**Growth, yield and economics of rice as influenced by graded levels of nitrogen and sulphur in temperate Kashmir**

**Abstract**

A field experiment entitled as **“Growth, yield and economics of rice as influenced by graded levels of nitrogen and sulphur in temperate Kashmir”** was conducted at the Crop Research Farm of Division of Agronomy, Faculty of Agriculture, Sher-e- Kashmir University of Agricultural Sciences and Technology of Kashmir during *Kharif*, 2021. The soil of the experimental field was silt clay loam with neutral pH, low in available nitrogen, medium in phosphorous, potassium and organic carbon, however sufficient in sulphur. The experiment consisted of two factors: Factor A being Nitrogen Levels (kg ha-1) as Control, N60, N80, N120 and Factor B being Sulphur Levels (kg ha-1) as Control, S15, S30, S45 laid out in Factorial Randomized Complete Block Design with three replications. Significant variations in growth parameters, yield attributes and yield were recorded among different levels of nitrogen and sulphur management practices under investigation. Significantly higher plant growth parameters, yield attributes and yield were recorded in 80 kg ha-1 level of nitrogen and 30 kg ha-1 level of sulphur. Significant interaction was also seen between nitrogen (80kg N ha-1) and sulphur (30kg S ha-1) on panicle no m-2, filled grains per panicle and grain yield. Among the various treatments, treatment combination N2S2 (80kg N ha-1 and 30 kg S ha-1) revealed highest B:C ratio of 2.23 followed byN3S3 (120kg N ha-1 and 45 kg S ha-1) with B:C ratio of 2.22.

***Keywords***: Rice, nitrogen levels, sulphur levels, yield, economics. interaction

**Introduction**

Rice (*Oryza sativa* L**.)** is one of the important staple food crop for the world’s population. More than 90% of the world’s rice is produced and consumed in Asia. Out of 782 million tonnes of global rice production from 167.1 million hectares, India produced 116.42 million tonnes in 44.5 million hectares (FAO, 2020). In Jammu and Kashmir, rice is grown from immemorial and stands as the principal staple food crop. The total rice area of the UT of Jammu and Kashmir is around 0.28 million hectares with a production and productivity of 0.55 million tonnes and 2.1 tonnes per hectares, respectively (DES, 2018).

Rice is a nutritional staple food which provides instant energy as its most import ant component is carbohydrate (starch). It provides about 700 calories per day per person for about 3000 million people living mostly in developing countries (USDA 2020). It is also used in manufacturing of paper pulp and livestock bedding. The per capita food intake in India is 2234 calories per day of which 30 percent comes from rice only. Its protein is highly digestible with excellent biological values and protein efficiency ratio owing to the presence of higher concentration (4%) of lysine (Oko *et al*., 2012). Nitrogen and Sulphur both are involved in plant protein synthesis, a process that determines the crop yields. Nitrogen is the main factor to improve the rice grain nutritional quality which positively affects the protein fraction of glutelin rich in essential amino acids (Mingotte *et al.,* 2012) and also involves in productivity (Fageria and Filho, 2010). Sulphur fertilization improves the nutrient uptake and fertilizer use efficiency of N, P, K and Zn because of synergistic relationship of sulphur with these nutrients. Sulphur tends to increase the yield in cereals up to certain limit (Ying- xing *et al*., 2017). Nitrogen is considered as the most yield-limiting nutrient in irrigated rice production around the world (Samonte *et al*., 2006). Nitrogen is the most limiting nutrient for rice crop growth and yield which is required in higher amounts compared to other nutrients (Djaman *et al*., [2018](https://www.tandfonline.com/doi/full/10.1080/24749508.2020.1742509)).

