***Original Research Article***

**Economics of production enhancement on scented rice (*Oryza sativa* L.) through bio-fertilizer, organic manure and micro-nutrients in central plain zone of Uttar Pradesh**

**ABSTRACT**

Field experiments were conducted during Kharif seasons of 2021 and 2022 at Crop Research Farm, Nawabganj, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh. The experiment consisted three varieties (PB-1509, PB-1121 and PB-1), three bio-fertilizer and organic manure levels (BGA @ 10 kg ha-1, FYM @10 t ha-1 and BGA @ 10 kg ha-1 + FYM @10 t ha-1) and three nutrient management treatments (NPK- 120:60:60 kg ha-1 only, NPK + ZnSO4 @ 25 kg ha-1 as basal + FeSO4 1% sprayed at tillering stage and NPK + ZnSO4 @ 25 kg ha-1 as basal + FeSO4 1% sprayed at panicle initiation stage). The treatments were accommodated in split-split plot design with three replications. The soil of experimental field was sandy loam in texture having low organic carbon (0.39 %), medium in available nitrogen (179 kg ha-1), low in available phosphorus (13.0 kg ha-1), medium in available potassium (156 kg ha-1), low in available zinc (0.58 mg ha-1) and normal in available iron (7.83 mg ha-1) with normal pH (7.95). Pooled results of two years experimentation indicated that highest value of net income (Rs 75749.43, Rs 61471.54 and Rs 57129.86) and B:C ratio (2.06, 1.85 and 1.79) was recorded under the variety PB-1121, BGA @ 10 kg ha-1 + FYM @ 10 t ha-1 and NPK (120:60:60 kg ha-1) + ZnSO4 @ 25 kg ha-1 as basal + FeSO4 1% sprayed at tillering stage respectively.

Keywords: Scented rice (*Oryza sativa* L.), gross income, net income and B:C ratio.

**INTRODUCTION**

Rice (*Oryza sativa* L.) is a most important staple food of about more than 60% of total world population. Rice is cultivated world-wide over an area of about 163.20 million hectares with an annual production of about 758.90 million tonnes. (503.80 million tonnes, milled basis) and productivity 4.60 tons per hectare (Anonymous, 2022a). About 90% of all rice grown in the world is produced and consumed in Asian region. It accounts 43% of total food grain production and 55% of cereal production in the country. It is a high caloric food, which contains 75% starch, 6-7% protein, 2-2.5% fat, 0.8% cellulose and 5-9% ash%.

India is the world’s 2nd largest producer with approximately 43.0 million hectare area, accounting for 22% of the world’s rice production. At the end of fiscal year 2019, India had approximately 44 million hectares of area for cultivation of rice. This area had been relatively consistent over during the past three years. Total production of rice during 2019-20 was recorded 117.47 million tonnes. It is higher by 9.67 million tonnes than the five years average production of 107.80 million tonnes but production of rice is 110 million tonnes with an average productivity of 2590 kg ha-1. In UP, it is grown in an area of about 5.86 million ha with production of 12.90 million tonnes and productivity of 2132 kg ha-1 (Anonymous,2022b).

Modernization of agriculture does not only affect the diversity of crops but also the diversity of nutrition. Crop production geared towards high yielding cereal crops mainly wheat, rice and maize could significantly reduce the production of nutritionally rich grains. The reliance of few crops is the major reason for wide spread of zinc and iron deficiency. Selective application of particular fertilizers for increased crop productivity and restoration of heavily degraded soils could limit bioavailability of certain micronutrients through fixation. For instance, high level of available phosphorus in the soil is usually ends up in zinc deficiency (Bilski *et al.,* 2012).

Worldwide, there is a growing interest in the role of micronutrients in optimizing health and in prevention of overall diseases of human being. Micronutrient play a crucial role for human nutrition, including the prevention and treatment of various diseases and conditions, as well as the optimization of physical and mental functioning has also been fully recognized globally in Asia, Africa and Latin America countries, the deficiency of micronutrients such as iron and zinc are the most prevalent for human disorders. (Anteneh *el al.,* 2016).

Nutrient management through organics plays a major role in maintaining soil health due to build-up of soil organic matter, beneficial microbes and enzymes, besides improving soil physical and chemical properties. Therefore, combined use of organic manure and inorganic fertilizers in an integrated manner will give better performance in cereals by sustaining higher yield and maintaining soil health as well (Sharma *et al.,* 2017).

Nitrogen, phosphorus and potassium as major nutrients, zinc and boron as micronutrients play an important role in the yield and quality of rice. The ability of the plants to produce more is dependent on the availability of adequate plant nutrients because cultivation of high yielding varieties coupled with intensive cropping system has depleted the soil fertility, causing multi-nutrient deficiencies in soil-plant system. Under such a situation, use of only one or two primary nutrients will not be sufficient for maintaining the long-term sustainability of crop production (Reena et al., 2017 and Islam et al., 2014).

