



## Research Article

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# Adaptability Trial of Black Rice (*Oryza Sativa* L.) Under Conner, Apayao Condition

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## Abstract

The field trial on the adaptability of black rice (*Oryza sativa*) under Conner Apayao climatic condition was conducted during wet and dry seasons to determine its growth, yield and economic performance of this rice variety. It was conducted at the Agriculture Instructional, Research and Production Unit, College of Agriculture and Forestry, Apayao State College, Cubet-Malama, Conner, Apayao from July to November 2021 for the wet season and December 2021 to April 2022 for the dry season. The experimental treatments were randomly allocated in plot following the Randomized Completely Block Design in three (3) replications. Black rice seeds were requested from the Department of Agriculture. Results of the study revealed that black rice is best to plant during dry cropping season, and 20 cm × 25 cm revealed best spacing to adopt. Furthermore, black rice showed better and significant growth and yield performance ( $P > 0.01$ ) during dry cropping season in terms of the number of productive tillers per hill, total number of tillers per hill, number of grains per panicle, number of filled grains, and 20 cm × 25 cm garnered the highest yield per hectare leading to highest net income per hectare. It is recommended therefore, that black rice be adapted as one of the optional rice varieties to be planted in rice production area in Conner, Apayao, Philippines.

## Keywords

Black rice, Health, Organic, Adaptability, Growth, Yield

## Introduction

In the Philippines, rice is the number one agricultural commodity where most of our farmers engaged in. Nueva Ecija and Isabela in Central Luzon and Cagayan Valley regions respectively are the consistent rice producers that contributed a lot on the rice sufficiency program of the government. Apayao province is known as agricultural province of the Cordillera Administrative Region (CAR). During the first semester of 2022, yield per hectare was registered 3.48 metric tons. According to Philippine Statistic Report [1] the economy of Apayao accelerated with 5.2 percent growth but this was coming from Gross Provincial Domestic Product. Major economic industries namely: Industry and services grew by 18.4 percent and 8.3 percent, respectively. On the other hand, agriculture, forestry, and fishing declined by -11.7 percent. This is a reflection that the economic status most of our farmers in Apayao and likewise the whole country is still in low income. Most Filipinos are eating more white rice every day. Harvard School of Public Health reported that eating white rice regularly may raise type 2 diabetes risk. The researchers found that people who ate the most rice-three to four serving a day-were 1.5 times more likely to have diabetes than people who ate the least

amount of rice. Diabetes mellitus recorded 6.6 percent share making it the fourth leading cause of death in the Philippines. Researchers recommended to take less rice particularly on white rice which richly increases blood sugar. On the other hands, some suggested to take brown rice than white rice because it helps reduce blood sugar levels and aid in weight management effort.

Black rice in Apayao is not yet familiar. Farmers in upper municipalities of Apayao are planting upland colored rice but not in lowland rice field. With health reason, the introduction of black rice as another rice variety to be adapted and option

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to farmers not only of higher income due to price advantage compare to common rice varieties but for producing a healthy consumption.

Black rice is variety of rice now being introduced by the Department of Agriculture known with its health benefits such as good source of several nutrients like protein, fats, fiber, iron, and calories, rich in antioxidants, contains the plant compound anthocyanin which research shows that anthocyanin have strong anti-inflammatory, antioxidant, anticancer effects, may boost heart health, support eye health, may aid weight loss, lower blood sugar, decrease risk of non-alcoholic fatty liver disease. Black rice is famous because of high nutritional value. This black rice is also called forbidden rice, emperor's rice, and royal rice.

Food security, economic sustainability, and health are the common concerns we need to address. Panda, et al. [2] stated that Rice is the most popular food variety globally and is consumed as a staple food due to its high nutritional value. It is primarily black rice because of its rich anthocyanin levels, carbs, lipids, proteins, dietary fibres and minerals. Consumers are increasingly more aware of consuming healthy foods to maintain good health. Because of the strong demand from consumers, cultivars are now more interested in developing black rice due to its high anthocyanin content. The rice appears black because of the presence of anthocyanin in rice bran. Lysine, tryptophan and other essential amino acids are found in black rice. It also contains many antioxidants, the first line that protects against free radical damage and helps maintain good health.