Nitrogen is one of the most important plant nutrients and plays a vital role in plant photosynthesis and biomass production. Increasing panicle numbers in per unit area is the main factor of yield increment as a result of nitrogen application (Bindra *et al.,* 2000; Laroo and Shivay, 2011). Nitrogen influences rice yield by playing major role in the photosynthesis, biomass accumulation and spikelets formation (Yoshida *et al*., 2006). Furthermore, excessive use of high analysis fertilizers in the recent past for improved cultivars has led to nutrient imbalance in soil particularly to the deficiency of secondary nutrients like sulphur. After N, P, and K, sulphur has long been acknowledged as the fourth most important nutrient for plants. According to Prasad (2004), sulphur is moving up from fourth to third on the list of essential nutrients in India. Both inorganic and organic forms of sulphur are found in soils, with organic sulphur accounting for more than 93% of all sulphur in soils from humid and semi-humid locations. However, depending on the kind of soil and sampling depth, there are significant differences in the percentage of inorganic and organic sulphur in a soil sample. Sulfate-S is continuously present in soil solution at very low concentrations, depending on the balance of S plant uptake, fertiliser input, immobilization, and mineralization at any given time (Balik *et al.,* 2009). Realizing the importance of sulphur and nitrogen on growth and yield in rice a study entitled **“Growth, yield and economics of rice as influenced by graded levels of nitrogen and sulphur in temperate Kashmir”** was conducted during 2021.

**Materials and methods**

The present investigation entitled **“Growth, yield and economics of rice as influenced by graded levels of nitrogen and sulphur in temperate Kashmir”** wasconducted at Agronomy Research Farm, Faculty of Agriculture, Wadura (Sopore), Sher-e-Kashmir University of Agricultural Sciences & Technologyof Kashmir, during *kharif* season of2021. The experimental site is situated in temperate zone between 34o35/ N latitude and 74o40/ E longitude at an altitude of 1584 meters above mean sea level. Climatically the experimental site was in mid altitude temperate zone characterized by hot summers and very cold winters with an average annual precipitation of 812 mm (average of past 20 years) most of which is received from December to April in the form of snow and rains. The soil of experimental site was silty clay loam, medium in available P, K, S and organic carbon however it was low in available N.

The plant height was measured from ground level to the tip of the tallest leaf and at the maturity up to the tip of the tallest panicle. The plant height was presented as the average of the five hills in centimeters. Five hills were cut from the base of the middle row randomly from each treatment at 15 days interval. After sun drying for 3-4 days, the plant samples were oven dried at 60- 650C for 48 hours to a constant value. The dry weight was recorded in grams and then converted into q ha-1. The periodic leaf area at 15 days interval was measured from five hills for each treatment with canopy analyzer Accupar LP-80 (Decagon Devices, USA). The number of panicles falling in quadrant 0.25 m-2 were counted from each plot before harvesting and the number was converted into m-2. Panicle length of six randomly selected panicles from each plot was measured from neck node to the tip of panicle and then averaged and expressed in centimeters. Number of spikelets from six panicles was counted from each plot and averaged and expressed as spikelets panicle-1. Number of filled grains from each panicle was counted and averaged and expressed as filled grains per panicle. Grain samples from each plot collected separately at threshing were dried properly. 1000-grains from each of these samples were taken and their weights recorded and expressed in grams. After proper threshing and cleaning the produce from each plot was sun dried. The yield from each plot was recorded separately as kg per plot and then converted into t ha-1. Straw yield of each plot was computed by deducting the grain yield from the respective biological yield and expressed in t ha-1. Economics of different treatments was worked out on the basis of grain and straw yield per hectare. The cost of input and output was estimated as per prevailing market rates.

**Results and discussion**

**Plant height (cm)**

The data revealed that graded level of nitrogen and sulphur had a significant effect on periodic plant height of rice (Table 1). Among different treatments of nitrogen levels, 120 N ha-1 recorded significantly taller plants at different growth stages (15 DAT, 30 DAT, 45 DAT, 60 DAT, 75 DAT, 90 DAT and at harvest) compared to no application of nitrogen N0 and 60 N kg ha-1 (N60) and was at par to 80 kg N ha-1 (N80) application. However, at different growth stages of 75 DAT, 90 DAT, 105 DAT and at harvest 120 kg N ha-1 recorded taller plants. Sulphur application of 45 kg S ha-1 (S45) recorded taller plants compared to 15 kg S/ha (S15) and no application of sulphur (Table 1) at all growth stages. However, 45kg S/ha (S45) and 120kg N/ha (N120) application recorded significantly taller plants than 30 kg S ha-1 (S30) application at all growth stages (15 DAT, 30 DAT, 45 DAT, 60 DAT, 75 DAT, 90 DAT and at harvest). Significant effect on increased plant height of rice with higher rates of nitrogen may be attributed to fact that nitrogen being an essential constituent plant tissue favors rapid cell division and enlargement. These results are in accordance with the finding of Dahipahle and Singh (2018), Balasubramanian (2002) and Walker *et al*. (2008).

