that there is no significant difference in plant height among

the different treatment groups (Table 6). In the research conducted by Shrestha et al. (2020), it was found that the concurrent application of organic manure and inorganic fertilizers has an impact on both the growth and yield traits of rice.

Table 6. Analysis of Variance on the effect of carrageenan and synthetic fertilizer on the growth of rice in terms of Plant Height.

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	60.12933	4	15.0323333	0.185099903	0.940842	3.47805
Within Groups	812.12	10	81.212			
Total	872.2493	14				

The average plant height across all treatments ranged from 122.1 cm to 127.3667 cm. The variance in plant height within treatments varied, with Treatment 4 showing the highest variance (216.493333) and Treatment 3 showing the lowest variance (2.11) as shown in Figure 1.

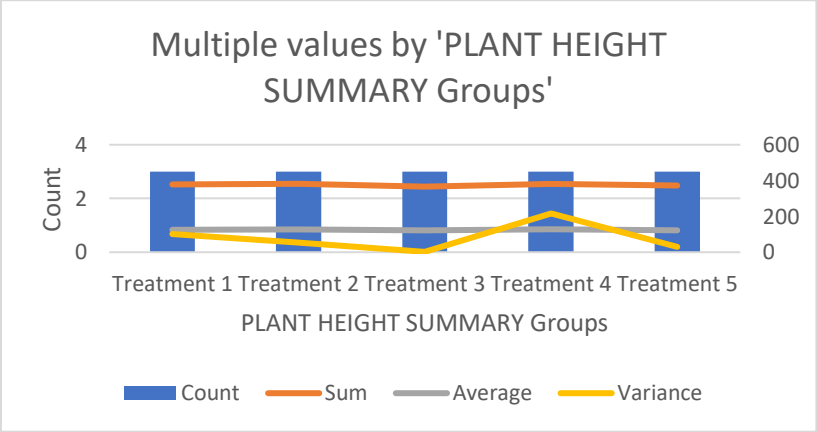

Figure 1. Plant Height Summary

Figure 1. Plant Height Summary Groups

In summary, based on the ANOVA results and the descriptive statistics provided, it can be concluded that there is no significant effect of carrageenan and synthetic fertilizer on rice plant height in this study.

Effect of Carrageenan and Synthetic Fertilizer on the Yield and Yield Components of Rice

Number of productive and unproductive tillers

Table 7 shows the analysis of the number of tillers in each treatment group indicates that there were no significant differences observed in terms of productive tillers across all treatments. This aligns with the non-significant p-value of 0.96, suggesting that neither carrageenan nor synthetic fertilizer had a substantial impact on the development of productive tillers in rice.

Table 7. Analysis of Variance on the effect of carrageenan and synthetic fertilizer on the yield and yield components of rice in terms of number of tillers.

Source of Variation	SS	Df	MS	F	P-value	F crit
Between Groups	12.48451	4	3.12112667	0.12637167	0.969493	3.47805
Within Groups	246.9799	10	24.6979933			
Total	259.4644	14				

However, it's noteworthy that in Treatment 3 (Application of fertilizer 50% of synthetic and 50% of carrageenan) and Treatment 5 (Application of carrageenan), all tillers were classified as unproductive, as they fell below the average number of tillers (Table 8). This could suggest that these treatments may have experienced conditions or received treatments that inhibited the development of productive tillers.

Table 8. Number of Productive and Unproductive Tillers.

Treatment	Productive Tillers	Unproductive Tillers
Treatment 1	52.63	None (all above average)
Treatment 2	53.6	None (all above average)
Treatment 3	None (all below average)	48.6
Treatment 4	51.6	None (all above average)
Treatment 5	None (all below average)	46.2

Length of panicle

The study investigated the effect of carrageenan and synthetic fertilizer on the yield and yield components of rice, specifically focusing on panicle length. The obtained p-value of 0.81 indicates that there is no significant effect of the treatments on panicle length. Hasanuzzaman et al. (2010) found that higher nitrogen (N) levels led to a significant increase in the length of the panicle compared to the use of organic fertilizers alone or a combination of organic and inorganic fertilizers with equal nutrient content. They observed a noticeable enhancement in panicle length with the application of NPKS fertilizer.

