

Original Research Article

“Influence of Phosphorus and Bio-fertilizers on growth and yield of Black gram(*Phasiolusmungo*L.)”

ABSTRACT

The field experiment was conducted during *kharif*2022 at the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology And Sciences, Prayagraj (U.P.) to determine the “Effect of Phosphorus and Bio -fertilizer on growth and yield of black gram(*Phasiolusmungo* L)”. The results showed that treatment -9[Phosphorus -50kg/ha+Rhizobium +PSB] significantly higher plant height (45.69cm), higher number of nodules/ plant (38.15), higher plant dry weight (6.64g), higher Crop growth rate (2.99 g/m²/day) , higher number of pods/plant (40.8), maximum number of seeds/pod(6.23), higher test weight (34.75gm), higher seed yield (1371kg/ha) ,higher stover yield (2980kg/ha) , Maximum gross return (INR89,290.00/ha), Maximum net return (INR60,797.00/ha) and highest B:C ratio (2.13) was also recorded in treatment-9[Phosphorus 50 kg/ha + Rhizobium+ PSB] as compared to other treatments

Keywords: *Black gram, Phosphorus, Bio-fertilizers, growth parameters, yield attributes and Economics.*

INTRODUCTION

Pulses stand a strategic position in the agriculture economy of our country. They contain high percentage of quality protein three times more than cereals. Pulses contain vitamin B, minerals and contain a certain quality fibre, which is desirable in human diet because of medical consideration. Pulse crops enrich the soil through symbiotic nitrogen fixation from atmosphere. Besides being a rich source of protein, they maintain soil fertility through biological nitrogen fixation in soil and thus, play a vital role in sustainable agriculture.

Black gram is third most important pulse crop grown under rainfed, rice fallow, irrigated

conditions and during kharif, rabi and summer seasons, which matures in 90-100 days and it, enriches soil with nitrogen. India is major producer and consumer of blackgram. It is used for preparation of different food **Sivasubramanian et al. (2015)**, with rice flour.

Pulses are “Marvel of Nature” because of their drought resistance and ability to soil erosion due to deep root structure and good ground covering . Which contains 24 % protein, 60 % carbohydrate, 1.3 % fat, 3.2 % minerals, 0.9 % fibre, 154 mg Ca, 385 mg P, 9.1 mg Fe and small amount of vitamin-B complex. It is rich source of vitamins like A, B1, B3 and has small amount of thiamine, riboflavin, niacin, and vitamin C. It contains 78% to 80% nitrogen in the form of albumin and globulin.

The global black gram market size reached 3.4 million Tons in 2022. Looking forward to expects the market to reach 5.0 million Tons by 2028, exhibiting a growth rate (CAGR) of 6.5% during 2023-2028. India is its primary origin and is mainly cultivated in Asian countries including Pakistan, Myanmar, and parts of Southern Asia. India is the world's largest producer as well as consumer of blackgram. It produces about 23.4 lakhtonnes of blackgram annually from 46.7 lakh hectares of area, with an average productivity of 501Kg per hectare in 2020-21. Black gram area accounts for about 15.7 per cent of India's total pulse acreage and contributes 9.09 per cent of total pulse production. The major Kharif growing states are Uttar Pradesh 6.99 lakh ha, Odisha 1.66 lakh ha, Chhattisgarh 1.3 lakh ha and Telangana 0.119 lakh ha . According to 4th Advance Estimates of Production of Food grains for 2021-22, all India Black gram production estimate was 2.84 million tonnes as against 2.23 million tonnes in 2020-21. (**GOI, 2021**).

Despite of these features, the productivity of this crop is below the average owing to several constraints. The major reason for the low productivity of black gram in the country, apart from natural constraints, is due to supply imbalance use of nutrients. Proper fertilization is essential to improve the productivity of blackgram. It can meet its nitrogen requirements by symbiotic fixation of atmospheric nitrogen. The nutrient which needs attention is Phosphorus.