**Leaf area index**

The data pertaining to leaf area index is presented in Table 2 and the results of the reveal that higher levels of nitrogen application (80 kg N/ha and 120 kg N/ha) significantly recorded higher leaf area index compare to lower doses of N application and this may be attributed to optimum availability of nitrogen at higher doses and higher photosynthetic rate, that leads to better development of LAI. Further, it was recorded that 120 kg N ha-1 was at par with 80 kg N ha-1. The lowest LAI was recorded under N0 treatment where no nitrogen was applied (0 kg N ha-1). It was possibly due to the poor plant height with no application of nitrogen. Almost same finding were reported by Gupta *et al*. (2011) and Uddin *et al*. (2013)**.** The results of the present study also indicated that at all the growth stages of the crop application of 45 kg S ha-1 recorded highest LAI as compared to rest of the treatments while at par with 30 kg S ha-1. This indicated that higher levels of sulphur application at 45 kg S ha-1 and 30 kg S ha-1 helped to better development of leaf area index. Increase in the functional leaf area of rice due to application of ‘S’ have been reported by Sumathy *et al.* (1999) and Martin *et al.* (2010).

**Yield attributes**

The important yield contributing characters *viz.,* number of panicles m-2, panicle length, spikelets panicle-1, number of filled grains panicle-1 and 1000 grain weight showed significant variation due to the effect of different doses of nitrogen and Sulphur (Table 3). The application of and 60 kg N ha-1 and no application (control) resulted in significantly the lower number of panicles m-2 and significantly lowest panicle length, spikelets panicle-1, number of filled grains per panicle and test weight. These characters were improved with the corresponding increase in nitrogen levels from 80 to 120 kg N ha-1 being the maximum under 120 kg N ha-1. However, significant increase in yield attributes was up to 80 kg N ha-1. The decreased growth parameters of the rice plants under lower dose of nitrogen *i.e* and 60 kg N ha-1 and under no application was due to less availability of nitrogen from the soil which have resulted in decreased yield attributing characters. However, the case was just opposite for the plots receiving nitrogen at the higher dose. The overall fact is that increasing levels of N significantly or non-significantly improved all the yield attributing characters which might be due to higher growth characters, increased accumulation of photosynthetic from the source to the sink. Singh and Kumar (2014) and Tiwari *et al.,* (2015) had also reported the response of rice crop to nitrogen in augmenting the yield attributing characters. The results of the present study also revealed that at all the yield attributing characters of the crop which received 45 kg S ha-1 recorded highest number of panicles m-2, panicle length, spikelets panicle-1, number of filled grains panicle-1 and 1000-grain weight as compared to rest of the treatments and was at par with 30 kg S ha-1. This could be attributed to the availability of Sulphur nutrient in soil which increases these yield attributing characters. The results are in conformity with the findings of Bhubaneshwar *et al.* (2007), Rahaman *et al.* (2007), Jawahar and Vaiyapuri (2010) and Martin Luther *et al.* (2010).

**Interaction of nitrogen and sulphur on panicle number m-2**

Number of panicles m-2, was markedly influenced by combined application of nitrogen and sulphur. The application rate of 120 kg N + 45 kg S ha-1 recorded the maximum number of panicle m-2 and was found to be at par with treatment 80 kg N + 30 kg S ha-1 (Table 4). This could be due synergistic effect of nitrogen and sulphur on growth and yield attributes (panicles m-2) resulting in greater translocation of photosynthates from source to sink. Same findings were also reported by Channabasamma *et al.* 2013.