Hartati FK, et al. [3] showed the potential of black rice as anticancer through mrtaln-p53 complex inhibitors. Analysis showed that the campesterol compound contained in black rice has the potential as a cancer drug that has a mechanism that is by binding to the binding site ligand on mortalin so that it can inhibit the occurrence of the mortalin-p53 complex.

Dewi Ratih Tirta Sari, et al. [4] concluded from their research study entitled "Black rice cultivar from Java Island of Indonesia revealed genomic, proteomic, and anthocyanin nutritional value" that the genomic, preteomic and anthocyanins composition of Java black rice cultivars may be used the improvement of their functional nutrition values. Siroha, et al. [5] sighting their findings that Pigmented rice cultivars are found in various colors i.e. black, purple, red, and brown. Pigmented rice contains good amounts of vitamins, minerals, fiber, and different phytochemicals with beneficial health effects. Pigmented rice is abundant in phenols, flavonoids, and antioxidant compounds. Pigmented rice has been reported to have several health benefits including preventing hypertension, gluten-related disorders, and heart diseases; as well as having anti-diabetic potential, antioxidant properties, anti-inflammatory activity, and anti-cancer activity. Recently, growing demand for products enriched with natural compounds that support human health has been observed. Black rice, its by-products, and residues are known to have in their composition a large amount of these compounds with biological potential, mainly anthocyanins. These compounds have reported effects on anti-obesity,

antidiabetic, antimicrobial, anticancer, neuroprotective, and cardiovascular disease stated by Leonarski, et al. [6].

The nutritional value of black rice means that it has the potential to be used in the production of healthy foods and beverages, such as functional products and gluten-free cereals, thereby providing extra health benefits to consumers. Furthermore, Kumar and Murali [7] cited from their study that black rice possessed major essential nutrients with lot of health benefits. Hence, they concluded that the use of black rice as an ingredient in food processing might help in creating value added products. As to the economic analysis of black rice production, Catherine, et al. [8] found from their study that though farmers in Manipur, India were cultivating black rice on a marginal piece of land compared to regular rice, the results obtained a benefits ratio ranging from 1.81 to 3.82, suggesting that they can also go for large-scale cultivation of black rice the commercial objectives.

Food security, economic sustainability, and health are the most common concerns of humanity in which we need to address. Hence, this study was conducted to find out if Black rice is adaptable in Conner, Apayao climatic condition.

## Objectives of the study

Generally, the study was conducted to evaluate the growth and yield performance of black rice (*Oryza sativa* L.) under Conner, Apayao climatic condition. Specifically, it was conducted to determine the performance of black rice in Conner, Apayao in terms of growth and yield parameters, the optimum transplanting distance or black rice suited to the climatic condition in Conner, Apayao during wet and dry seasons, and the economic implication to farmers' income.

## Materials and Methods

### Place and time of the study

This study was conducted at Agriculture Instructional, Research, and Production Unit of the Agriculture Department, Apayao State College in Cubet, Malama, Conner, Apayao from July Desquitado AMS 14, 2021 [9] to November 13, 2021 for wet season, and December 28, 2021 to April 8, 2022 for the dry season.

### Materials used

The materials used were the Black rice seeds, complete fertilizer (14-14-14), urea (46-0-0-0), herbicides, insecticides, foliar fertilizer, knapsack sprayer, tie wire, nylon, meter stick, pen touch or marker, placard, bamboo and shovel.

### Procurement of seeds

Seeds of black rice were procured at Isabela Grains Multi-Purpose Cooperative in Roxas, Isabela, Philippines.

### Preparation of the area

The experimental area was plowed and harrowed using hand tractor and making sure that farm debris were fully incorporated in the soil. After 2-3 weeks, final harrowing and soil levelling was done using animal drawn implements.