Phosphorus deficiency in soil is widespread and crops grown under deficient situation show significant response to fertilizer phosphorus. At several places normal yield of crops could not be achieved despite judicious use of NPK fertilizers due to deficiency of micronutrients in soil, in general, that of Zn in particular. The knowledge regarding the use of optimum dose of nutrients especially Phosphorus and Zinc is of serious concern **Rathore et al. (2014)**. Biofertilizers deficiency is usually the most important single factor which is responsible for

poor yield of pulses on all soils. It is a major constituent of protein and nucleic acids. The cost of nitrogenous and phosphatic fertilizers are increasing day by day hence, it is required to use some cheaper source of fertilizers like Rhizobium and phosphatic solubilizing bacteria etc. Bio-fertilizers like Rhizobium and phosphate solubilizing bacteria plays an important role in increasing availability of nitrogen and phosphorus through increase in biological fixation of atmospheric nitrogen and enhanced phosphorus availability to the crop **Abhishali&Debbarama, (2023)**

Phosphorous is one of the most important elements significantly affecting the plant growth and metabolism. In legumes, the high requirement for P is consistent with the involvement of P in high rates of energy transfer that take place in the nodule. Phosphorous has also an enhancing impact on growth and biological yield through its importance as energy storage and transfer necessary for metabolic processes” **Singh et al. (2014).**

“Phosphorous addition increases the efficiency of plants photosynthesis, enhances the activity of rhizobia. Phosphorus contributes substantially to increased yield of legumes by enhancing the physiological functions of the crop plants, root development, and nodulation. Phosphorus application not only increases the dry matter and seed yield of black gram but also enhances the N and P content of the seed by increasing nodulation and root development.

Biofertilizers such as (PSB solubilise insoluble soil phosphates like tri-calcium phosphates and produce plant growth substances in soil. Among various bio-fertilizers Rhizobium is of paramount importance. Rhizobium fixes atmospheric nitrogen symbiosis with legumes. PSBinoculation showed more available phosphorus in soil, which favoured better root growth and resulted in a beneficial effect of nodulation with increased PSB bacterial activity. For maximizing the yield, it is essential that green gram should not suffer due to inadequate mineral nutrient especially nitrogen and phosphorus. Since chemical fertilizers are scarce and costly, it is necessary to use them economically in combination with bio fertilizers, as green gram shows high response to bio fertilizers. Phosphorus plays a key role in various physiological processes concerning root and dry matter production, nodulation and N₂ fixation and also in metabolic activities especially in protein synthesis **Bhatt et al. (2013).**

Introduction of efficient strain of Rhizobium in the soil poor in nitrogen may be helpful in boosting up the production through more nitrogen fixation. Phosphorus solubilizing bacteria as inoculants in the root zone of crop plants partially solubilize the insoluble

phosphate and improve the phosphorus use efficiency and the productivity. Mineral nutrition plays a vital role not only in exploiting the realizable potential of the crop, but also to maintain the sustainability of soil for agricultural production. Due emphasis on nutritional part is very essential. Fertilizer and its management is one of the important cost effective agronomic factors to augment the production. The degree of response of the crop to fertilizer application depends on fertility status of the soil. Inadequate or excess supply of any plant nutrient limits the crop production. Keeping these points in view, the present study entitled “**Influence of Phosphorus and Bio-fertilizers on growth and yield of Blackgram (*Vigna mungo* L.)**”, was conducted at Crop Research Farm, Department of Agronomy, Naini Agriculture Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, Uttar Pradesh during *Kharif* season of 2022.

Comment [DAL1]: Very long Introduction! Please give an essential informations!

Materials and Methods

The experiment was conducted during *Kharif* of 2022, Crop Research Farm, Department of Agronomy, Naini Agriculture Institute, Sam Higginbottom University of Agriculture Technology And Sciences, Prayagraj, Uttar Pradesh. Which is located at 25.24° 42' N latitude, 81° 50' 56" E longitude and 98m altitude above the mean sea level (SL). The experiment was conducted in Randomized Block Design with 10 treatments each replicated thrice. The plot size of each treatment was 3m x 3m. Factors are three levels of Phosphorus (30, 40, 50 kg/ha) and the Bio-fertilizers are Rhizobium -20g/kg seeds, PSB - 20g/kg seeds, Rhizobium(10g) +PSB (10g)/kg seeds. The Blackgram crop was sown on 20 June 2022 by maintaining a spacing of 30 cm × 10 cm. Harvesting was done by taking 1m² area from each plot. And from it five plants were randomly selected for recording growth and yield parameters. The treatment details are as follows, T1 – [Phosphorus (30kg/ha) + Rhizobium], T2 – [(Phosphorus (40kg/ha) + Rhizobium] , T3 – [Phosphorus (50kg/ha) + Rhizobium] T4 – [Phosphorus (30 kg/ha) + PSB], T5 – [(Phosphorus (40kg/ha) + PSB], T6 – [(Phosphorus (40kg/ha) +PSB], T7 – [Phosphorus (30 kg/ha)+ Rhizobium +PSB], T8 – (Phosphorus (40 kg/ha) +Rhizobium + PSB], T9 – [Phosphorus -50 kg/ha + Rhizobium +PSB], and Control Plot. The observations were recorded for plant height, dry weight, number of nodules/plant, Crop growth rate, number of pods/plant, number of seeds/pod, test weight, seed yield and stover yield. The data was subjected to statistical analysis by analysis of variance method (Gomez and Gomez (1976)).