Table 9. Analysis of Variance on the effect of carrageenan and synthetic fertilizer on the yield and yield components of rice in terms of number of tillers.

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	5.458028	4	1.36450693	0.390471785	0.810937	3.47805
Within Groups	34.94508	10	3.4945084			
Total	40.40311	14				

Panicle length is an important yield component in rice cultivation, as it directly influences the number of grains produced per panicle and, consequently, the overall yield. In this study, the data provided includes the count, sum, average, and variance of panicle lengths observed across different treatment groups (Figure 2).

The count indicates the number of samples taken from each treatment group, while the sum represents the total length of panicles observed in those samples. The average panicle length per sample and the variance in panicle lengths within each treatment group are also provided.

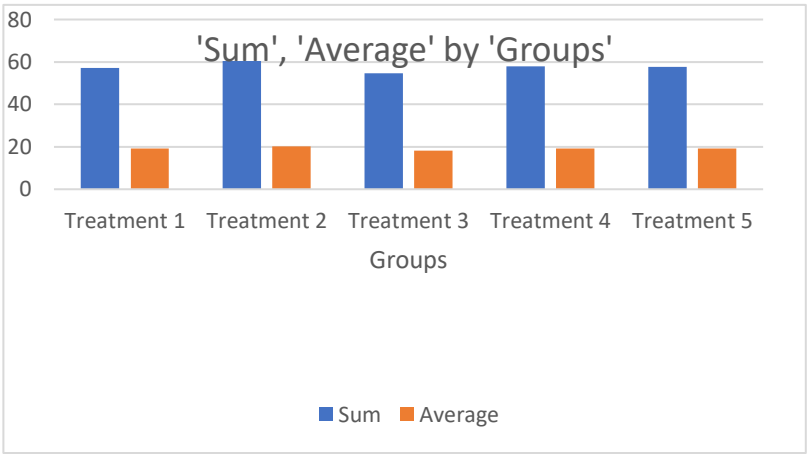

Figure 2. Sum and Average by Groups in terms of Panicle Length

The non-significant p-value suggests that the variations in panicle length observed among the treatment groups are likely due to random chance rather than the effects of carrageenan and synthetic fertilizer. Therefore, the treatments did not lead to statistically significant differences in panicle length.

Weight of 1000 grains

The weight of 1000 grains are an important indicator of grain size and yield potential in crops like rice. In this study, different treatments were applied, and the weight of 1000 grains was measured for each treatment group.

Table 10. Weight of 1000 grains.

Treatment	Weight of 1000 grains (grams)
Treatment 1	24.17
Treatment 2	76.10
Treatment 3	48.93
Treatment 4	69.30
Treatment 5	32.20

These results demonstrate considerable variation in grain weight among the different treatments. Grain weight is an essential determinant of yield and grain quality. Generally, larger grains contribute to higher yields and better market value. Therefore, treatments that result in larger grain weight are typically preferred by farmers and agricultural researchers.

In this dataset, Treatment 2, which involved applying 75% synthetic fertilizer and 25% carrageenan, exhibited the highest weight of 1000 grains, measuring 76.10 grams. This suggests that this particular treatment resulted in significantly larger grain size compared to the other treatments. Conversely, Treatment 1, which followed the farmer's practice of fertilizer application, yielded the smallest grain size, with a weight of 1000 grains at 24.17 grams. This finding contrasts with the results reported by Ram et al. (2000), where an increase in grain yield was observed with the use of organic matter.