## Experimental treatments and field lay-out

A total 138 square meters was used in the study wherein it was subdivided into 3m × 3m subplots representing as treatments, 0.75m between block, and 0.5m between plots. The different treatment was determined as follows: T<sub>1</sub>-Black rice @ 15 × 15 cm, T<sub>2</sub>-Black rice @ 15 × 20 cm, T<sub>3</sub>-Black rice @ 20 × 20 cm, T<sub>4</sub>-Black rice @ 20 × 25 cm. The experimental treatments were randomly allocated in plot following the procedure for Randomized Complete Block Design (RCBD).

## Seed sowing and seedlings maintenance

A 1m × 5m seedbed was prepared for sowing the pre-germinated Black rice seeds were soaked in usual period like other varieties of rice. Application of 5 kilograms urea (46-0-0) at 18 days after sowing was done to ensure robust seedling growth.

## Transplanting

The seedlings were uprooted and transplanted 21 days after sowing. For uniform transplanting distance, a metal wire with loops was used as planting guide.

## Fertilization

The application of inorganic fertilizers at 15, 30, 45 days after transplanting (DAT) where in equal amount of urea (46-0-0) and complete (14-14-14) at 4.5 kg. was broadcasted as side dress and top dress for the rice plants.

## Pest and disease management

The pests observed in the study includes orange ladybug (*Harmonia axyridis*), Brown leaf folder (*Branchmia convolvuli*), Green leafhoppers (*Cicadella viridis*), Stem borer (*Scirpophaga incertulas*) and Rice bug (*Leptocoris oratorius*). These pests were controlled through application of (Cypermethrin and Magnum). There were no diseases observed during the conduct of the research study.

## Harvesting

Harvesting of the crops was done at 100 days after transplanting (DAT) during wet season and 90 DAT during dry season, when at least 85% of the grains have already matured.

## Data gathering

Data on growth and yield was gathered on ten (10) sample hills, while the management of the outbreaks of pests and diseases were based separately on the general observation in the experimental areas.

## Data gathered

### Growth parameters:

1. **Plant height (cm)**- Average height of 10 sample plants from the soil level to the longest extended leaf. This was obtained by getting the total height divided by 10 done at 20, 45, 60 and 100 DAT
2. **Number of productive/unproductive tillers**- Average number of productive/unproductive from the 10

sample tillers per hill were counted and divided by ten to arrive with the average number of productive and unproductive.

3. **Length of tillers**- Average length of tillers from the 10 sample hills measured from the neck of the tiller to the tip of the last grain were measured.

### Yield parameters:

4. **Number of grain per panicle**- The average number of grains per panicle were counted and divided by the total number of panicles from the 10 samples
5. **Number of filled and unfilled grain**- The average number of filled and unfilled grains were obtained from the panicle of the 10 sample plants divided by the total number of panicles.
6. **Weight of yield per sampling area**- This was taken from actual yield per plot after complete sun-drying.
7. **Computed Yield per Hectare**- The projected yield per hectare was computed by ratio and proportion using the Formula:

$$\text{Yield/ha} = \frac{\text{yield/plot (kg)}}{\text{size of plot (sq.m)}} = \frac{X}{10,000 \text{ sq.m}}$$

## Cost and return analysis

The Return on Cash Expenses (ROCE) was computed using simple economic analysis. The cost of production was based on the prevailing price of farm inputs and labor. The gross income was determined by the multiplying the total yield per treatment with the prevailing price of the rice. The net income was derived by deducting the total cost of production from the gross income. The Return on Cash Expenses (ROCE) was computed by dividing the net income with the total of cost of production multiplied by 100.

## Statistical analysis

All data were tabulated and analyzed using the Analysis of Variance (ANOVA) following the Randomized Complete Block Design (RCBD). Comparison between treatment means was conducted using Duncans' Multiple Range Test (DMRT).

## Results and Discussions

### General observation

It was observed that black rice planted during wet season reach beyond maximum height of normal or regular rice varieties. Hence, black rice was easily damaged during wet season due to typhoons. While, black rice when planted during dry season, it's almost had the same height with regular rice varieties. Insects were also observed most during wet season but it was easily managed adapting the Good Agricultural Practices (GAP) in all aspects of production management.