Comment [DAL2]: Which what software??? Please give the details for data analysis

Results and Discussion

Growth parameters:

Plant height–The result revealed that significantly higher Plant height (45.69 cm) was recorded with the treatment-9 [Phosphorus -50kg/ha+Rhizobium+PSB] over the other treatments. However, treatments -6[Phosphorous 50 kg/ha+ PSB] and treatment -8[Phosphorus -40kg/ha+Rhizobium+PSB] were found to be statistically at par with treatment-9 [Phosphorus -50kg/ha+Rhizobium+PSB] (Table-1). Significant and higher plant height was observed with application of biofertilizer PSB and Rhizobium might be due to better uptake and translocation of plant nutrients. Similar results were reported by **Yadav et al. (2017)**. Further, increased in plant height with application of phosphorous-50kg/ha. it might be due to formation of new cells, promote plant vigour and hastens leaf development, which help in harvesting more solar energy and better utilization of nitrogen, which help towards higher growth attributes. Similar result was reported by **Mir et al. (2013)**.

Number of nodules/plant –The result revealed that significantly higher number of nodules/plant (9.61) was recorded with the treatment-9 [Phosphorus -50kg/ha+Rhizobium +PSB] over the other treatments. However, treatments -6[Phosphorous 50 kg/ha+ PSB] and treatment-8[Phosphorus -40kg/ha+Rhizobium +PSB] were found to be statistically at par with treatment-9 [Phosphorus -50kg/ha+Rhizobium+PSB] (Table-1). Significant and higher number of nodules/plant was recorded with the application of Rhizobium, might be due to more competitive availability of microbes near roots which is the site for microbial infection and well-developed root system provides more evidence for maximum Number of nodules/plant. Similar results were reported by **Hussain et al. (2015)**. Further, increase in number of nodules/plant with application of Phosphorus (50kg/ha), may be due to influenced the protein formation leads to increase number of nodules. Similar results were conformity with **Kachave et al. (2018)**

Plant dry weight(g/plant)-The result revealed that the treatment-9 [Phosphorus -50kg/ha+Rhizobium(10g) +PSB(10g)] recorded significantly higher dry weight/plant (6.64 g/plant) However, treatment -8[Phosphorus -40kg/ha+Rhizobium+PSB] were found to be statistically at par with treatment-9 [Phosphorus -50kg/ha+Rhizobium +PSB](Table-1) it might be due to chief constituent of lipoids and nucleoproteins, an abundance of phosphorus in meristematic region might have helped in cell division and multiplication and it is also concerned carbohydrates, transformation and nitrogen fixation and hence boosted plant growth. Similar results were reported by **parshare et al. (2020)**. Further,

plant dry weight increased due to application of PSB may be due to strains released greater amounts of available P and this enable the plant to absorb more P resulting in improved growth attributes. similar result was reported by **Kachaveet al. (2018)**.

Crop Growth Rate(g/m²day) -The result revealed that significantly higher Crop growth rate (2.99 g/m²/day) was observed in treatment -9 [Phosphorous(50 kg/ha)+Rhizobium + PSB]. However, treatment -8 [Phosphorous(40 kg/ha)+Rhizobium +PSB] (2.79 g/m²/day) were found statistically par with treatment -9 [[Phosphorous (50 kg/ha)+Rhizobium+ PSB](Table-2). Significant and higher crop growth rate was recorded with the application of PSB might be due to better accumulation of dry matter throughout the plant's vegetative and reproductive phase, which enhances the physiological and metabolic activity and growth by assimilating the available nutrients at higher rate on growth parameters and facilitating more photosynthesis, resulting in higher crop growth rate. similar result was reported (**Gupta et al., 2006**)

YIELD ATTRIBUTES:

Number of pods/plant - The result revealed that significant and higher Number of Pods/Plant (40.08) were observed in treatment -9 [Phosphorus -50kg/ha+Rhizobium +PSB]. However, the treatment -8 [Phosphorus -40kg/ha+Rhizobium+PSB] were found to be statistically at par with treatment-9 [Phosphorous(50 kg/ha +Rhizobium+ PSB) (Table-2). The significant and higher number of pods/plant were observed with application of rhizobium, this might be due to enhanced nitrogen fixation, thereby increasing the availability of plant efficient growth and development, particularly number of pods/plant. Similar result was concluded by **Kumar et al. (2010)**. Further, maximum number of pods/plant with application of Phosphorous (50kg/ha) may be due to better root proliferation, higher root development, increased availability and uptake of nutrients energy transformation and metabolic processes in plant. Similar results lined with by **Hussain et al. (2011)**.

Number of seeds/pod—The Significantly and higher number of seeds/pod (6.23) were recorded in treatment-9 [Phosphorus (50kg/ha)+Rhizobium+PSB]. However, the treatment -8 [Phosphorus (40kg/ha) +Rhizobium +PSB] was found to be statistically at par with treatment-9 [Phosphorous(50kg/ha)+Rhizobium+ PSB](Table-2). The significant and higher number of seeds/pod were observed with application of rhizobium might be due to

the increased nodulation, extensive root system, and the greater production of metabolites and their translocation to various sinks especially the productive structures (pods and seeds) might have helped to increase into the number of pods/ plant besides increasing the overall growth. Similar results were reported by **Ghansyam et al. (2010)** in green gram. Further, maximum number of seeds/pod was observed with the application of phosphorus(50kg/ha) may be due to the increase in phosphorus fertilization in ensuring availability of other plant nutrients which increased carbohydrate accumulation and their remobilization to reproductive parts of the plant, being the closest sink. Phosphorus is known to encourage flowering and fruiting which might have stimulated the plants to produce more pods/ plant and enables development of a greater number of seeds/pod. Similar findings were reported by **Shah et al. (2000)**.

Test Weight (gm)–The significantly and higher Test Weight (34.75 g) was observed in treatment-9 [Phosphorus (50kg/ha)+Rhizobium +PSB] over the other treatments. However, treatment -8 [Phosphorus(40kg/ha)+Rhizobium+PSB] were found to be statistically at par with treatment-9 [Phosphorus -50kg/ha+Rhizobium+PSB](Table-2). Significant and maximum test weight was observed with application of PSB might be due to the yield attributing character because of beneficial effect of PSB along with basal application of phosphorus helps in development of extensive root system to extract more water and nutrient from soil thus resulting in better plant growth and yield attributes similar results was reported by **Pramanik and Singhet al.(2003)** in cowpea. Further, the increase in test weight observed with the application of phosphorus(50kg/ha) may be due to the increases the symbiotic nitrogen fixation power and in turn, increased number of pods/plant, Length of pod, number of grain/ pod and test weight and ultimately grain yield. Similar result was reported by **Parasharet al. (2020)**.

Seed Yield (kg/ha) –The significantly and higher Seed yield (1371 kg/ha) was observed in treatment-9[Phosphorus -50kg/ha+Rhizobium+PSB]. However, the treatment -8 [Phosphorus (40kg/ha)+Rhizobium +PSB] was found to be statistically at par with treatment-9[Phosphorus(50kg/ha) +Rhizobium+PSB](Table-2). Significant and higher seed yield was observed with the application Phosphorus (50kg/ha) might be due to it increases the photosynthesis and translocation of assimilates to different plant parts for enhanced growth and yield attributing characters of the crop as observed in number of pods/plant and number of seeds/ pods, which later stage, the excess assimilates stored in the leaves was translocated towards sink development which ultimately contributed to higher seed

yield. Similar results were reported by Yumna *et al.* (2017). Further, the increase in seed yield with the application Rhizobium may be due to the bio-fertilizer have attributed to supply of more plant hormones (auxin, cytokinin, gibberellin etc.) by the microorganisms inoculated or by the root resulting from reaction to microbial population. Similar results were in conformity with Umamaheswari *et al.* (2001) in green gram.