Understanding the factors contributing to variations in grain weight among treatments is essential for optimizing agricultural practices and maximizing yield. Factors such as soil fertility, water availability, nutrient management, and the application of growth regulators or fertilizers (like carrageenan and synthetic

fertilizers mentioned in previous discussions) can influence grain development and ultimately affect grain weight.

Moisture Content

The study examined the moisture content of rice under different treatments, with a focus on evaluating the effect of carrageenan and synthetic fertilizer. The obtained p-value of 0.99 suggests that there is no significant difference in moisture content among the treatment groups (Table 11).

Table 11. Analysis of Variance on the effect of carrageenan and synthetic fertilizer on the yield and yield components of rice in terms of moisture content.

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	1.51E-06	4	3.7767E-07	0.007275039	0.999875	3.47805
Within Groups	0.000519	10	5.1913E-05			
Total	0.000521	14				

Moisture content is a critical parameter in rice cultivation, as it affects various aspects such as grain quality, storability, and processing. In this study, the data provided includes the count, sum, average, and variance of moisture content observed across different treatment groups.

The count indicates the number of samples taken from each treatment group, while the sum represents the total moisture content observed in those samples. The average moisture content per sample and the variance in moisture content within each treatment group are also provided.

The high p-value indicates that the observed variations in moisture content among the treatment groups are likely due to random chance rather than the effects of the treatments. Therefore, the treatments did not lead to statistically significant differences in moisture content.

It is important to note that while moisture content did not show a significant difference among treatments in this study, other factors such as soil type, environmental conditions, or application rates of carrageenan and synthetic fertilizer may influence moisture retention in the soil and subsequently affect moisture content.

Total Yield

The study investigated the total yield of rice under different treatments involving the use of carrageenan and synthetic fertilizers. The resulting p-value of 0.89 suggests that there is no significant difference in rice yield among the treatment groups. Xu (2010) and Kumar et al. (2014) noted considerable enhancements in rice yield attributes when organic amendments were combined with chemical fertilizers, compared to using chemical fertilizers alone.

Table 12. Analysis of Variance on the effect of carrageenan and synthetic fertilizer on the yield and yield components of rice in terms of total yield.

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	2.077294	4	0.51932343	0.259867038	0.89704	3.47805
Within Groups	19.9842	10	1.9984198			
Total	22.06149	14				

With a p-value of 0.89, the observed variations in rice yield among the treatment groups are likely due to random chance rather than the effects of the treatments. Therefore, the treatments did not lead to statistically significant differences in rice yield.

In summary, based on the obtained p-value and the descriptive statistics provided, it can be concluded that carrageenan and synthetic fertilizers did not significantly affect the yield of rice in this study.

5. CONCLUSION

The study assessing the impact of carrageenan and synthetic fertilizer on rice production yielded non-significant results across various parameters such as plant height, number of tillers, panicle length, moisture content, and rice yield, with p-values ranging from 0.81 to 0.99. These findings imply that neither carrageenan nor synthetic fertilizer led to statistically significant differences in rice growth and productivity.

Despite the absence of significant effects, this study contributes valuable insights to agricultural research by challenging existing assumptions about the efficacy of these treatments. It underscores the necessity for empirical validation of agricultural practices and emphasizes the ongoing need for exploration and refinement of agricultural technologies. By fostering innovation and evidence-based decision-making, researchers and practitioners can collaboratively develop sustainable solutions to address challenges like climate change, soil degradation, and resource limitations.

In conclusion, while this study did not identify significant effects of carrageenan and synthetic fertilizer on rice production, it sets the stage for future investigations. Further research could explore alternative application rates, timings, or formulations of these treatments to uncover optimal conditions for enhancing rice production. Additionally, conducting field trials across diverse environments and adopting integrated approaches that combine various agricultural practices may offer new insights into improving crop performance. Lastly, conducting comprehensive economic analyses will aid in assessing the cost-effectiveness of these treatments and informing farmers' decisions regarding their adoption.

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