### Data gathered

#### Growth parameters

**Plant height (cm):** Plant height of black rice at 20, 45,

60, and 100 DAT was presented in Table 1. Data revealed no significant difference among all treatments. This implies that spacing between hills did not influence plant height on black rice planted during wet or dry cropping season under Conner, Apayao climatic condition. On the other hand, results showed plant height was taller during wet season as compared during dry season regardless of the planting distance and days after transplanting. Hence, black rice was recommended to be planted during dry planting season to avoid higher possibility of lodging due to floods and strong winds caused by typhoons or other weather disturbances. Desquitado, et al. [9] stated 80 percent of severe typhoons hits Luzon Island in the Philippines during the months of September to November in which rice were on its reproductive to ripening stage.

**Number of productive and unproductive tillers per hill:** The number of tillers of black rice is presented in Table 2. Data revealed significant difference among treatments in terms of productive tillers ( $p < 0.05$ ). Black rice in 20 cm  $\times$  25 cm spacing garnered the highest productive tillers, followed by 20 cm  $\times$  20 cm, and 15 cm  $\times$  20 cm which were found significantly different ( $p < 0.05$ ) to 15 cm  $\times$  15 cm spacing during wet season. Likewise, highly significant ( $p < 0.01$ ) result was observed on black rice planted during dry season with same spacing with that of black rice planted during wet season. Analysis of variance showed that the wider the space between hills affect productive tillering performance on black rice, and the total tillering performance of black rice significantly revealed based on wider spacing both on wet and dry seasons. Result of the study was in conformity of experiment conducted by Paul Reuben, et al. [10] that wider

transplanting spacing of 25 cm  $\times$  25 cm, 30 cm  $\times$  30 cm, and 35 cm  $\times$  35 cm significantly performed better than rice planted with 15 cm  $\times$  15 cm, and 25 cm  $\times$  25 cm had performed higher than the rest. Furthermore, Yumman, et al. [11] supports the findings of the study that 20 cm  $\times$  25 cm spacing gave the maximum tillers per hill.

**Length of panicle:** The length of panicle of black rice planted during wet and dry seasons is presented in Table 3. Analysis of variance found no significant differences among all treatment means both on wet and dry seasons with means ranging from 22.91 to 21.20 during wet season and 22.09 to 20.36 centimeters on dry season. This implies that spacing between hills had revealed no significant effect in terms of the length of panicle as evidently showed on the comparable result of the gathered data.

#### Yield parameters

**Number of grains per panicle:** The number of grains per panicle of black rice planted during wet and dry seasons under Conner, Apayao condition is presented in Table 4. Based on the gathered data, black rice that was planted during wet season revealed no significant different among designated spacing per treatment with mean value from 134.67 to 117.80. Despite of the statistical comparability among treatments, the 20 cm  $\times$  25 cm still garnered the highest number grains compared with 15 cm  $\times$  15 cm which recorded lowest grains per panicle.

On the other hand, during dry season, black rice in 20 cm  $\times$  20 cm and 20 cm  $\times$  25 cm spacing posted significant

**Table 1:** Plant height of black rice at 20, 45, 60, and 100/90 DAT.

| Planting Distance    | 20 DAT |       | 45 DAT |       | 60 DAT |        | 100/90 DAT |        |
|----------------------|--------|-------|--------|-------|--------|--------|------------|--------|
|                      | Wet    | Dry   | Wet    | Dry   | Wet    | Dry    | Wet        | Dry    |
| 15 cm $\times$ 15 cm | 45.92  | 39.30 | 96.92  | 64.15 | 125.84 | 128.83 | 164.68     | 137.37 |
| 15 cm $\times$ 20 cm | 44.32  | 40.78 | 94.87  | 64.25 | 124.68 | 126.92 | 160.46     | 133.38 |
| 20 cm $\times$ 20 cm | 44.47  | 38.97 | 97.87  | 60.75 | 125.05 | 124.57 | 160.48     | 135.30 |
| 20 cm $\times$ 25 cm | 44.23  | 37.92 | 98.23  | 59.50 | 121.25 | 127.40 | 157.34     | 135.30 |
| ANOVA                | ns     | ns    | ns     | ns    | ns     | ns     | ns         | ns     |
| C.V.                 | 8.89   | 33.84 | 5.36   | 4.92  | 4.64   | 28.31  | 2.95       | 146.13 |