**Table 1: Effect of treatments on Grain yield (Kg ha-1) and Straw yield (Kg ha-1) of scented rice**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Treatment Combinations** | **Grain yield (kg ha-1)** | | | **Straw yield (kg ha-1)** | | |
| **2021** | **2022** | **Pooled** | **2021** | **2022** | **Pooled** |
| **Varieties** | | | | | | |
| PB-1509 | 5019.77 | 5130.47 | 5075.12 | 10469.70 | 10570.92 | 10520.31 |
| PB-1121 | 6071.69 | 6232.78 | 6152.24 | 10706.89 | 10733.88 | 10720.39 |
| PB-1 | 4049.44 | 4135.52 | 4092.48 | 10883.04 | 11000.98 | 10942.01 |
| SE (d) ± | 95.26 | 108.85 | 125.27 | 109.32 | 68.00 | 111.49 |
| CD (P=0.05) | 262.99 | 300.52 | 288.87 | 301.81 | 187.74 | 257.11 |
| **Bio-fertilizer and organic manure** | | | | | | |
| BGA – 10 kg ha-1 | 4739.59 | 4824.14 | 4781.87 | 10092.64 | 10180.74 | 10136.69 |
| FYM – 10 t ha-1 | 5046.86 | 5166.27 | 5106.57 | 10675.29 | 10768.52 | 10721.91 |
| BGA10 kg ha-1 + FYM 10 t ha-1 | 5354.45 | 5508.36 | 5431.41 | 11291.69 | 11356.51 | 11324.10 |
| SE (d) ± | 122.98 | 140.55 | 161.73 | 140.56 | 68.14 | 135.28 |
| CD (P=0.05) | 267.89 | 306.18 | 333.82 | 306.20 | 148.43 | 279.21 |
| **Nutrient Management** | | | | | | |
| N:P:K (120:60:60 kg ha-1) | 4759.62 | 4867.35 | 4813.49 | 10283.66 | 10386.35 | 10335.01 |
| N:P:K (120:60:60 kg ha-1) + ZnSO4 @ 25 kg ha-1 (Basal) + FeSO4 1% solution sprayed at TS | 5149.32 | 5280.25 | 5214.79 | 10914.90 | 10964.68 | 10939.79 |
| N:P:K (120:60:60 kg ha-1) + ZnSO4 @ 25 kg ha-1 (Basal) + FeSO4 1% solution sprayed at PIS | 5046.96 | 5166.17 | 5106.57 | 10675.07 | 10768.73 | 10721.90 |
| SE (d) ± | 77.78 | 88.89 | 102.29 | 88.89 | 136.22 | 140.87 |
| CD (P=0.05) | 157.78 | 180.32 | 203.55 | 180.33 | 276.34 | 280.33 |

TS - Tillering Stage and PIS - Panicle Initiation Stage

**Table 2: Effect of treatments on Gross income (Rs ha-1), Net income (Rs ha-1) and B:C ratio of scented rice**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Treatment Combinations** | **Gross income (Rs ha-1)** | | | **Net income (Rs ha-1)** | | | **B:C ratio** | | |
| **2021** | **2022** | **Pooled** | **2021** | **2022** | **Pooled** | **2021** | **2022** | **Pooled** |
| **Varieties** | | | | | | | | | |
| PB-1509 | 120416.90 | 130243.40 | 125330.15 | 49288.26 | 58067.03 | 53677.65 | 1.69 | 1.80 | 1.75 |
| PB-1121 | 141345.90 | 153124.60 | 147235.25 | 70217.24 | 81281.62 | 75749.43 | 1.99 | 2.13 | 2.06 |
| PB-1 | 102501.90 | 110987.00 | 106744.45 | 31373.21 | 39144.04 | 35258.63 | 1.44 | 1.54 | 1.49 |
| SE (d) ± | 1767.88 | 1991.48 | 2306.19 | 1024.37 | 1316.34 | 2306.19 | 0.02 | 0.02 | 0.03 |
| CD (P=0.05) | 4880.76 | 5498.06 | 5318.07 | 2877.76 | 3634.14 | 5318.09 | 0.06 | 0.05 | 0.06 |
| **Bio-fertilizer and organic manure** | | | | | | | | | |
| BGA – 10 kg ha-1 | 114151.90 | 123049.90 | 118600.90 | 44679.94 | 52863.60 | 48771.77 | 1.64 | 1.75 | 1.69 |
| FYM – 10 t ha-1 | 121394.60 | 131451.80 | 126423.20 | 49937.64 | 58947.15 | 54442.39 | 1.69 | 1.81 | 1.75 |
| BGA10 kg ha-1 + FYM 10 t ha-1 | 128718.10 | 139853.30 | 134285.70 | 56261.14 | 66681.94 | 61471.54 | 1.78 | 1.91 | 1.85 |
| SE (d) ± | 2284.01 | 2576.71 | 1978.01 | 1346.83 | 1698.28 | 2981.96 | 0.03 | 0.02 | 0.03 |
| CD (P=0.05) | 4975.49 | 5613.10 | 4082.62 | 2933.93 | 3699.54 | 6154.78 | 0.06 | 0.05 | 0.07 |
| **Nutrient Management** | | | | | | | | | |
| N:P:K (120:60:60 kg ha-1) | 116023.90 | 125717.90 | 120870.90 | 45474.24 | 54488.28 | 49981.74 | 1.64 | 1.76 | 1.70 |
| N:P:K (120:60:60 kg ha-1) + ZnSO4 @ 25 kg ha-1 (Basal) + FeSO4 1% solution sprayed at TS | 123909.60 | 134251.80 | 129080.70 | 52490.91 | 61768.80 | 57129.86 | 1.73 | 1.85 | 1.79 |
| N:P:K (120:60:60 kg ha-1) + ZnSO4 @ 25 kg ha-1 (Basal) + FeSO4 1% solution sprayed at PIS | 121396.20 | 131450.30 | 126423.25 | 49977.57 | 59300.61 | 54639.09 | 1.70 | 1.82 | 1.76 |
| SE (d) ± | 1444.43 | 1629.69 | 1885.93 | 851.86 | 1074.08 | 1885.93 | 0.02 | 0.02 | 0.02 |
| CD (P=0.05) | 2930.23 | 3306.07 | 3752.99 | 1728.11 | 2178.92 | 3752.99 | 0.04 | 0.03 | 0.04 |