**Interaction of nitrogen and sulphur on filled grains per panicle**

Regarding nitrogen and sulphur level effect, increased rate of nitrogen and sulphur from 0 to 120 kg N ha-1 and 0 to 45 kg S ha -1 significantly enhanced the number of filled grains per panicle. The combined application rate of 120 kg N + 45 kg S ha-1 recorded the maximum number of filled grains per panicle and was found to be at par with treatment 80 kg N + 30 kg S ha-1 (Table 5). It is attributed to more availability of nitrogen and sulphur to rice crop. Similar results have been obtained by Abd EL-Hamed (2002) and Sorour *et al*. (2016). This might be also be due to the fact that N and S supply was found to increase the photo assimilation of carbon and also promoted assimilates to rice panicles. Same findings were also reported by Ahmed *et al*. (2005), Yoon *et al*. (2012) and Tanweer *et al*. (2014).

**Yield**

The data presented in Table 6 revealed that N levels and S levels had a significant effect on grain yield, straw yield and biological yield of rice. The grain yield was recorded significantly higher under 120 kg N ha-1 as compared to other treatments while statistically at par with 80 kg N ha-1. This might be due to increased nutrient availability under these treatments which might have resulted in better growth characters and yield contributing characters under. Productivity of a crop is collectively determined by vigor of the vegetative growth, development as well as yield attributes which is the result of better translocation of photosynthates from source to the grains. Similar results have been reported by Rao *et al*. (2014). The rice grain yield was significantly influenced by different levels of sulphur. Application of sulphur at 45 kg ha-1 produced significantly higher grain yield as compared to other levels and was at par with treatment 30 kg S ha-1. It is attributed to more panicle no., filled grains and highest 1000 grain weight and these characters are correlated to yield and also increased the grain yield. Similar findings are also reported by Priyanka *et al*. (2013). Increase in yield due to sulphur fertilizer application could also be attributed to its important role in the synthesis of proteins and S containing amino acids as well as enhanced photosynthetic activity of the plant by increased chlorophyll synthesis.

Straw yield and biological yield were influenced significantly by different levels of nitrogen application (Table 6). Maximum straw yield and biological yield was recorded under 120 kg N ha-1 and was at par with treatment 80 kg N ha-1. This might be due to higher plant height and hence increased dry matter production. Similar findings were reported by Kumar and Singh (1998).Straw yield and biological yield were influenced significantly by different levels of sulphur application. Maximum straw yield was recorded under 45 kg S ha-1 and was at par with treatment 30 kg S ha-1. It is attributed due to more plant height and more dry matter was accumulated in these treatments which increased the straw yield of rice. Same findings were also reported by Kumar *et al*. (2012) and Priyanka *et al*. (2013). The biological yield was recorded highest in treatment 45 kg S ha-1 and was at par with treatment 30 kg S ha-1. It is attributed due to more grain and straw yield which ultimately increased the biological yield. These results are in conformity with Priyanka *et al*. (2013) and Tanweer *et al*. (2014).

Harvest index was influenced significantly due to different nitrogen levels (Table 6). The higher harvest index was recorded with 80 kg N ha-1 (45.06 %), due to higher grain yield of rice per unit biological yield, led higher harvest index. The results are in conformity with Choubey *et al*. (2018). The maximum harvest Index was recorded in treatment 45 kg S ha-1 and was at par with treatment 30 kg S ha-1. It is attributed due to more economic yield was recorded in these treatments; harvest index shows the physiological efficiency of plants to convert the fraction of photo- assimilation to grain yield. Higher the harvest index is, greater will be the grain yield of crop. Same findings also reported by Ponnamperuma and Deturck (1993).

**Interaction of nitrogen and sulphur on grain yield (t/ha)**

Regarding the interaction effect between nitrogen and sulphur on grain yield of rice. The combined application of N with S increased on average the grain yield respectively, compared to the control (N0S0). The highest significant grain yield was obtained when nitrogen at 80 kg N ha-1 was combined with sulphur at 45 kg ha-1 (Table 7). This could be attributed due to the fact that sulphur is reported to enhance the photosynthetic assimilation of N in crop plants (Anderson, 1990; Ahmad and Abdin, 2000). Hence, the application of N and S fertilizers increases the net photosynthetic rate in crop plants, which in turn increases their dry matter and grain yield, as 90% of the plant’s dry weight is considered to be derived from products formed during photosynthesis. Peoples *et al*. (1980).