**Table 2:** Number of productive and unproductive tillers of black rice per hill.

| Planting Distance    | Productive tillers per hill |                   | Unproductive tillers per hills |       | Total number of tillers per hill |                   |
|----------------------|-----------------------------|-------------------|--------------------------------|-------|----------------------------------|-------------------|
|                      | Wet                         | Dry               | Wet                            | Dry   | Wet                              | Dry               |
| 15 cm $\times$ 15 cm | 8.50 <sup>b</sup>           | 6.53 <sup>b</sup> | 2.13                           | 2.07  | 10.40 <sup>b</sup>               | 6.53 <sup>b</sup> |
| 15 cm $\times$ 20 cm | 9.37 <sup>a</sup>           | 8.40 <sup>a</sup> | 2.50                           | 1.03  | 11.87 <sup>a</sup>               | 8.40 <sup>a</sup> |
| 20 cm $\times$ 20 cm | 11.17 <sup>a</sup>          | 9.63 <sup>a</sup> | 3.03                           | 1.40  | 14.03 <sup>a</sup>               | 9.63 <sup>a</sup> |
| 20 cm $\times$ 25 cm | 13.10 <sup>a</sup>          | 9.83 <sup>a</sup> | 2.37                           | 1.50  | 15.47 <sup>a</sup>               | 9.83 <sup>a</sup> |
| ANOVA                | *                           | **                | ns                             | ns    | **                               | **                |
| C.V.                 | -                           | -                 | 23.24                          | 24.24 | -                                | -                 |
| DMRT                 | 2.61                        | 2.23              | -                              | -     | 3.18                             | -                 |

Note: Means with common letter are statistically comparable

\*Significant @ 5% level; \*\*Highly Significant @ 1% level

**Table 3:** Length of panicle of black rice planted during wet and dry seasons (cm).

| Planting Distance | Length of Panicle |       |
|-------------------|-------------------|-------|
|                   | Wet               | Dry   |
| 15 cm × 15 cm     | 21.20             | 20.36 |
| 15 cm × 20 cm     | 22.91             | 21.15 |
| 20 cm × 20 cm     | 22.15             | 21.82 |
| 20 cm × 25 cm     | 22.80             | 22.09 |
| ANOVA             | ns                | ns    |
| DMRT Value        | -                 |       |
| C.V. %            | 5.01              | 3.94  |

**Table 4:** Number of Grains per panicle during wet and dry seasons.

| Planting Distance | Mean Value Number of Grains Per Panicle |                     |
|-------------------|-----------------------------------------|---------------------|
|                   | Wet                                     | Dry                 |
| 15 cm × 15 cm     | 117.80                                  | 119.27 <sup>b</sup> |
| 15 cm × 20 cm     | 127.07                                  | 121.73 <sup>b</sup> |
| 20 cm × 20 cm     | 129.23                                  | 158.27 <sup>a</sup> |
| 20 cm × 25 cm     | 134.67                                  | 154.00 <sup>a</sup> |
| ANOVA             | ns                                      | **                  |
| DMRT Value        | -                                       | 24.46               |
| C.V%              | 23.21                                   | -                   |

difference ( $p < 0.01$ ) as compared to 15 cm × 15 cm which is comparable to 15 cm × 20 cm. This implies that wider spacing generate better results as to the number of grains per panicle as compared to the closer planting distances.

The study is in consonance with the findings of Yumman, et al. [11] stated that 20 cm × 25 cm spacing per hill significantly increased the yield and yield attributes, gave the maximum number of effective tillers per hill, number of seeds per panicle, grain yield, biomass yield, and harvest index.