Stover Yield (t/ha)– The significantly and higher Stover yield (2980 kg/ha) was recorded in treatment -9 [Phosphorus -50kg/ha+Rhizobium + PSB]. However, the treatment -8 [Phosphorus -40kg/ha+Rhizobium +PSB] was found to be statistically at par with treatment-9 [Phosphorous (40 kg/ha)+Rhizobium + PSB] (Table-2). Significant and higher stover yield was observed with application Phosphorous (50kg/ha) might be due to the increased growth and development in terms of plant height, branches and dry matter by improving nutritional environment of rhizosphere and plant system leading to higher plant metabolism and photosynthetic activity. Similar result was reported by Yadav *et al.* (2017). Further, the increase in stover yield was observed with the application of PSB and Rhizobium may be due to the having higher dry matter accumulation and better root development through phosphorous, resulting into maximum uptake of nutrient and moisture which ultimately lead to higher stover yield. Similar results were reported by Rajesh *et al.* (2013).

ECONOMIC ANALYSIS:

Economics

The result revealed that Maximum gross return (89,290.00 INR/ha), Maximum net return (60,797.00 INR/ha) and highest benefit cost ratio (2.13) was recorded in treatment-9 [Phosphorus (50kg/ha)+Rhizobium +PSB] as compared to other treatments (Table-3). Higher gross Return, net return and benefit cost ratio was recorded with the application of [Phosphorus (50kg/ha) +Rhizobium +PSB] it might be due to the higher growth and yield attributes resulting in more seed and stover yield with the recommended dose of phosphorus. Similar results were reported by Bhat *et al.* (2013) in field pea.

CONCLUSION

Based on the above findings it can be concluded with the application of Phosphorus 50kg/ha along with Rhizobium and PSB has performed better in growth parameters and yield

attributes of and also economically viable . Since the findings are based on one season, further trials are needed to confirm the result |

UNDER PEER REVIEW

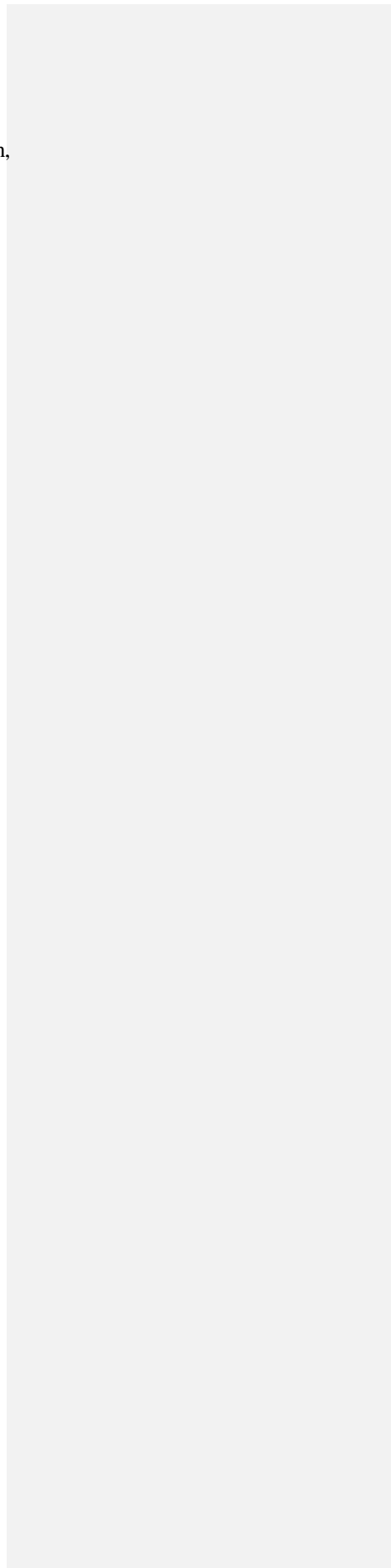


Table 1. Influence of Phosphorus and Bio-fertilizer on growth parameters of Black gram.

| S. No. | Treatment combinations | Plant height | Number of nodules | Plant Dry weight | Crop Growth Rate (g/m ² day) |
|-------------|--|--------------|-------------------|------------------|---|
| 1. | Phosphorus -30kg/ha + Rhizobium | 42.40 | 7.02 | 5.69 | 2.20 |
| 2. | Phosphorus -40kg/ha + Rhizobium | 43.36 | 7.64 | 5.97 | 2.33 |
| 3. | Phosphorus -50kg/ha + Rhizobium | 44.47 | 8.67 | 6.29 | 2.66 |
| 4. | Phosphorus -30kg/ha + PSB | 42.81 | 7.27 | 5.78 | 2.26 |
| 5. | Phosphorus -40kg/ha + PSB | 43.66 | 8.13 | 6.09 | 2.45 |
| 6. | Phosphorus -50kg/ha + PSB | 44.98 | 8.91 | 6.40 | 2.79 |
| 7. | Phosphorus -30 kg/ha + Rhizobium + PSB | 44.12 | 8.47 | 6.16 | 2.56 |
| 8. | Phosphorus -40 kg/ha + Rhizobium + PSB | 45.41 | 9.36 | 6.46 | 2.87 |
| 9. | Phosphorus -50 kg/ha + Rhizobium + PSB | 45.69 | 9.61 | 6.64 | 2.99 |
| 10. | Control (20:40:20 NPK Kg/ha) | 41.52 | 6.75 | 5.44 | 1.93 |
| F test | | S | S | S | S |
| S Em.(±) | | 0.30 | 0.24 | 0.11 | 0.14 |
| CD (P=0.05) | | 0.88 | 0.70 | 0.32 | 0.41 |