**Relative economics**

The efficiency of a treatment or a combination of treatments is finally decided in terms of the economics (benefit: cost) of the treatments. The cost of cultivation was registered highest (46959.7 Rs ha-1) respectively, with the application of 120 kg N + 45 kg S ha-1 (Table 8). This is attributed due to the high dose of fertilizers and labor cost. The net returns and B: C ratio increased with increasing the levels of nitrogen and sulphur. The maximum net returns (104650.60 Rs ha-1) was recorded under treatment N3S3 (120 kg N + 45 kg S ha-1) and the maximum B: C ratio (2.23) was recorded under treatment N2S2 (80 kg N + 30 kg S ha-1) and was statically at par with treatment N3S3. The higher benefit cost ratio in the case of application at 80 kg N +30 kg S ha-1 is due to lower cost of cultivation, low cost of fertilizers and also due to higher grain and straw yield in the above treatments. The combined application of nitrogen and sulphur increases the grain yield, straw yield, and quality which ultimately increases the gross returns and net returns. The results were in line with the results of Jeet *et al*. (2013).

**Conclusion**

The existing recommended dose of nitrogen in rice variety ‘Shalimar rice-4’ is 120 kg N ha-1 in Kashmir valley. From the findings of present study the nitrogen dose can be reduced to 80 kg N ha-1 with 30 kg S ha-1, results in 33 percent saving of nitrogen in rice. However, for final recommendation, the experimental findings should be validated on other location of Kashmir valley. The reduced application will reduce losses of different forms of nitrogen to surface water, ground water and to atmosphere.

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**Table 1: Plant height (cm) of Rice as influenced by graded levels of nitrogen and Sulphur**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Treatments** | **15 DAT** | **30 DAT** | **45 DAT** | **60 DAT** | **75 DAT** | **90 DAT** | **105 DAT** | **Harvest** |
| **N0** | 23.68 | 37.53 | 54.81 | 78.47 | 92.24 | 98.93 | 99.98 | 100.07 |
| **N60** | 26.25 | 43.47 | 61.98 | 85.13 | 98.07 | 107.03 | 108.64 | 109.12 |
| **N80** | 28.08 | 46.93 | 67.95 | 91.52 | 105.31 | 113.19 | 115.96 | 116.60 |
| **N120** | 30.33 | 48.47 | 71.02 | 93.97 | 107.50 | 115.21 | 117.48 | 118.24 |
| **SE(m)±** | 0.57 | 0.40 | 0.72 | 0.63 | 0.76 | 0.80 | 0.78 | 0.83 |
| **CD(p≤0.05)** | **1.64** | **1.16** | **2.10** | **1.82** | **2.02** | **2.12** | **2.03** | **2.41** |
| **S0** | 24.42 | 39.23 | 58.35 | 80.32 | 93.84 | 101.16 | 102.38 | 103.09 |
| **S15** | 26.17 | 43.67 | 62.50 | 85.59 | 98.49 | 106.96 | 108.72 | 108.80 |
| **S30** | 28.08 | 45.58 | 66.95 | 91.65 | 103.77 | 111.89 | 114.01 | 115.16 |
| **S45** | 29.67 | 46.92 | 68.96 | 92.57 | 106.02 | 114.36 | 116.01 | 116.98 |
| **SE(m)±** | 0.57 | 0.40 | 0.72 | 0.63 | 0.76 | 0.80 | 0.78 | 0.83 |
| **CD(p≤0.05)** | **1.64** | **1.16** | **2.10** | **1.82** | **2.02** | **2.12** | **2.03** | **2.41** |