**Number of filled and unfilled grains:** The number of filled and unfilled grains of black rice during wet and dry seasons under Conner, Apayao condition is presented in Table 5. Results during dry season showed highly significance ( $p < 0.01$ ) in 20 cm × 20 cm and 20 cm × 25 cm was statistically similar but significantly different with 15 cm × 15 cm spacing. Yumman, et al. [11] stated that 20 cm × 25 cm spacing per hill significantly increased grain yield, biomass yield, and harvest index.

Thus, the 20 cm × 20 cm and 20 cm × 25 cm can be both recommended spacing of black rice during dry season under the Conner, Apayao condition resulting to a higher number of filled grains.

**Weight of yield per sampling area:** Table 6 showed the weight yield of black rice during wet and dry seasons under Conner, Apayao condition. Analysis of variance showed no significant differences among treatment means both wet and dry seasons. It was observed that during wet season, closer spacing garnered highest weight yield per sampling area and

**Table 6:** Weight of Yield Black Rice per plot during wet and dry seasons.

| Planting Distance | Mean Value Weight of Yield per Sampling Area (Kg) |       |
|-------------------|---------------------------------------------------|-------|
|                   | Wet                                               | Dry   |
| 15 cm × 15 cm     | 2.99                                              | 5.50  |
| 15 cm × 20 cm     | 2.27                                              | 6.08  |
| 20 cm × 20 cm     | 1.91                                              | 5.44  |
| 20 cm × 25 cm     | 1.57                                              | 6.27  |
| ANOVA             | ns                                                | ns    |
| DMRT Value        | -                                                 | -     |
| C.V%              | 31.50                                             | 12.05 |

**Table 5:** Number of Filled and Unfilled Grains of Black Rice during wet and dry seasons.

| Planting Distance | Filled Grains |                     | Unfilled Grains |       |
|-------------------|---------------|---------------------|-----------------|-------|
|                   | Wet           | Dry                 | Wet             | Dry   |
| 15 cm × 15 cm     | 82.77         | 89.63 <sup>b</sup>  | 35.03           | 29.63 |
| 15 cm × 20 cm     | 77.70         | 83.53 <sup>b</sup>  | 49.15           | 38.97 |
| 20 cm × 20 cm     | 83.90         | 121.27 <sup>a</sup> | 45.33           | 37.00 |
| 20 cm × 25 cm     | 80.90         | 114.93 <sup>a</sup> | 53.77           | 39.07 |
| ANOVA             | ns            | **                  | ns              | ns    |
| DMRT Value        | -             | 22.80               | -               | -     |
| C.V%              | 32.71         | -                   | 22.54           | 13.77 |

the wider spacing recorded the lowest weight yield. Likewise, it was observed that weight yield of black rice during dry season was higher compared with wet season wherein 20 cm × 25 cm and 15 cm × 20 cm recorded the highest weight yield per sampling area, followed by black rice in 15 cm × 15 cm and 20 cm × 20 cm respectively.

**Computed yield per hectare:** The computed yield per hectare of black rice based on the gathered data was clearly revealed dry planting season as the recommendable time of planting black rice, and 20 cm × 25 cm found the best planting distances which yield performance was observed. Yumman, et al. [11] supported the findings of the study that higher planting space (20 cm × 25 cm) significantly increased the yield and yield attributes of black aromatic rice. Furthermore, the computed yield per hectare of black rice with 20 cm × 25 cm during dry season is more convincing to rice farmers for at least 139.33 bag (50 kg/bag) per hectare and the price per kilogram of black rice is more promising than white rice leading towards higher income (Table 7).