TS - Tillering Stage and PIS - Panicle Initiation Stage

**MATERIAL AND METHODS**

**Cost of cultivation (Rs ha-1)**

The cost of cultivation was worked out treatment wise. The common cost of cultivation of all treatment was added to the respective additional cost involved in each treatment. Based on input rates at the farm, we calculated the cost of cultivation. Costs associated with treatments were calculated separately. To obtain the total cost of cultivation, all expenses incurred in cultivation were taken into account, and treating costs (including interest on working capital) were added.

**Gross income (Rs ha-1)**

For gross income the grain yield kg ha-1 and straw yield kg ha-1 were multiplied by prevailing market price of the produce and gross income worked out.

Gross income = Total income from grain and straw yield

**Net income (Rs ha-1)**

For obtaining the net income, the cost of cultivation was subtracted from the gross income (Rs ha-1).

Net return = Gross return – cost of cultivation

**Benefit: cost ratio (B:C)**

For calculating the cost benefit ratio, the gross income was divided by the cost of cultivation. The value obtained was considered as cost benefit cost ratio.

B:C ratio = Gross income (Rs ha-1) / Cost of Cultivation (Rs ha-1)

**RESULTS AND DISCUSSION**

On the basis of gross income, net income and B: C ratio the most profitable variety identified was PB-1121 which gave 14.87 % and 27.50 % more gross income, 29.14 % and 53.45 % more net income, 0.31 paise and 0.57 paise more B: C ratio compared to PB-1509 and PB-1, respectively. The variety PB-1121 recorded maximum gross income (Rs 147235.25 ha-1), net income Rs 75749.43 ha-1) and, B:C ratio (2.06) and significantly higher over other two varieties.

The application of BGA @ 10 kg ha-1 + FYM @ 10 t ha-1 recorded 5.86 % and 11.68 % more gross income, 11.46 % and 20.65 % more net income and 0.10 and 0.16 paise more B: C ratio compared to only FYM @ 10 t ha-1 and only BGA @ 10 kg ha-1 treatments, respectively. The application of BGA @ 10 kg ha-1 + FYM @ 10 t ha-1 along with NPK doses recorded. maximum gross income (Rs 134285.70 ha-1), net income (Rs 61471.54 ha-1) and B:C ratio (1.85) and significantly superior as compared to FYM @ 10 t ha-1 and BGA @ 10 kg ha-1. The findings are in conformity with the results of Chaudhary *et al.,* (2021).

Among nutrient management treatment NPK + ZnSO4 @ 25 kg ha-1 as basal + FeSO4 (1%) at tillering stage recorded significantly more gross income (6.36 %), net income (12.51 %) and more B: C ratio (0.09 paise) compared to only NPK treatment. The application of NPK + ZnSO4 @ 25 kg ha-1 as basal + FeSO4 (1%) at panicle initiation stage resulted in 4.39 % more gross income, 8.52 % more net income and 0.06 paise more B: C ratio compared to only NPK treatment found less responsive then FeSO4 applied at tillering stage. Application of NPK + ZnSO4 @ 25 kg ha-1 as basal + FeSO4 (1%) sprayed at tillering stage recorded maximum gross income (Rs 129080.70 ha-1), net income (Rs 57123.86 ha-1) and B:C ratio (1.79) which proved significantly superior as compared to other nutrient management treatments. The above findings are correlated with the Prakash *et al.,* (2015).

**CONCLUSION**

Among three varieties PB-1121, three bio-fertilizer and organic manure levels BGA @ 10 kg ha-1 + FYM @ 10 t ha-1 and three nutrient management treatments NPK + ZnSO4 @ 25 kg ha-1 as basal + FeSO4 (1%) sprayed at tillering stage showed higher net income (Rs 75749.43 ha-1, Rs 61471.54 ha-1and Rs 57129.86 ha-1, respectively) and B:C ratio (2.06, 1.85 and 1.79, respectively).

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