**Table 2: Leaf area index of rice as influenced by different graded levels of**

**nitrogen and sulphur**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Treatments** | **15 DAT** | **30 DAT** | **45 DAT** | **60 DAT** | **75 DAT** | **90 DAT** |
| **N0** | 0.13 | 0.45 | 1.50 | 3.83 | 2.89 | 2.31 |
| **N60** | 0.16 | 0.53 | 1.83 | 4.01 | 3.07 | 2.55 |
| **N80** | 0.21 | 0.64 | 2.13 | 4.39 | 3.56 | 3.07 |
| **N120** | 0.23 | 0.74 | 2.29 | 4.57 | 3.75 | 3.19 |
| **SE(m)±** | 0.007 | 0.02 | 0.09 | 0.10 | 0.09 | 0.08 |
| **CD(p≤0.05)** | **0.03** | **0.05** | **0.21** | **0.32** | **0.23** | **0.20** |
| **S0** | 0.11 | 0.44 | 1.51 | 3.84 | 2.87 | 2.32 |
| **S15** | 0.14 | 0.51 | 1.80 | 4.02 | 3.04 | 2.52 |
| **S30** | 0.20 | 0.63 | 2.14 | 4.34 | 3.58 | 3.09 |
| **S45** | 0.22 | 0.72 | 2.25 | 4.53 | 3.72 | 3.17 |
| **SE(m)±** | 0.007 | 0.02 | 0.09 | 0.10 | 0.09 | 0.08 |
| **CD(p≤0.05)** | **0.03** | **0.05** | **0.21** | **0.32** | **0.23** | **0.20** |

**Table 3: Yield attributes of Rice as influenced by different graded levels**

**of nitrogen and sulphur**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Treatments** | **Panicle no m-2** | **Panicle length(cm)** | **Spikelets / Panicle** | **Filled Grains / panicle** | **Sterility Percentage (%)** | **Test weight (g)** |
| **N0** | 210.12 | 17.59 | 90.12 | 57.81 | 35.21 | 19.63 |
| **N60** | 243.12 | 18.82 | 98.47 | 84.02 | 15.12 | 21.87 |
| **N80** | 313.65 | 21.32 | 113.57 | 98.19 | 13.50 | 24.22 |
| **N120** | 325.77 | 23.40 | 133.58 | 100.38 | 24.84 | 26.33 |
| **SE(m)±** | 2.94 | 0.71 | 1.86 | 1.76 | 2.51 | 1.05 |
| **CD(p≤0.05)** | **8.52** | **2.05** | **5.41** | **5.12** | **7.28** | **3.09** |
| **S0** | 211.06 | 17.96 | 94.87 | 70.85 | 25.30 | 20.05 |
| **S15** | 243.32 | 18.53 | 104.77 | 79.70 | 23.91 | 21.92 |
| **S30** | 316.19 | 20.63 | 115.19 | 93.34 | 19.26 | 23.78 |
| **S45** | 322.09 | 22.70 | 120.92 | 96.51 | 20.20 | 25.29 |
| **SE(m)±** | 2.94 | 0.71 | 1.86 | 1.76 | 2.51 | 1.05 |
| **CD(p≤0.05)** | **8.52** | **2.05** | **5.41** | **5.12** | **NS** | **3.09** |

**Table 4: Interaction of nitrogen and sulphur on panicle number m-2 as influenced**

**by nitrogen and sulphur**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **S0** | | | **S15** | | **S30** | | **S45** | **Mean** |
| **N0** | 158.50 | | | 181.45 | | 247.71 | | 252.83 | 210.12 |
| **N60** | 162.70 | | | 221.87 | | 289.97 | | 297.92 | 243.12 |
| **N80** | 258.98 | | | 274.66 | | 355.83 | | 365.13 | 313.65 |
| **N120** | 264.05 | | | 295.29 | | 371.26 | | 372.46 | 325.77 |
| **Mean** | 211.06 | | | 243.32 | | 316.19 | | 322.09 |  |
| **Factors** | | **CD(p≤0.05)** | | | **SE(m)** | |
| **Factor A (Nitrogen)** | |  | **8.52** | | 2.94 | |
| **Factor B (Sulphur))** | |  | **8.52** | | 2.94 | |
| **Factor(A X B)** | |  | **17.05** | | 5.88 | |

**Table 5: Interaction of nitrogen and sulphur on filled grains per panicle**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **S0** | **S15** | **S30** | **S45** | **Mean** |
| **N0** | 53.88 | 55.36 | 59.06 | 62.92 | 57.81 |
| **N60** | 64.69 | 74.93 | 93.63 | 102.81 | 84.02 |
| **N80** | 78.01 | 95.39 | 111.02 | 108.34 | 98.19 |
| **N120** | 86.82 | 93.12 | 109.63 | 111.96 | 100.38 |
| **Mean** | 70.85 | 79.70 | 93.34 | 96.51 |  |

|  |  |  |  |
| --- | --- | --- | --- |
| **Factors** | **CD(p≤0.05)** | | **SE(m)** |
| **Factor A (Nitrogen)** |  | **5.12** | 1.76 |
| **Factor B (Sulphur))** |  | **5.12** | 1.76 |
| **Factor(A X B)** |  | **10.24** | 3.53 |