**Return on Cash Expense (ROCE) of black rice on wet and dry cropping seasons:** The Return on Cash Expense (RoCE) of black rice during wet and dry season is presented in Table 8 and Table 9. Based on the result of the study, black rice planted in a 20 cm × 25 cm spacing recorded the highest net income and the Return of Cash Expenses (RoCE) reached 85.11 percent. Data showed that in black rice production specifically planted during dry season with 20 cm × 25 cm revealed promising income. Table 9 presents 20 cm × 25 cm

Table 7: Computed Yield of black rice/hectare during wet and dry seasons.

| Planting Distance | Sampling Area |      | Tons/Ha |      | Cavans/Ha |        |
|-------------------|---------------|------|---------|------|-----------|--------|
|                   | Wet           | Dry  | Wet     | Dry  | Wet       | Dry    |
| 15 cm × 15 cm     | 2.91          | 5.50 | 3.23    | 6.11 | 64.66     | 122.22 |
| 15 cm × 20 cm     | 2.21          | 6.08 | 3.52    | 6.75 | 50.44     | 135.11 |
| 20 cm × 20 cm     | 1.91          | 5.44 | 2.12    | 6.04 | 42.44     | 120.85 |
| 20 cm × 25 cm     | 1.57          | 6.27 | 1.74    | 6.96 | 34.88     | 139.33 |

Table 8: Computed Return on Cash Expense of Black Rice on Wet and Dry Seasons per plot (9 m²).

| Planting Distance | Wet Season |              |            |       | Dry Season |              |            |       |
|-------------------|------------|--------------|------------|-------|------------|--------------|------------|-------|
|                   | Expenses   | Gross Income | Net Income | ROCE  | Expenses   | Gross Income | Net Income | ROCE  |
| 15 cm × 15 cm     | 56.00      | 174.60       | 118.60     | 67.93 | 56.00      | 330.00       | 274.00     | 83.03 |
| 15 cm × 20 cm     | 56.00      | 132.60       | 76.60      | 57.77 | 56.00      | 364.80       | 308.80     | 84.65 |
| 20 cm × 20 cm     | 56.00      | 114.60       | 58.60      | 51.18 | 56.00      | 326.40       | 270.40     | 82.84 |
| 20 cm × 25 cm     | 56.00      | 94.20        | 38.20      | 40.55 | 56.00      | 376.20       | 320.20     | 85.11 |

\*Price of Fresh Black Rice per kilograms P60.00

Table 9: Computed Net Income of black rice per hectare at P60.00 per kilo fresh grains during wet and dry seasons under Conner, Apayao condition.

| Planting Distance | Net Income Per Hectare |            |
|-------------------|------------------------|------------|
|                   | Wet Season             | Dry Season |
| 15 cm × 15 cm     | 131,777.80             | 304,444.40 |
| 15 cm × 20 cm     | 85,111.11              | 343,111.10 |
| 20 cm × 20 cm     | 65,111.11              | 300,444.40 |
| 20 cm × 25 cm     | 42,444.44              | 355,777.80 |

spacing have income of P355,777.80 per hectare in which farm gate price of fresh black rice is P60.00 compared to white rice with only P16.00-19.00 per kilo. The study confirms the findings of Yumman, et al. [11] who shared that the 20 cm × 25 cm spacing for black aromatic rice gave the highest gross return, net return, and benefit-cost ratio.

Conclusion

Based on the result of the study, black rice is best recommended to be planted during dry cropping season, and 20 cm × 25 cm observed best spacing to adapt. It was therefore concluded that black rice significantly revealed its growth and yield performance during dry cropping season in terms of the number of productive tillers per hill, total number of tillers per hill, number of grains per panicle, number of filled grains, and 20 cm × 25 cm (T<sub>4</sub>) garnered the highest yield per hectare resulted to highest net income per hectare.

Recommendation

Based on the above-mentioned result, black rice is adaptable to the climatic condition of Conner, Apayao. Therefore, it is recommended to be planted as alternative option of rice varieties in the locality. Furthermore, it is recommended to conduct same study of black rice to verify the significant performance in terms of growth and yield

during dry cropping season to be conducted in the different regions of Conner, Apayao, and later on, the whole province of Apayao.

Conflict of Interest

The authors declare that there is no conflict of interest.

Ethical Approval

Not Applicable.

Consent for Publication

The authors have explicitly consented to the publication of the data or the analysis results.

Availability of Supporting Data

Not Applicable.

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Conflict of Interest

The authors declare no competing interest.

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