Table 2. Influence of Phosphorus and Bio-fertilizer on yield attributes of Blackgram.

| Treatments | Pods/plant | Seeds/pod | Test Weight (g) | Seed Yield (kg/ha) | Stover Yield (kg/ha) |
|---|------------|-----------|-----------------|--------------------|----------------------|
| 1. Phosphorus -30kg/ha + Rhizobium | 27.2 | 4.75 | 32.64 | 942 | 1853.33 |
| 2. Phosphorus -40kg/ha + Rhizobium | 29.5 | 5.06 | 33.11 | 976 | 2173.33 |
| 3. Phosphorus -50kg/ha + Rhizobium | 32.3 | 5.64 | 33.52 | 1035 | 2080.00 |
| 4. Phosphorus -30kg/ha + PSB | 30.6 | 4.90 | 32.74 | 1101 | 2280.00 |
| 5. Phosphorus -40kg/ha + PSB | 34.0 | 5.23 | 33.26 | 1160 | 2333.33 |
| 6. Phosphorus -50kg/ha + PSB | 35.3 | 5.70 | 34.01 | 1209 | 2490.00 |
| 7. Phosphorus -30 kg/ha + Rhizobium + PSB | 37.4 | 5.40 | 33.49 | 1275 | 2573.33 |
| 8. Phosphorus -40 kg/ha + Rhizobium + PSB | 39.3 | 5.90 | 34.33 | 1333 | 2816.67 |
| 9. Phosphorus -50 kg/ha + Rhizobium + PSB | 40.8 | 6.23 | 34.75 | 1371 | 2980.00 |
| 10. Control (20:40:20 NPK Kg/ha) | 28.3 | 4.59 | 32.37 | 965 | 1833.33 |
| F test | S | S | S | S | S |
| S. EM (\pm) | 0.70 | 0.16 | 0.26 | 12.89 | 77.58 |
| CD (P = 0.05) | 2.08 | 0.48 | 0.76 | 38.30 | 230.52 |

Table 3. Influence of Sulphur and silicon economic analysis of rice.

| | Treatments | Cost of cultivation | Gross returns | Net returns | B:C Ratio |
|-----|---------------------------------------|----------------------------|----------------------|--------------------|------------------|
| 1. | Phosphorus -30kg/ha + Rhizobium | 27290 | 61840 | 34550 | 1.27 |
| 2. | Phosphorus -40kg/ha + Rhizobium | 27842 | 64128 | 36286 | 1.30 |
| 3. | Phosphorus -50kg/ha + Rhizobium | 28393 | 67929 | 39536 | 1.39 |
| 4. | Phosphorus -30kg/ha + PSB | 27490 | 71883 | 44393 | 1.61 |
| 5. | Phosphorus -40kg/ha + PSB | 28042 | 75759 | 47717 | 1.70 |
| 6. | Phosphorus -50kg/ha + PSB | 28593 | 78965 | 50372 | 1.76 |
| 7. | Phosphorus -30 kg/ha + Rhizobium +PSB | 27390 | 83025 | 55635 | 2.03 |
| 8. | Phosphorus -40 kg/ha + Rhizobium+ PSB | 27942 | 86618 | 58676 | 2.10 |
| 9. | Phosphorus -50 kg/ha + Rhizobium +PSB | 28493 | 89290 | 60797 | 2.13 |
| 10. | Control (20:40:20 NPK Kg/ha) | 27242 | 63174 | 35932 | 1.32 |

- DATA WAS NOT SUBJECTED TO THE STATISTICAL ANALYSIS

Comment [DAL3]: Must be performed! Are there or not difference between variables or treatment?

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