**Table 6: Yield of rice as influenced by different levels of nitrogen and sulphur**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Treatments** | **Grain Yield t/ha** | **Straw Yield t/ha** | **Biological Yield t/ha** | **Harvest Index** |
| **N0** | 3.35 | 6.03 | 9.38 | 35.81 |
| **N60** | 5.49 | 7.57 | 13.07 | 41.67 |
| **N80** | 7.69 | 9.11 | 16.80 | 45.06 |
| **N120** | 7.86 | 10.63 | 18.50 | 42.77 |
| **SE(m)±** | 0.35 | 0.51 | 0.69 | 1.86 |
| **CD(p≤0.05)** | **1.02** | **1.48** | **1.99** | **5.39** |
| **S0** | 4.46 | 6.46 | 10.92 | 40.34 |
| **S15** | 5.61 | 8.04 | 13.65 | 40.95 |
| **S30** | 6.81 | 9.26 | 16.07 | 41.57 |
| **S45** | 7.52 | 9.59 | 17.10 | 43.14 |
| **SE(m)±** | 0.35 | 0.51 | 0.69 | 1.86 |
| **CD(p≤0.05)** | **1.02** | **1.48** | **1.99** | **NS** |

**Table 7: Interaction of nitrogen and sulphur on Grain Yield t** **ha-1**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **S0** | | | **S15** | | **S30** | | **S45** | **Mean** |
| **N0** | 3.08 | | | 3.11 | | 3.46 | | 3.72 | 3.34 |
| **N60** | 3.45 | | | 4.33 | | 6.54 | | 7.64 | 5.49 |
| **N80** | 4.74 | | | 6.80 | | 8.93 | | 10.30 | 7.69 |
| **N120** | 6.56 | | | 8.20 | | 8.28 | | 8.39 | 7.86 |
| **Mean** | 4.46 | | | 5.61 | | 6.80 | | 7.51 |  |
| **Factors** | | **CD(p≤0.05)** | | | **SE(m)** | |
| **Factor A (Nitrogen)** | |  | **1.06** | | 0.35 | |
| **Factor B (Sulphur))** | |  | **1.07** | | 0.35 | |
| **Factor(A X B)** | |  | **2.03** | | 0.69 | |

**Table 8: Relative economics of rice as influenced by nitrogen and sulphur**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Treatments** | **COC** | **Gross** | **Net Returns** | **B.C** |
| **N0S0** | 44491.0 | **56153.7** | 11662.70 | 0.26 |
| **N0S1** | 44894.2 | 59206.3 | 14312.10 | 0.32 |
| **N0S2** | 45297.5 | 67231.7 | 21934.20 | 0.48 |
| **N0S3** | 45700.7 | 71161.7 | 25461.00 | 0.56 |
| **N1S0** | 44967.5 | 64044.3 | 19076.80 | 0.42 |
| **N1S1** | 45370.7 | 80312.7 | 34942.00 | 0.77 |
| **N1S2** | 45773.9 | 113024.7 | 67250.80 | 1.47 |
| **N1S3** | 46177.1 | 128261.0 | 82083.90 | 1.78 |
| **N2S0** | 45228.3 | 85939.2 | 40710.90 | 0.90 |
| **N2S1** | 45631.6 | 117801.9 | 72170.30 | 1.58 |
| **N2S2** | 46034.8 | 148747.9 | 102713.10 | **2.23** |
| **N2S3** | 46438.0 | 147811.9 | 101373.90 | 2.18 |
| **N3S0** | 45750.0 | 111205.7 | 65455.70 | 1.43 |
| **N3S1** | 46153.3 | 140753.7 | 94600.40 | **22. 2.05** |
| **N3S2** | 46556.5 | 147173.3 | 100616.80 | 2.16 |
| **N3S3** | 46959.7 | 151910.3 | 104650.60 | 2.22 |